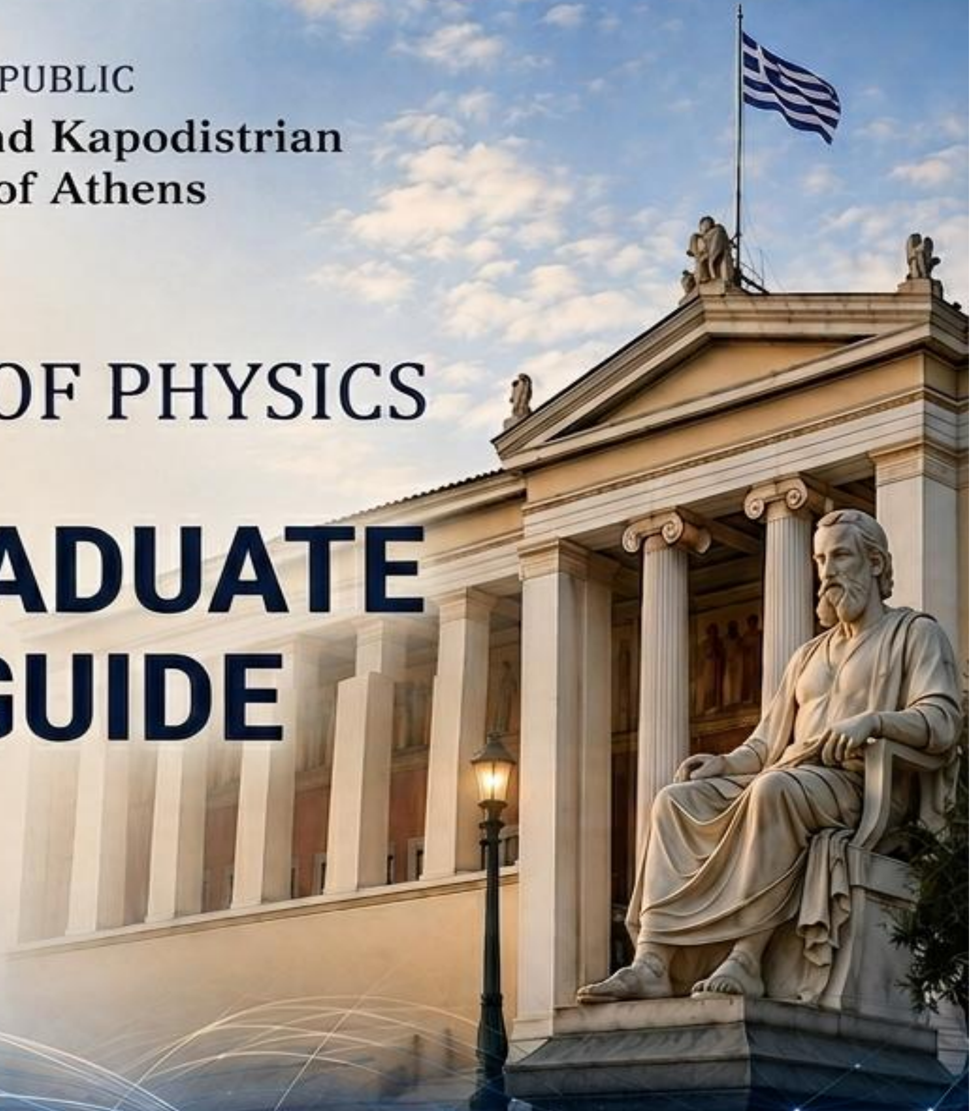
1837-2027
190
YEARS

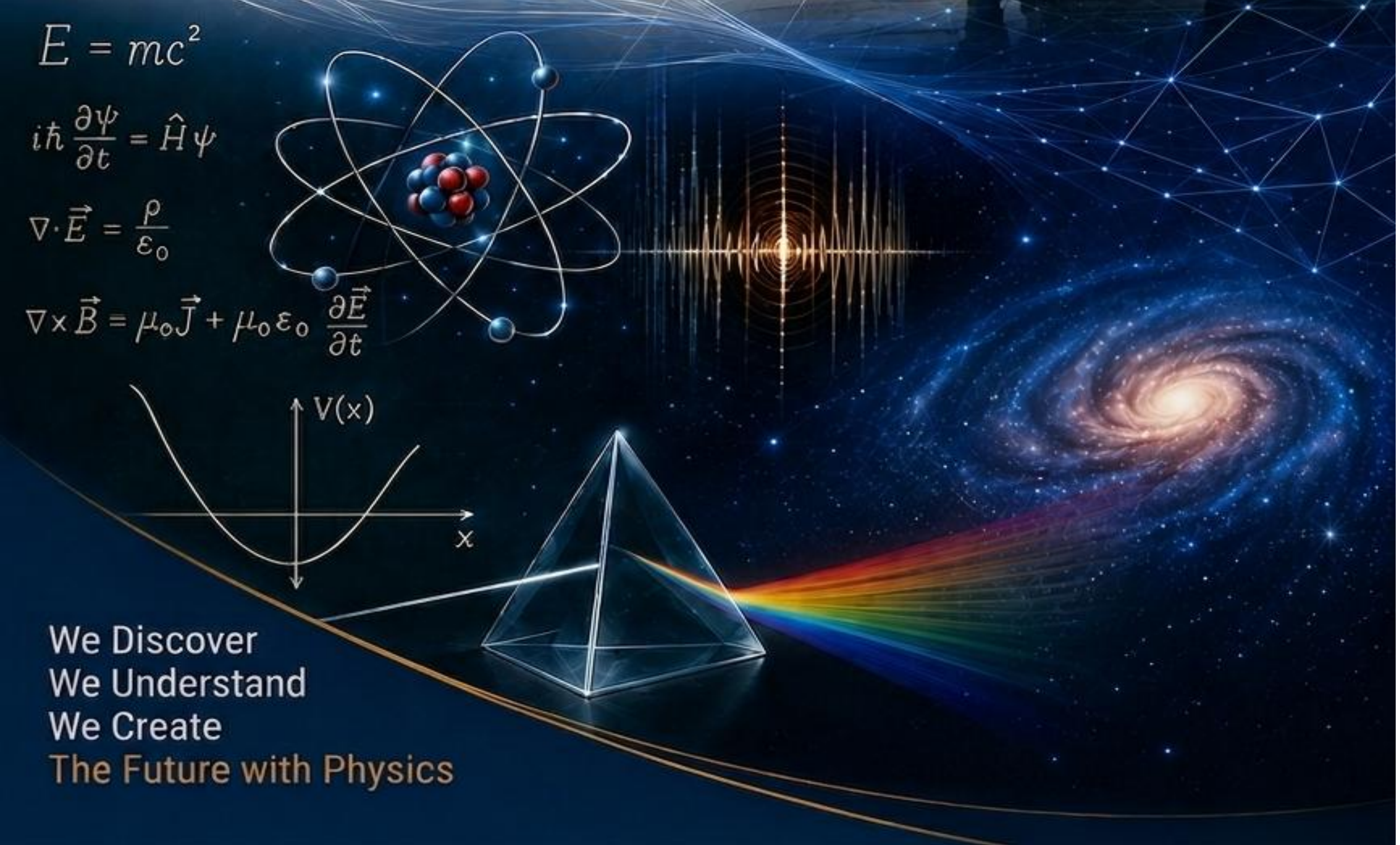
HELLENIC REPUBLIC
National and Kapodistrian University of Athens

DEPARTMENT OF PHYSICS

UNDERGRADUATE STUDIES GUIDE

ACADEMIC YEAR
2026-2027





We Discover
We Understand
We Create
The Future with Physics

The cover was created using artificial intelligence tools.

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1. PREFACE

In an era of rapid technological advances and the remarkable growth of artificial intelligence, the study and understanding of the science of Physics, upon which these developments are based, is more relevant than ever. Although demanding, Physics provides a very strong intellectual foundation, cultivates creativity and the ability to understand the fundamental laws governing our world, while at the same time fostering a scientific and rational way of thinking. These skills and attributes make graduates of Physics Departments highly versatile, enabling them to adapt to new challenges and excel in a wide range of professional and research fields.

The Department of Physics of the National and Kapodistrian University of Athens (NKUA) provides its students with education across a broad spectrum of fields within the science of Physics. The subjects covered by its Sections span a wide range of scales, beginning with the elementary particles of the microscopic world, extending to the properties of organized matter, traversing the planetary scale, and reaching the cosmic and interstellar scales and distant galaxies. A distinctive feature of the Department is the coexistence, both in research and teaching, of fundamental and applied Physics, including Environmental Physics, Electronics Physics, and Medical Physics. Graduating students can specialize and initiate research and professional activities in theoretical and practical areas addressing challenges of contemporary civilization.

The increase in the annual number of graduates from the Department observed in recent years reflects the systematic and effective enhancement of the educational process, the continuous improvement of the curriculum, as well as the support and ongoing commitment to the academic progress of our students.

Supporting our students, both during their studies and after graduation, constitutes a central priority for the Department which is implemented in practice. For this reason, practices of transparency and accountability are implemented, such as the publication of information regarding the educational process and the systematic and timely utilization of course evaluations provided by the students themselves. Our goal is the continuous enhancement of the quality of *studies and the creation of an academic environment that encourages learning, creativity, collaboration, and excellence, while simultaneously strengthening outward orientation through international mobility programmes that broaden students' academic and professional horizons.*

Special mention should be made of the Department's postgraduate programmes, which have received the highest evaluation from the Hellenic Authority for Higher Education (HAHE) and are offered without tuition fees. This choice reflects the Department's long-standing commitment to public, high-quality university education.

Emphasis is also placed on connecting studies at the Department with the meaningful future professional prospects of our graduates. Every year, the Department organizes career orientation events with the participation of scientists, researchers, business executives, and alumni from Greece and abroad, presenting to students the many opportunities available to them: from internationally recognized fundamental and applied research to education, technology, energy, the environment, biophysics, geosciences, machine learning, healthcare, finance, and the management of complex technical systems etc.

At the same time, the Department maintains strong ties with the school community. Every year, thousands of students visit our facilities and attend basic physics laboratory sessions of basic physics performed by our undergraduate students or participate in international competitions, educational activities, and presentations organized by the Department in schools throughout the country. The response of young people to these initiatives is a source of optimism for us, as well as a reminder of our responsibility towards the new generation.

The research activity of the Department constitutes a fundamental pillar of its mission. Its members participate in many competitive national and international research projects, publish in leading scientific journals, and actively contribute to the advancement of scientific knowledge. The publicly available data regarding the number of research projects, publications, and scientific citations reflect the international impact and recognition of the research work produced within the Department.

The Department of Physics of NKUA holds a leading position within the Greek academic community and maintains a strong presence in the global scientific arena. According to the most objective international academic rankings and evaluations, it is consistently ranked as the leading Physics Department in Greece, while it is continuously placed among the best Physics Departments worldwide, based on its scientific and educational achievements across its fields of specialization. This distinction provides, in practice, the opportunity for its graduates to obtain a highly respected degree with substantial prospects and broad choices for a successful research and professional career, in Greece and abroad, according to their aspirations, decisions, and personal choices.

Hector Nistazakis, Professor

Chair of the Department of Physics NKUA

2. THE UNIVERSITY

2.1 Academic Units – Administration – Degrees

According to the Greek Constitution and current legislation, the National and Kapodistrian University of Athens (NKUA), a Higher Education Institution, is a fully self-governing legal entity under Public Law, and is supervised and subsidized by the Greek state through the Ministry of Education, Religious Affairs and Athletics.

The basic academic unit of the University is a Department, which covers a single field of knowledge. Departments within a related set of fields comprise a School. In the case at hand, the Department of Physics is one of the departments in the School of Science, which also includes (in alphabetical order) the Departments of Aerospace Science and Technology, Biology, Chemistry, Digital Industry Technologies, Geology and Geoenvironment, History and Philosophy of Science, Informatics and Telecommunications, and Mathematics. Departments are divided into Sections. Each Section coordinates the educational and research activities that correspond to a specific, usually specialized, field of knowledge.

The administration of the University is exercised by the Governing Council, the Senate, the Rector and Vice-Rectors, and the Executive Director. The governing bodies at the School level are the Dean and the Dean's Council; at the Departmental level, it is the Department Chair and the Departmental Assembly; at the Section level, it is the Section Director and the corresponding Section Assembly.

Upon successful completion of their undergraduate curriculum, Departments in the School of Science grant a "ptyhion", which is equivalent to a four-year BSc. Postgraduate programs are organized by one or more Departments or Universities with the corresponding studies leading to Specialization Diplomas (equivalent to a MSc) and doctoral degrees.

Governing Council of NKUA

- **Rector-President of the Governing Council**
  Gerasimos Siasos, Professor School of Medicine,
  e-mail: gsiasos [at] med.uoa [dot] gr

- **Vice President**
  Nikolaos Thomaidis, Professor, School of Science,
  e-mail: ntho [at] chem.uoa [dot] gr

- **Internal Members**
  1. Spyridon Vlachopoulos, Professor, School of Law,
     e-mail: svlacho [at] law.uoa [dot] gr

2. Dimitrios Kenourgios, Professor, School of Economic and Political Sciences, e-mail: dkenourg [at] econ.uoa [dot] gr
3. Athanasia Smirniotou, Professor, School of Physical Education and Sport Science, e-mail: asmirn [at] phed.uoa [dot] gr
4. Achilleas Chaldæakes, Professor, School of Philosophy, e-mail: axaldaiak [at] music.uoa [dot] gr

- **External Members**
  1. Vasilis Vasiliou, Professor, Yale School of Public Health, e-mail: vasilis.vasiliou [at] yale [dot] edu
  2. Anastasios Germenis, Emeritus Professor, School of Medicine, University of Thessaly, e-mail: agermen [at] med.uth [dot] gr
  3. Irene-Evelyn-Michaela-Mary Sharpe, President Emeritus of the Greek Council of State, e-mail: irenemarysharpe [at] yahoo [dot] gr
  4. Georgios Stasinos, President of the Technical Chamber of Greece, e-mail: president [at] central.tee [dot] gr
  5. Pantelis Tzortzakis, Executive Vice President of the Hellenic Development Bank, e-mail: ptzortz [at] gmail [dot] com

Rector and Vice Rectors of NKUA

- **Rector**

  Professor Gerasimos Siasos

  Tel.: 210 368 9770, 9771, e-mail: rector [at] uoa [dot] gr

- **Vice Rector of Research and Innovation**

  Professor Efstathios Efstathopoulos

  Tel.: 210 368 9786, e-mail: vrec-rd [at] uoa [dot] gr

- **Vice Rector for Academic Affairs, International Relations, and Extroversion**

  Professor Sophia Papaioannou

  Tel.: 210 368 9766, e-mail: vrec-acafir [at] uoa [dot] gr

- **Vice Rector of Finance and Development**

  Professor Aristidis Samitas

  Tel.: 210 368 9764, 9712, e-mail: vrec-fin [at] uoa [dot] gr

- **Vice Rector for Administrative Affairs, Student Welfare, and Lifelong Learning**

  Professor Christos Karagiannis

  Tel.: 210 368 9760, e-mail: vrec-admin [at] uoa [dot] gr

Executive Director of NKUA

Dr. Eleni Vasilopoulou

Tel.: 210 368 9704, e-mail: elvasilop [at] med.uoa [dot] gr

School of Science

- **Dean**

  Professor Aristeidis Parmakelis
  Tel.: 210 727 4736 e-mail: aparmakel [at] biol.uoa [dot] gr

2.2 Staff and Students

The NKUA staff consist of the teaching and research staff, i.e., Professors and Lecturers, special teaching staff, laboratory teaching staff, special technical staff, and administrative personnel.

The University registers two types of students: Undergraduate and postgraduate. Admission of undergraduate students to the Departments of the University and other institutions of higher education is secured through the yearly Panhellenic Examinations, which are held by the Ministry of Education and Religious Affairs. Graduates from one Department can be admitted to another Department after successfully passing qualifying exams organized by the host Department. Admission to graduate programs is achieved through fulfillment of the prerequisites and selection procedures of individual Departments.

In Greece, university Professors of all levels and Lecturers are public officials and, consequently, enjoy functional and personal independence in the execution of their teaching and research work. Their rights, obligations and duties of the faculty are defined individually by each University through the corresponding “Organization”, i.e. the set of rules and regulations pertaining to the operation of the University.

2.3 Facilities and Services for Students

During their studies, students can take advantage of a range of benefits, facilities, and services offered by the University. These cover meals, housing, healthcare, educational, cultural, and sports activities, etc. More information can be found on the NKUA website: https://en.uoa.gr/students

Upon enrollment, first-year students receive a registration certificate and a Student Identification Number (AM). Using this AM, they must submit an application for a new account in order to obtain an institutional University account and access rights to its online services.

Obtaining an Institutional Account

Visit the page https://webadm.uoa.gr and select "New Account Application" ("Αίτηση Νέου Λογαριασμού") → "Undergraduate Students" ("Προπτυχιακοί Φοιτητές").

During the registration process, to be identified by the system, you will be asked to provide:

- Your full AM (13 digits: Department Code followed by the year of admission and the 5-digit AM).
- Your ID card or passport number as registered in the Ministry of Education system (ID numbers must be entered without spaces using uppercase Greek characters, and passport numbers using uppercase Latin characters).

After system identification, you will be asked to enter your full name using both Greek and Latin characters. You must provide your exact first and last name, not a nickname. Upon correct completion and submission of these details, you will be issued an Application Protocol Number and a PIN, which will be used to activate your account.

The details you provided are reviewed and approved by the Department Secretariat. By following the "Account Activation (PIN)" link on the https://webadm.uoa.gr page, you can track the status of your application. If approved, you will be prompted to set your initial password and will receive the username used for the University's electronic services.

Online Secretariat (my-studies)

You will need to access the portal https://my-uni.uoa.gr in order to:

- Declare the courses you will attend each semester.
- Apply for a student ID card (pass).
- Access the online Secretariat to view your grades, request certificates, etc.

After activating your university electronic account, you can visit https://my-uni.uoa.gr and log into the service using your username and password.

Online Application for Student Card (PASO)

You can receive your discount ticket card (PASO) after applying online at https://academicid.minedu.gov.gr (following electronic pre-registration and identity verification).

To complete the online PASO application, you need the username and password used for https://my-uni.uoa.gr. If you have not received these credentials, or for any other access issues, contact your Department Secretariat.

Once logged in successfully, confirm that your information is correct. If you spot any errors, contact your Department Secretariat for corrections. Afterward, complete the remaining personal details requested.

Obtaining an e-mail Account

Visit the page https://webadm.uoa.gr/ and select "Account Management Services" ("Υπηρεσίες Διαχείρισης Λογαριασμού") → "Service Management" ("Διαχείριση Υπηρεσιών").

Enter the username and password you use for https://my-uni.uoa.gr. Various services will appear, some active and others inactive. Under the second option, "Email Service" ("Υπηρεσία Ηλεκτρονικού Ταχυδρομείου"), you will see in red text "Status: Inactive" ("Κατάσταση: Ανενεργή"). Click it to activate the service.

A prompt will appear stating: *"The page at webadm.uoa.gr says: Service activated!" ("Η υπηρεσία ενεργοποιήθηκε!")*. Click "OK".

Click "Continue" ("Συνέχεια") at the bottom of the Service Management page, and "Successful Change" ("Επιτυχής Μεταβολή") will appear, confirming your account has been created. Your email address will follow this format, e.g.: sph1234567@uoa.gr.

To use your email, go to https://webmail.noc.uoa.gr, enter your username (sph1234567) and password, then click "Continue". Inside the email interface, under "Shared Folders" ("Διαμοιραζόμενοι Φάκελοι") on the bottom left, you will find:

- **Announcements:** General NKUA announcements.
- **Phys:** Main folder of the Department of Physics.
- **Students:** Announcements sent by faculty members for students.
- **Seminars:** Seminars of the Department of Physics.

Web Service for Textbooks

The process of selecting textbooks is carried out through the EUDOXUS online service. By visiting, https://service.eudoxus.gr/coursebooks/#/ you can view the recommended course textbooks for the Department of Physics.

Go to the website https://www.eudoxus.gr and select the "Students" ("Φοιτητές") tab followed by "Textbook Selection" ("Επιλογή Συγγραμμάτων").

Log in using the username and password you use for https://my-uni.uoa.gr.

You can view the curriculum courses and their corresponding textbooks, complete with previews of the cover, table of contents, and a representative sample for each text.

Textbook selection does not occur simultaneously with course registration. Once you complete your course registration, select the textbooks you are entitled to for those registered courses via EUDOXUS, and enter your mobile phone number and email address.

The EUDOXUS system verifies whether each course code has been registered in the my-uni.uoa.gr portal. Textbook selection is only possible if the corresponding course has already been registered on my-uni.uoa.gr.

Websites

Below are key websites where students can find useful information regarding their studies in the NKUA Department of Physics (academic calendar/semester/exam dates, course assignments, core regulations, course outlines, student welfare issues, meals, medical services, accessibility services for students with disabilities, health insurance/care, internship program, Erasmus+, sports facilities, scholarships, endownments, etc.):

- **NKUA:** https://en.uoa.gr/
- **School of Science (Dean's Office):** http://deansos.uoa.gr/
- **Department of Physics:** https://en.phys.uoa.gr/

E-class

The NKUA e-Class platform https://eclass.uoa.gr/index.php?localize=en is an integrated, certified system for online course management. It follows open-source software principles and supports asynchronous e-learning without restrictions. Access is available via a standard web browser without requiring specialized technical knowledge.

Through e-Class, students can download and save lecture notes for each course, instantly read announcements posted by instructors, communicate with teaching staff, register online for courses and/or lab sections, and access all posted materials related to courses in the Department of Physics.

Therefore, all students in the Department must register on e-Class immediately to receive timely and accurate updates directly from their instructors regarding every course they attend.

Library of the School of Science

The Library of the School of Science is housed in a building located between the Department of Physics and the Department of Mathematics, where the main entrance is located. A second entrance is accessible from the 3rd-floor corridor of the Department of Mathematics building.

The library collection includes books, scientific journals (in print and electronic format), undergraduate and postgraduate theses, doctoral dissertations, and other resources. Facilities include three reading rooms with capacity 450 study positions, three group study rooms (capacity of six people each), a display room for recent journal issues, and dedicated computer workstations for database searches. Users may also bring personal laptops, with wireless connectivity in the reading rooms and wired connections in the group study rooms. Students of the School of Science have borrowing privileges. A student ID is required to issue a borrowing card.

Contact:

Secretariat: 210 727 6525, 210 727 6535
Borrowing Office: 210 727 6519
URL: https://sci-en.lib.uoa.gr/index.html
e-mail: sci [at] lib.uoa [dot] gr

Opening Hours:

Monday – Friday: 08.00 - 18.00

The Library Secretariat and the Borrowing Office are open:

Monday – Friday: 08.30 - 15.00.

2.4 International Mobility

The **Erasmus+ Studies** program grants student mobility to spend some of their undergraduate time at European Universities. The duration of these studies cannot exceed one academic semester per student, while their minimum duration is three months. Students can transfer to Physics Departments of European Universities that have signed bilateral agreements with the NKUA Department of Physics and are listed in the table below.

COUNTRY	UNIVERSITY	TEACHING LANGUAGE
FRANCE	Université Clermont Auvergne	FR
FRANCE	Université Grenoble Alpes	FR/EN
FRANCE	Université de Lille	FR/EN
GERMANY	Rheinische Friedrich-Wilhelms-Universität Bonn	DE
ITALY	Università degli Studi di Bari “Aldo Moro”	IT
ITALY	Università degli Studi di Milano	IT/EN
ITALY	Università degli Studi di Milano-Bicocca	IT

POLAND	University of Zielona Góra	EN/PL
POLAND	Jagiellonian University	EN/PL
SPAIN	Universidad de Castilla – La Mancha	EN

Eligibility for undergraduate participation in the Erasmus+ programme requires that students be enrolled in at least the second year of their studies at the time of application submission and that they have successfully completed a number of courses equivalent to one full academic year. Students in their final year of study, as well as those who have exceeded the standard duration of studies, may participate only if they retain a sufficient number of outstanding courses corresponding to a minimum of 30 ECTS (see Appendix). This ensures adequate flexibility in selecting courses from the host institution's curriculum and facilitates their subsequent recognition at NKUA. Furthermore, applicants must provide a language proficiency certificate at a minimum level of B2, as defined by the Common European Framework of Reference for Languages (Council of Europe), in the teaching language of the host institution. Further information is provided in the following official website of Erasmus+: https://en.interel.uoa.gr/erasmus

In addition, the Department of Physics participates in **CIVIS**, which is a new network of public European Universities aiming at creating a European University. The Universities that are members of this network are:

- the University of Aix-Marseille (Aix-en-Provence and Marseille, France)
- the National and Kapodistrian University of Athens (Athens, Greece)
- the Free University of Brussels (Université Libre de Bruxelles, Belgium)
- the University of Bucharest (Universitatea din București, Romania)
- the Autonomous University of Madrid, (Universidad Autónoma de Madrid, Spain)
- the University Sapienza of Rome (Sapienza Università di Roma, Italy)
- the University of Stockholm (Stockholms Universitet, Sweden)
- the University of Tübingen (Eberhard-Karls-Universität Tübingen, Germany)
- the University of Glasgow
- Paris Lodron University of Salzburg
- University of Lausanne

On 11 March 2022, CIVIS and its member universities signed an ambitious partnership agreement with six prestigious African universities, namely, the Makerere University, the Eduardo Mondlane University, the University Hassan II of Casablanca, the University of Sfax (Tunisia), the University Cheikh Anta Diop of Dakar, and the University of the Witwatersrand, Johannesburg. Since

September 2024, these institutions have been Associate Members of CIVIS, committing to a shared agenda that fosters cooperation in education, research, and societal outreach.

CIVIS is co-financed by Erasmus+. More information is available on the CIVIS website: https://civis.eu/en.

Responsible for ERASMUS+/CIVIS: Kosmas Tsakmakidis
Secretary support: Paraskevi Psoma

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3. THE DEPARTMENT OF PHYSICS

3.1 Historical Note

When the National and Kapodistrian University of Athens was established in 1837, Physics was taught within the School of Philosophy. The first Physics Laboratory was set up in 1890 in a separate building (designed by the famous German architect H. Chiller) in the center of Athens, at 104 Solonos street. This was followed by the Laboratory of Experimental Physics in 1894. A major change in the structure of the University occurred in 1904, when the School of Philosophy was split into two separate Schools: Philosophy and Sciences, the latter consisting of the Departments of Physics and Mathematics, and the School of Pharmacy. In 1919 the Department of Chemistry was separated from the Department of Physics. Following the structural reform of 1982, the Department of Physics is now one of the Departments of the School of Science.

3.2 Structure and Management

The governing bodies of the Department are the Chair, the Vice-Chair, the Management Board and the Assembly of the Department. The Chair of the Department, who is elected by the faculty of the Department, chairs the Management Board and the Departmental Assembly, and represents the Department in the Board of the Dean of the School of Science and in the University Senate. The Vice-Chair of the Department is elected by all faculty members of the Department, participates in the Department's Administrative Council and Assembly, and substitutes for the Chair in the Dean's Council of the School of Science and in the Senate, in the event of the Chair's absence

The Management Board consists of the Chair and the Vice Chair of the Department, the Directors of the Sections and one representative of the combined three categories of special staff (special teaching staff, laboratory teaching staff and special technical staff).

The Assembly of the Department consists of faculty members elected by the Sections for a one-year term (their number is set at 30% of the serving faculty members per Section), the Chair, the Vice Chair, the Section Directors, representatives of the undergraduate and postgraduate students in a proportion of 15% of the aforementioned (with a minimum representation of one (1) student per cycle of studies, provided that the Department organizes study programs for all three cycles), and three (3) representatives, one per category of special staff, i.e., special teaching staff, the laboratory teaching staff and the special technical staff, if these categories exist, who are elected for a one-year term.

- **Chair**: Professor Hector-Emmanouil Nistazakis
- **Vice Chair**: Professor Phivos Mavropoulos

Sections

The Department of Physics consists of five (5) Sections, within which the teaching and research activities of the Department are organized:

- **Section A'**: Section of Condensed Matter Physics
  Director: Professor Efthimios Skordas
- **Section B'**: Section of Nuclear and Particle Physics
  Director: Professor Konstantinos Sfetsos
- **Section Γ'**: Section of Astrophysics, Astronomy, and Mechanics
  Director: Professor Theocharis Apostolatos
- **Section Δ'**: Section of Environmental Physics – Meteorology
  Director: Professor Helena Flocas
- **Section E'**: Section of Electronic Physics and Systems
  Director: Professor Aris Moustakas

Laboratories

The Sections also include institutionalized specialized educational and research Laboratories, in which undergraduate and postgraduate students of the Department are trained. These Laboratories are the following:

- **Laboratory of Solid State Physics** (Section A')
  Director: Associate Professor Antonios Papathanassiou
- **Laboratory of Nuclear and Particle Physics** (Section B')
  Director: Professor Dimitrios Fassouliotis
- **Laboratory of Astronomy** (Section Γ')
  Director: Professor Theocharis Apostolatos
- **Laboratory of Astrophysics** (Section Γ')
  Director: Professor Nektarios Vlahakis
- **Laboratory of Environmental Physics – Meteorology** (Section Δ')
  Director: Professor Constantinos Cartalis
- **Laboratory of Electronic Physics** (Section E')
  Director: Professor Ioannis Tigelis

In addition to the above specialized Laboratories operated by the Sections, three Laboratories with a department-wide scope are operated directly by the Department:

- **Laboratory of Physics "Caesar Alexopoulos"** which includes the "Machine Shop" and the "Laboratory of Mechanical Engineering and Design"
  Director: Professor Hector-Emmanouil Nistazakis

- **Laboratory** (Center) **of Computers and Informatics**
  Director: Professor Aris Moustakas

- **Gerostathopoulion University Observatory**
  Director: Professor Ioannis Daglis

University Research Institutes

The following University Research Institutes are associated with the Department:

- **Solid Earth Physics Institute:** It was jointly established by the NKUA (Department of Physics, Condensed Matter Physics Section) and by the University of Ioannina (Department of Physics, Solid State Physics Section).
  Director: Professor Nikolaos Sarlis

- **Institute of Accelerating Systems and Applications:** co-founded by NKUA and the National Technical University of Athens (NTUA), the institute belongs to three NKUA Departments (Department of Physics, School of Medicine and Department of Informatics and Telecommunications), and to three NTUA Schools (School of Electrical and Computer Engineering, School of Applied Mathematical and Physical Sciences, and School of Chemical Engineering).
  Director: Professor Paraskevas Sphicas

3.3 Staff

PROFESSORS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Apostolatos Theocharis	Γ'	6902	thapostol	04, 05
Assimakopoulos Margarita-Niki	Δ'	6922	masim	06, 07
Cartalis Constantinos	Δ'	6774	ckartali	28, 29
Daglis Ioannis	Γ'	6857	iadaglis	20, 21
Diakonos Fotios	B'	6952	fdiakono	-
Fassouliotis Dimitrios	B'	6955	dfassoul	92, 93
Flocas Helena	Δ'	6706	efloca	94, 95

Frantzeskakis Dimitrios	A'	6714	dfrantz	96, 97
Hatzidimitriou Despina	Γ'	6721	deshatzi	98, 99
Likodimos Vlassios	A'	6824	vlikodimos	38, 39
Mavropoulos Phivos	A'	6893	fmavrop	40, 41
Mertzimekis Theodoros	B'	6953	tmertzi	42, 43
Moustakas Aris	E'	6775	arislm	44, 45
Nistazakis Hector-Emmanouil	E'	6710	enistaz	48, 49
Saoulidou Niki	B'	6879	nsaoulid	60, 61
Sarlis Nikolaos	A'	6736	nsarlis	62, 63
Sfetsos Konstantinos	B'	6938	ksfetsos	72, 73
Skordas Efthimios	A'	6735	eskordas	-
Sofianos Sarantis	Δ'	6932	sofianos	66, 67
Sphicas Paraskevas	B'	6883	sphicas	74, 75
Tetradis Nikolaos	B'	6907	ntetrad	80, 81
Tigelis Ioannis	E'	6860	itigelis	86, 87
Tzanakaki Anna	E'	6862	atzanakaki	82, 83
Vlahakis Nektarios	Γ'	6903	vlahakis	12, 13

ASSOCIATE PROFESSORS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Anastasopoulos Markos	E'	6916	maanast	02, 03
Avramidis Konstantinos	E'	6872	kavramidis	00, 01
Dasyra Kalliopi	Γ'	6815	kdasyra	22, 23
Gardelis Spiros	A'	6985	sgardelis	16, 17
Lelidis Ioannis	A'	6818	ilelidis	36, 37
Simserides Constantinos	A'	6810	csimseri	64, 65
Spanos Vassilis	B'	6967	vspanos	68, 69
Stamopoulos Dimosthenis	A'	6823	densta	70, 71
Theofilatos Konstantinos	B'	6904	ktheofi	24, 25
Tzanis Christos	Δ'	6937	chtzanis	84, 85
Vellidis Constantinos	B'	6946	cvellid	08, 09

ASSISTANT PROFESSORS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Bossioli Elissavet	Δ'	6836	ebossiol	46, 47
Giannakaki Eleni	Δ'	6928	elina	18, 19
Kazantzidis Stylianos	Γ'	6898	skazantzidis	26, 27
Koseoglou Pavlos	B'	6948	pkoseoglou	30, 31
Koutsokeras Loukas	A'	6811	lkoutsok	32, 33
Latsas Georgios	E'	6865	glatsas	34, 35
Papadimitriou Ioannis	B'	6874	ioannis. papadimitriou	50, 51
Papathanassiou Antonios	A'	6730	antpapa	52, 53
Papathanasiou Georgios	B'	6982	gpapathanasiou	54, 55
Petropoulou Maria	Γ'	6894	mpetropo	56, 57
Sakellis Elias	A'	6727	e_sakel	58, 59
Sotiropoulou Georgia	Δ'	6923	georgiasot	76, 77
Tasolamprou Anna	E'	6725	atasolam	78, 79
Tsakmakidis Kosmas	A'	6821	ktsakmakidis	88, 89
Tyrlis Evangelos	Δ'	6934	etyrlis	90, 91
Vervatis Vassilios	Δ'	6929	vvervatis	10, 11

LECTURERS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Gazeas Kosmas	Γ'	6892	kgaze	14, 15

Each member of the faculty of the Department acts as Academic Advisor to a set of students, as listed in the tables above. The advisory role lasts throughout the entire duration of their studies, for any issue related to their studies or of general concern to them. The Academic Advisor, for each new student enrolled in the academic year 2026-27, is assigned based on the last two (2) digits of the student's ID, as shown in the last column of the above tables.

LABORATORY TEACHING STAFF	TEL. 210727 ####	Email [at] phys.uoa.gr
Dandou Aggeliki	6806	antant
Ganoti Paraskevi	6986	pganoti
Georgaki Chrisoula	6870	cgeorgakis
Gerontidou Maria	6901	mgeront
Giannouri Maria	6771	mgiannouri
Kapoyannis Athanasios	6881	akapog
Karatasou Stavroula	6995	ckarat
Mamalougkos Nektarios	6958	nektar
Mantziafou Anneta	6849	amant
Mitsakou Eleftheria	6854	emitsaku
Peponis Demetrios	6795	dpeponis
Philoppopoulos Konstantinos	6783	kphilip
Prosalentis Evangelos	6996	eprosaled
Protonotariou Anna	6813	aprot
Tsetseri Maria	6782	mtsetse
Tsochantzis Ioannis	6984	etsochantzis
Vlastou Georgia	6808	gvlastou

LABORATORY TECHNICAL STAFF	TEL. 210727 ####	Email [at] phys.uoa.gr
Chatzikontis Efstratios	6704	stratisch
Holeva Eleni	6712	eholeva
Ioannidis-Vamvakas Dimitrios	6789	dioannid
Kyrkos Christos	6772	ckyrkos
Lampithianakis Georgios	6741	glabit
Moutziki Eleftheria	6830	emoutziki
Petrokokkinos Loukas	6888	lpetrok
Tsalpatourou Angeliki	6744	atsalpat

ADMINISTRATIVE STAFF	TEL. 210727 ####	Email
Filoppopoulou Anastasia	6797	afilippop [at] phys.uoa.gr
Kitsios Georgios	6745	gkitsios [at] phys.uoa.gr
Kotoula Panagioula	6803	gioulakot [at] uoa.gr

Maltezou Triantafillia-Maria	6856	mmaltezou [at] phys.uoa.gr
Mourouti Fani	6966	fmourouti [at] phys.uoa.gr
Pappas Dimitrios	6702	dpappas [at] phys.uoa.gr
Psoma Paraskevi	6799	vpsoma [at] uoa.gr
Rizou Maria	6990	m_rizou [at] uoa.gr
Spyropoulou Konstantina	6754	nsprirop [at] phys.uoa.gr
Zografaki Eftychia	6804	ezografaki [at] phys.uoa.gr

Departmental Committees

INTERNAL EVALUATION

D. Hatzidimitriou (Chair), T. Apostolatos, H. Flocas, C. M. Giannouri, A. Kapoyannis, G. Latsas, A. Mantziafou, F. Mavropoulos, E. Mitsakou, A. Moustakas, H. E. Nistazakis, M. Petropoulou, C. Philipopoulos, C. Sfetsos, E. Skordas, G. Vlastou

UNDERGRADUATE STUDIES

P. Mavropoulos (Chair), T. Apostolatos, A. Dandou, H. Flocas, D. Frantzeskakis, D. Hatzidimitriou, A. Moustakas, H. E. Nistazakis, C. Sfetsos, N. Tetradis

STUDENT PRACTICE PROGRAMME

Coordinator: C. Simserides, H. E. Nistazakis (substitute)

Evaluation Commitee:

1. D. Hatzidimitriou, M. Anastasopoulos (substitute)
2. A. Tzanakaki, N. Vlahakis (substitute)
3. M. Tsetseri, E. Prosalentis (substitute)

Appeals Committee:

1. H. Flocas, M. Petropoulou (substitute)
2. S. Gardelis, C. Tzanis (substitute)
3. E. Skordas, G. Latsas (substitute)

PEDAGOGICAL COMPETENCE

C. Simserides (Chair), S. Gardelis, M. Giannouri, H. E. Nistazakis, M. Tsetseri

DISABLED STUDENTS

M. Petropoulou, P. Kotoula (Administrative Staff Member), M. Rizou (Administrative Staff Member)

COURSE TIMETABLE AND EXAMINATIONS COMMITTEE

P. Mavropoulos (Chair), K. Avramidis, M. Gerontidou, E. Giannakaki, S. Kazantzidis, A.Protonotariou

DEPARTMENT WEBSITE COMMITTEE
G. Latsas, M. Maltezou, B. Vervatis, G. Vlastou

COMMITTEE FOR THE MANAGEMENT OF STUDENT COMPLAINTS AND APPEALS
C. Kartalis, V. Likodimos, H.E. Nistazakis

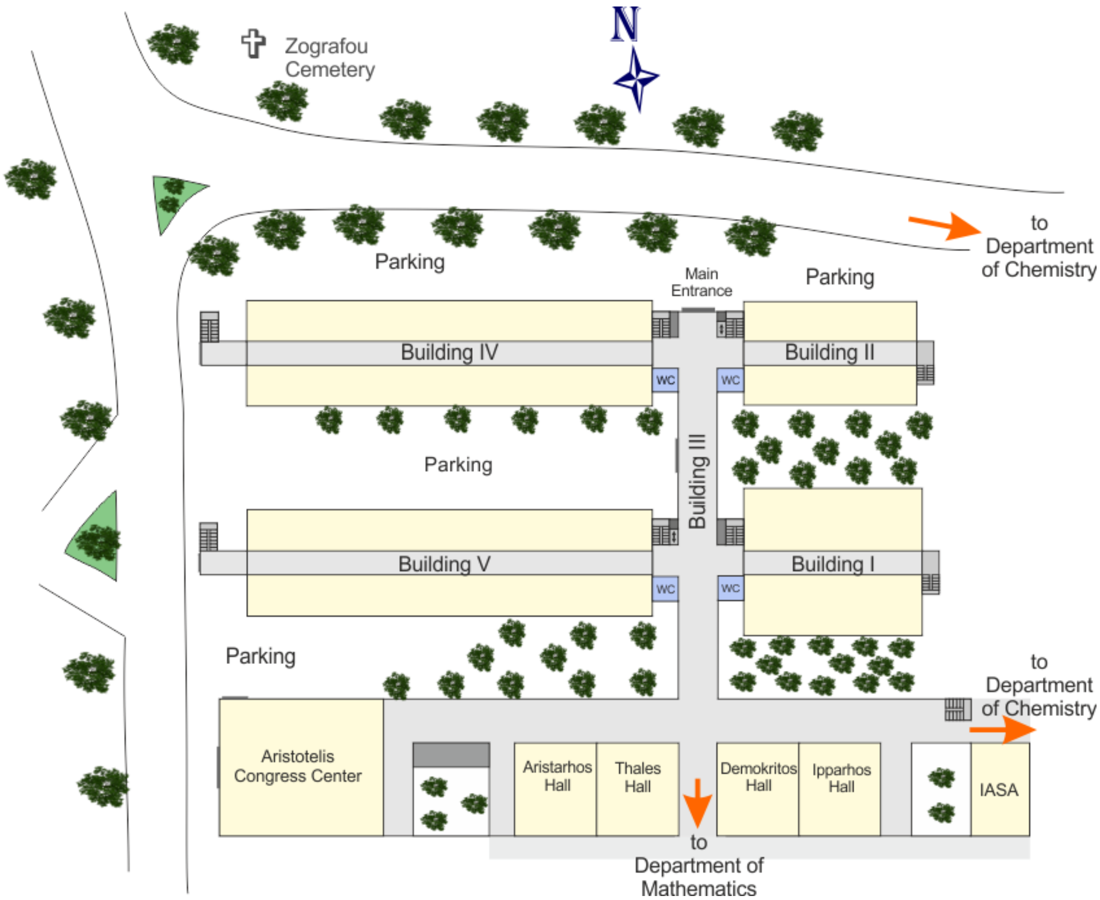
3.4 Buildings and Infrastructure

The Department of Physics disposes of a congress hall, lecture halls, classrooms, conference room, reading room, laboratories with modern equipment and high-speed internet connection. Specifically, the Department's infrastructure consists of:

- Four (4) lecture halls with live streaming and recording equipment:
  "Aristarchus" (242 seats)
  "Demokritus" (208 seats)
  "Thales" (208 seats)
  "Hipparchus" (208 seats)
- Three (3) central classrooms fully equipped with multimedia facilities:
  "Kotsakis" (63 seats)
  "Karapiperis" (49 seats)
  "Hondros" (49 seats)
- Three (3) lecture/exam rooms:
  "Archimedes" (90 seats)
  "Heraclitus" (70 seats)
  "Heron" (50 seats)
- Classrooms/seminar rooms and libraries in the five Departmental Sections
- Congress Hall "Aristotle" (285 seats) with live streaming and recording equipment
- Conference/telemeeting room
- Reading room "Anastasiadis"
- Computer center (60 seats)
- Observatory (Gerostathopoulion University Observatory)
- Cosmic Ray Station
- Specialized educational and research laboratories in the different Sections
- Laboratory of Physics "Caesar Alexopoulos" and its machine shop.
- The IASA building, with office and laboratory space, and a Computing Cluster connected to the European Grid and Cloud computing infrastructure.

3.5 Contact and Access

The Department of Physics is located within the School of Science complex, in a five-section building as shown in the figure below, in the University Campus (Panepistimioupoli) - Zografou.



- **Building Superintendent**: Evangelos Prosalentis

Postal address:

DEPARTMENT OF PHYSICS
NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS
University Campus, 157 84 Zografou, Athens

Secretariat opening hours:

Monday-Wednesday-Friday 12:00 - 14:00
Tel: 210 727 6799, -6803, -6745, -6990, -6754, -6825
e-mail: secr [at] phys.uoa [dot] gr

- **Secretary**: Eftychia Zografaki

Access by Public Transportation

There are several options for accessing the Univerity Campus and the Physics Department using public transport:

- From the metro and bus stop "Evangelismos", using one of the following buses and getting off at their terminal stop located at the main entrance of the University Campus. The Physics Department is within walking distance (800 m, uphill):
  - **220**: Ano Ilisia-Akadimia
  - **221**: Panepistimiouloli-Akadimia
  - **235**: Zografou-Akadimia
- Also departing from the "Evangelismos" stop, taking one of the following two buses that enter into the University Campus and disembarking at the stop "Physics", which is a short 100 m from the Department:
  - **250**: Panepistimioupoli-St. Evaggelismos
  - **E90**: Peiraias-Panepistimioupoli
- Taking one of the following buses, getting off at their terminal stop, which is close to the second entrance to the campus from the Zografou side, at a distance of 350 m from the Physics Department:
  - **608**: Galatsi-Akadimia-Nekr. Zografou
  - **230**: Akropoli-Zografou
- The final option is to take the following bus, getting off at its terminal stop, which is close to the third entrance to the campus from the Kaisariani side, at a distance of 1250 m from the Physics Department:
  - **224:** Kaisariani-El. Venizelou

Access by Car

There is access from the three campus gates (Main Gate: Olof Palme Avenue; Zografou Gate and Kaisariani Gate). The Kaisariani and Zografou gates are open on weekdays from 7:00 to 10:00 and from 14:30 to 17:30. The main gate is open 24 hours on all days.

4. UNDERGRADUATE STUDIES

4.1 Introduction

The new, reformed curriculum is deployed beginning with the 2021-22 academic year. As expected from an internationally renowned Physics Department, the curriculum aims at providing students with a thorough, multifaceted and rigorous scientific training in physics, which remains to this day the most fundamental discipline. Beyond the importance of physics in the evolution of science and modern technology, a physics education, which includes extensive quantitative problem solving, provides a strong background for other scientific pursuits and professional career fields.

Nowadays more than ever, the study of physics is not limited to acquiring knowledge and understanding deep concepts and principles of nature. Indeed, a key aim of an education in physics is the highlighting of the importance of fundamental knowledge in physics in the rapidly evolving world of science, where specialization is coupled with interdisciplinarity, resulting in the evolution of science and even the genesis of new scientific fields.

Educational Objectives

The main goal of the undergraduate curriculum of the Department of Physics is to provide a thorough, comprehensive and high level theoretical and laboratory education in the broader field of physics, basic knowledge of mathematics as a fundamental tool and the language of physics, as well as participation in original research, in both basic and applied fields.

The expected learning outcomes from a successful completion of the Physics Department curriculum are numerous. The Department’s graduates are equipped as follows:

- To understand, interpret and explain the fundamental theories, principles and laws of physics.
- To be able to design experimental setups, perform experiments, and analyze and interpret measurements.
- To know and understand basic mathematics as a tool of physics.
- To recognize and determine the laws that govern physical phenomena.
- To be able to calculate the parameters that characterize physical phenomena and to interpret them according to the results of their calculations.
- To analyze the various problems of physics and apply the appropriate theories, laws and formulas.
- To combine theories and formulas to solve complex physics problems.
- To produce research ideas and conclusions in the broader field of science.
- To evaluate project results and conclusions and propose solutions.

- To propose ideas for tackling problems and issues in the constantly evolving science of physics.
- To propose new ideas and to implement new directions and applications based on the principles and theory of the science of physics.
- To impart their knowledge to pupils and students.

Graduates are expected to develop skills in: searching for, analyzing and synthesizing data and information using the necessary technologies; decision making; working both independently and within a team; working in an interdisciplinary environment; producing new research ideas; promoting freedom, creative thinking alongside inductive, analytical, synthetic and critical thinking; managing time, scheduling and meeting deadlines; working with new technologies, including computer programming; problem solving.

The success of a university-level curriculum is inextricably dependent on an effective and efficient collaboration of instructors and students, which in turn requires good and frequent communication. To facilitate the integration of students in the Department, and also to provide students with a source of information and guidance throughout their studies, the Department assigns each student a Faculty Advisor, as presented in Section 3.3. Students are encouraged to consult frequently with their Faculty Advisor.

Career Prospects

Physicists can be employed professionally in both public and private institutions, usually in service sectors, as specialist scientists, consultants or experts, either on an individual basis or in collaboration with scientists from other disciplines. They may also be self-employed in any field of the science of physics and its applications. In particular, the graduates of the Department of Physics can be effective, depending on the content of their studies, in the following sectors:

- **Education**, at Universities and Technological Education Institutions, secondary education and technical and vocational training, public and private, tutoring, public and private Vocational Training Institutes, Vocational Training Centers and other post-secondary education institutions, in the subject of physics as well as in any other subject directly or indirectly related to physics and its applications, such as radio-electronics, computer science, environment, energy.

- **Research**, at both public and private institutions, in any field related to the subject of theoretical, experimental and applied physics, whether in a purely theoretical-scientific direction or in the direction of industrial applications.

- **Manufacturing**, offering services, either as freelancers or as employees, in any field of physics science and its applications, as well as in any other subject directly or indirectly related to physics science and its applications.

- **Health**, in the field of medical physics, at medical physics departments of hospitals or, in general, in the area of medical physics applications.

- **Public administration**, in positions of an administrative and/or financial nature, in positions that require the general and specialized knowledge acquired during their studies in physics and its applications and in any other subject directly or indirectly related to the science of physics and its applications, as well as environmental inspectors.

4.2 Outline of the Curriculum

The undergraduate cycle of study in the Department of Physics of NKUA leads to a BSc in Physics, following the successful completion of a four-year curriculum that consists of 38 courses and a minimum of 240 ECTS credit points. The maximum duration of undergraduate studies is set at six (6) years, except for students with a certified disability of 50% or higher. Upon reaching this limit, an administrative act of permanent withdrawal is issued. Students may opt for part-time enrolment (e.g., for employed students, athletes, health-related reasons), in which each semester counts as half, thereby adjusting the total duration of studies accordingly. Moreover, students who have not exceeded the maximum duration of studies are entitled to suspend their studies for a period of up to two (2) years, either once or in segments, with a minimum duration of one academic year. During the suspension period, student status is paused and participation in any educational activity is not permitted. The suspension period does not count toward the maximum duration of studies. Finally, exceeding the maximum duration of studies is permitted following a decision of the Department Assembly exclusively for serious health reasons. The specific conditions, deadlines, required documentation, and procedures for all of the above are detailed in the Institution's Internal Regulations.

The general characteristics of the basic programme of study, without the detailed elements and specifications provided below, offer essential information for the rational orientation and integration of new students into their academic obligations, and help prevent uncritical and non-scientific notions regarding "easy" and "difficult" courses.

The courses taught over the four-year period, according to the curriculum, are distributed across eight (8) academic semesters, each lasting 13 weeks. Average daily attendance ranges between 4 and 5 hours, corresponding to an average weekly workload of approximately 21–22 hours.

The curriculum follows a structure with specialization selection in the 7th semester, enabling students during the 4th and final year of studies to pursue a specific track of physics courses aligned with their preferences and academic interests, whether pre-existing or developed up to the time of selection, in consultation with their Academic Advisor (see below)

The Department offers five specialization areas, which correspond to the five Departmental Sections:

- Astrophysics (K1)
- Electronics, Computers, Telecommunications and Control (K2)

- Environmental Physics (K3)
- Nuclear and Particle Physics (K4)
- Condensed Matter Physics (K5)

4.3 Structure of the Curriculum

The curriculum includes:

- 31 theory courses
- 5 laboratory courses and
- A final year dissertation (two semesters) or, alternatively, two (additional) introductory specialization courses.

Courses are characterized as **core** or **specialization** courses, and as **compulsory** or **elective**.

In particular, the 31 theory courses are divided into:

- 18 compulsory core courses (YKO)
- 3 elective core courses (EKO) selected from a total of 5 offered
- 3 introductory courses to specializations (EKA) selected from a total of 5 offered
- 2 compulsory specialization courses (YKj) and 2 elective specialization courses (EKj) selected from about 4-5 offered in each specialization area j=1, 2, 3, 4, 5
- 3 free elective courses (EΛE).

The 5 laboratories comprise:

- 4 laboratories on basic physics (Basic Physics Laboratory I, II, III and IV)
- 1 specialization laboratory (in the specialization area selected).

It should be noted that laboratory exercises are included in some theoretical courses as well, e.g. in "Computer Science", "Computational Physics"", in the five introductory specialization courses etc.

The final degree requirement consists of either the submission of a dissertation (undergraduate thesis) or the successful completion of two additional introductory specialization courses. Students selecting the former take on a thesis topic in their final year of study, in their specialization area. The work leading to the thesis lasts two semesters and is carried out in consultation with and under the supervision of an advising professor in the corresponding Departmental Section. A thesis can also be compiled under the supervision of any faculty member of the Department of Physics outside the Section corresponding to the student's specialization area, **after approval by the student's specialization Section**. It is also possible to carry out the work leading to a thesis outside the Department of Physics (within another Department of NKUA or research center in Greece), following **the approval of the relevant Section and the appointment of a supervisor within the Section**, who will be responsible for submitting the grade for the thesis. Students are strongly advised to choose a dissertation: The cognitive benefits and skills offered by its preparation are numerous. Moreover, the elaboration of a dissertation is for many students the first exposure to research and research methodology, while it is also a precursor to possible postgraduate studies. Students who nevertheless decide not to carry out thesis work, must instead complete successfully two more introductory specialization courses in addition to the three required of all students, i.e., they must take all five introductory courses offered by the Department.

The above courses correspond to a total of 240 ECTS credit points that are required for the award of the bachelor's degree by the Department of Physics. The final degree grade is calculated as the weighted average of the grades obtained in the courses that constitute the requirement of 240 ECTS points. The weighting factors are the ECTS points awarded by each course. The degree lists grades with a precision of two (2) decimal places and the designation EXCELLENT (grade ≥ 8.50), VERY GOOD (6.50 ≤ grade <8.50) or GOOD (grade <6.50). Students who complete more courses than required by the degree program, can select the ones to be included in determining the final degree grade, provided that the total number of ECTS points accumulated by these courses is greater than or equal to 240. The remaining courses are listed in the Diploma Supplement.

Students are also offered the opportunity to start engaging in research before or in addition to their final year thesis through research projects, which they undertake under the supervision of a faculty member of the Department, who may be from any Section of the Department. A research project has a separate course code and awards three (3) ECTS credits, which are not included in the minimum number of ECTS credits required for the award of the bachelor's degree. Students can take on a research project more than once (i.e. for more than one semester - up to four times in total - each with a different course code) if they continue their work in a first project or if they take on a new project, either with the same or another faculty member. Successfully completed research projects are listed in the Diploma Supplement, which is part of the full undergraduate transcript.

In the first and third semesters, students also attend introductory seminars, in which the Department’s five thematic areas are presented on educational and research basis. These seminars are not graded. Additionally, outside regular class and lab hours seminars are organized with stakeholders, where graduates of the Department of Physics can be employed.

During their studies and in parallel with their coursework, students can engage in a Practical Training exercise at one of the public or private host institutions designated by the Physics Department, for a first exposure to real-life working conditions. Students participating in this program are compensated by the Greek National Strategic Reference Framework (NSRF). More information and relevant announcements can be obtained at the Department’s website, as well as on the corresponding eclass entry, https://eclass.uoa.gr/courses/PHYS291, where students can also register for the Practical Training. The Practical Training appears on the curriculum as a free elective course of the sixth (ΣΤ΄) semester (course code "ΠΡΑΣΚ"), lasts two (2) months and grants five (5) ECTS credit units. The course and its ECTS units, however, are not included in the minimum number of ECTS credits required for the award of the bachelor's degree, though they are listed in the Diploma Supplement.

The undergraduate curriculum of the Physics Department has been designed so that the courses offered should be followed in the chronological order presented below. It is thus very important for students to follow the chronological order of the courses per semester and year. First-year courses and, even more so, those of the first semester highlight the inherently different educational approach of university-level education as compared to that of high school. In this context, weekly attendance of the course lectures and recitations is key for a smooth adaptation to the requirements of a university degree and the avoidance of gaps in knowledge that may well make it challenging to follow more advanced courses. The Department of Physics has structured the first-year courses to equip students with the essential background for a seamless transition from the high-school to the university curriculum, ensuring that they encounter no difficulties, gaps, or obstacles, irrespective of their previous academic track.

The 1st- and 2nd-year courses, i.e., those of the first four semesters, provide the necessary knowledge base, i.e., the background and skills needed to follow the courses of the following semesters, as they focus on general physics and mathematics. In particular, these courses cover basic concepts in physics and mathematical methods to achieve both qualitative and quantitative description of natural systems, establishing the fundamental laws of physics. Specifically, these four semesters include:

- **Courses of general-physics content.** This set consists of four (4) courses offered sequentially, one per semester: Physics I (Mechanics) and Physics II (Heat & Waves) in the 1st year, Physics III (Electromagnetism) and Physics IV (Contemporary Physics), in the 2nd year. These courses constitute the basis for understanding fundamental concepts in physics and should be followed sequentially.
- **General-physics laboratories (laboratory experiments)**. The aim of these is to complement the theoretical knowledge of the general physics courses as well as to understand the basic principles and methods of experimental physics. There are four (4) such mandatory laboratories, one per semester.
- **Courses of mathematical and general content**. There are seven (7) such courses, which aim at building a solid background of knowledge about mathematical concepts and methods. In addition, there are two (2) courses with practical orientation: Computer Science and Computational Physics, which are indispensable in almost all contemporary scientific specializations. Students are required to take these courses in the sequence prescribed by the Department's Study Program, ensuring that they can follow the material effectively and avoid any cognitive gaps.

- Elective courses can be taken beginning with semester Δ': Students can select two courses among the pool of elective core courses and the introductory courses to the specializations offered by the Department.
- **Two rounds of seminar courses** (one round in each of the 1st and the 3rd semesters), which are mandatory, but without examination requirements. Their scope is to provide first-year students with a broad picture of the various areas of physics, as well as current developments.

The core of the curriculum is completed by the five courses Special Theory of Relativity, Mechanics I, Electromagnetism I, Quantum Mechanics I and Statistical Physics I, which are offered in semesters Δ' and E'. In semester ΣT', the students can follow either additional introductory specialization courses or elective core courses. By the end of the 3rd year, students have obtained a broad picture of the existing areas of physics and, hence, can follow one of the five (5) specializations offered, in line with their interests. The choice of specialization is made in semester Z'.

The 4th year offers primarily specialization and some general electives. In these last two semesters of study (Z' and H'), students have to take the courses of the specialization selected, i.e., the two (2) compulsory specialization courses, the specialization laboratory, two (2) elective specialization courses as well as three (3) free elective courses. Students complete the requirement for the degree in Physics either by acquiring more breadth, by taking the remaining two introductory courses to the specializations, or by concentrating in their specialization and furnishing a thesis. It should be noted that, for the three free-choice electives, students may select any non-mandatory course offered by the Department, provided they have not already taken it.

After successful completion of the above program, the Department issues a Diploma Supplement, in Greek and in English. This document, which is issued in addition to the degree, does not replace the degree, but accompanies it and helps clarify the content of the studies pursued, especially outside Greece.

Upon receiving their degree, graduates of the Department of Physics obtain full teaching and educational competence without any additional examination or procedure, and are entitled to participate in all relevant public-sector competitions.

In addition to their degree, graduates receive upon request a certificate of computer skills (ECDL) from the Department.

Upon successful completion of the undergraduate program, graduates can proceed to postgraduate studies. Information about the postgraduate programs offered directly by the Department of Physics, or in association with other departments, as well as the doctoral program, can be obtained at the Department's website (phys.uoa.gr).

Student's Advisor

Each year, shortly after the enrolment process, each faculty member is appointed as Advisor (mentor) to a number of incoming students and for the duration of their studies. The Advisor assigned to each newly admitted student is determined on the basis of the last two digits of the student's registration number, as indicated in the final column of the tables listing the Department's faculty members in Section 3.3. Students are invited to contact and get acquainted with their respective advisors. They are also encouraged to consult with their advisor on any issues arising in the context of their studies.

5. DETAILED DESCRIPTION OF THE UNDERGRADUATE CURRICULUM

The current chapter presents the course categories, the course syllabi, and the course schedule per semester.

5.1 Course Categories

The twenty-two (22) compulsory core courses and laboratories (YKO) are given in the table below.

COMPULSORY CORE COURSES AND LABORATORIES		Hours/week.	ECTS
Introductory Courses – Physics			
10YKO01	Physics I	6	7
10YKO02	Physics II	6	7
10YKO03	Physics III	6	7
10YKO04	Physics IV	6	7
Basic Laboratories			
10YKO05	Basic Physics Laboratory I	3	4
10YKO06	Basic Physics Laboratory II	3	4
10YKO07	Basic Physics Laboratory III	3	4
10YKO08	Basic Physics Laboratory IV	3	4
Mathematics			
10YKO10	Basic Mathematical Methods	4	6
10YKO11	Analysis I and Applications	6	7
10YKO12	Analysis II and Applications	5	7
10YKO13	Probability Theory	4	6
10YKO14	Ordinary Differential Equations	4	6
10YKO15	Mathematical Methods in Physics I	5	7
10YKO16	Mathematical Methods in Physics II	5	7
Introductory Courses – Computer Science			
10YKO20	Computer Science	2 + 2 Lab	6
10YKO21	Computational Physics	2 + 2 Lab	6

Basic Physics I			
10YKO31	Mechanics I	5	7
10YKO32	Electromagnetism I	5	7
10YKO33	Quantum Mechanics I	5	7
10YKO34	Statistical Physics I	5	7
10YKO35	Special Theory of Relativity	4	6

There are also five (5) elective core (EKO) courses, from which students must choose three (3). Students who are interested can also take the other two (2) elective core courses as free elective courses. Depending on the specialization chosen, students are required to include among their three core electives one or two specific courses as follows:

- Students in the 1st specialization (K1: Astrophysics) must take Fluid Dynamics and any other two core electives of their choice, with a strong recommendation to take Electromagnetism II.
- Students in the 2nd specialization (K2: Electronics, Computers, Telecommunications and Control) must take Electromagnetism II and any other two core electives of their choice.
- Students in the 3rd specialization (K3: Environmental Physics) must take Fluid Dynamics and any other two core electives of their choice.
- Students in the 4th specialization (K4: Nuclear and Particle Physics) must take Quantum Mechanics II and Electromagnetism II, and any other core electives of their choice.
- Students in the 5th specialization (K5: Condensed Matter Physics) must take Quantum Mechanics II and any other two core electives of their choice.

ELECTIVE CORE COURSES		Hours/week	ECTS
10EKO01	Mechanics II	5	7
10EKO02	Electromagnetism II	5	7
10EKO03	Quantum Mechanics II	5	7
10EKO04	Statistical Physics II	5	7
10EKO05	Fluid Dynamics	5	7

Students must also take three (3) of the five (5) introductory specialization courses (EKA) offered by the Department. The following rules apply to these courses:

- Students who choose not to write a thesis must take all 5 introductory courses.
- Students who choose to do a dissertation can also take the other 2 introductory courses as free elective courses.
- Each introductory course includes a laboratory, and the final grade is derived from the grade of the course (by 75%) and the grade of the laboratory (by 25%). Students must also obtain a passing grade in both the course and the laboratory.

- Students must take the introductory course to the specialization they choose (e.g., students of the 1st specialization must take the course Introduction to Astrophysics).

The introductory courses to the five Specializations (EKA) and the final year dissertation (corresponding to two semesters) are presented in the table below.

INTRODUCTION TO/RESEARCH IN A SPECIALIZATION		Hours/week	ECTS
10EKA01	Introduction to Astrophysics	5 + 1 Lab	7
10EKA02	Introduction to Electronic Physics	5 + 1 Lab	7
10EKA03	Introduction to Atmospheric Physics	5 + 1 Lab	7
10EKA04	Introduction to Nuclear and Particle Physics	5 + 1 Lab	7
10EKA05	Introduction to Solid State Physics	5 + 1 Lab	7
10EKA06	Final-Year Dissertation I	3	7
10EKA07	Final-Year Dissertation II	3	7

Within each specialization area, students are required to attend the two (2) compulsory courses, the corresponding specialization laboratory and two (2) elective specialization courses. The compulsory courses of the five (5) specializations (YKn, n = 1, 2, 3, 4, 5) are presented in the table below.

COMPULSORY SPECIALIZATION COURSES		Hours/week	ECTS
1st Specialization: Astrophysics			
10YK101	Stellar Astrophysics	4	6
10YK102	Astrophysical Fluids	4	6
10YK103	Astrophysics Laboratory	4	6
2nd Specialization: Electronics, Computers, Telecommunications and Control			
10YK201	Signals and Systems	3 + 1 Lab	6
10YK202	Computer Systems Organization	3 + 1 Lab	6
10YK203	Electronics, Computers, Telecommunications and Control Laboratory	4	6
3rd Specialization: Environmental Physics			
10YK301	Atmospheric Dynamics	4	6
10YK302	Physics of the Atmospheric Boundary Layer	4	6
10YK303	Environmental Physics Laboratory	4	6
4th Specialization: Nuclear and Particle Physics			
10YK401	Nuclear Physics	4	6
10YK402	Elementary Particles	4	6

10YK403	Nuclear and Particle Physics Laboratory	4	6
5th Specialization: Condensed Matter Physics			
10YK501	Quantum Optics and Lasers	4	6
10YK502	Solid State Physics	4	6
10YK503	Condensed Matter Physics Laboratory	4	6

The elective courses of the five (5) specializations (EKn, n = 1, 2, 3, 4, 5) are presented in the following table. The list also includes some postgraduate courses, which students have the opportunity to select (up to a maximum of two); these courses follow the slightly different rules and regulations of the postgraduate program, including the teaching and examination periods.

ELECTIVE SPECIALIZATION COURSES		Hours/week	ECTS
1st Specialization: Astrophysics			
10EK101	High Energy Astrophysics	4	6
10EK102	Space and Solar Physics	4	6
10EK103	Galaxies	4	6
10EK111	General Theory of Relativity (postgraduate)	4	6
10EK112	Observational Techniques and Data Analysis in Astrophysics (postgraduate)	4	6
2nd Specialization: Electronics, Computers, Telecommunications and Control			
10EK201	Advanced Topics in Electronics	3 + 1 Lab	6
10EK202	Optoelectronics and Optical Communications	4	6
10EK203	Telecommunications	3 + 1 Lab	6
10EK204	Microelectronics	4	6
10EK211	Introduction to Control Systems (postgraduate)	4	6
10EK212	Computer Systems (postgraduate)	3 + 1 Lab	6
3rd Specialization: Environmental Physics			
10EK301	Quality of Atmospheric Environment	4	6
10EK302	Physical Oceanography	4	6
10EK303	Climate – Climate Change	4	6
10EK311	Synoptic Meteorology (postgraduate)	2 + 2 Lab	6
10EK312	Renewable Energy Sources (postgraduate)	4	6
4th Specialization: Nuclear and Particle Physics			
10EK401	Astroparticle Physics and Cosmic Rays	4	6
10EK402	Medical Physics	4	6

10EK403	Contemporary Quantum Physics and Applications	4	6
10EK111	General Theory of Relativity (postgraduate)	4	6
10EK411	Mathematical Physics (postgraduate)	4	6
10EK412	Elementary Particles (postgraduate)	4	6
10EK413	Nuclear Physics (postgraduate)	4	6
5th Specialization: Condensed Matter Physics			
10EK501	Correlated Quantum Systems	4	6
10EK502	Physics of Molecules and Nanomaterials	4	6
10EK503	Soft Matter Physics	4	6
10EK511	Physics of the Earth's Solid Crust (postgraduate)	4	6
10EK512	Physics of Semiconductor Devices (postgraduate)	4	6

Finally, the free elective courses (EΛE), out of which the students can select three (3), are listed in the table below. In addition to this list, students may also select, as free electives, any of the core electives (beyond three) or introductory specialization courses, or any course from other specializations.

FREE ELECTIVE COURSES		Hours/week	ECTS
From the Department of Physics			
10EΛE01	Atomic and Molecular Physics	4	6
10EΛE02	Stochastic Processes in Physics	4	6
10EΛE03	Applied Optics	4	6
10EΛE04	Group Theory and Applications	4	6
10EΛE05	States and Properties of Matter	4	6
10EΛE06	Non-linear Dynamical Systems	4	6
From the Department of Mathematics			
10EΛE11	Real Analysis	6	9
10EΛE11	Geometry II	6	9
From the Department of Informatics and Telecommunications			
10EΛE22	Pattern Recognition-Machine Learning	4	6
From the Department of Geology and Geoenvironment			
10EΛE31	Theoretical Geophysics	4	6

From the Department of Chemistry			
10ΕΛΕ41	Chemistry	4	6
10ΕΛΕ42	Chemistry Laboratory	4	6
From the Department of Biology			
10ΕΛΕ51	Current Issues in Cell Biology	4	6
From the Department of History and Philosophy of Science			
10ΕΛΕ61	History of Physical Sciences	4	6
From the Department of Primary Education			
10ΕΛΕ71	Physics Teaching Methods	4	6
Courses not included in the award of the bachelor's degree			
10ΕΡΕ01	Research Project I		3
10ΕΡΕ02	Research Project II		3
10ΕΡΕ03	Research Project III		3
10ΕΡΕ04	Research Project IV		3
10ΠΡΑΣΚ	Practical Training		5

5.2 Course Contents

Introductory Physics Core Courses and Basic Laboratories

10YKO01. PHYSICS I

- Linear motion. Curvilinear motion. Relative motion. Introduction to the Special Theory of Relativity.
- Impulsive forces. Collisions.
- One-body dynamics.
- Work. Energy. Dynamics of many-body systems.
- Rigid body rotation around a fixed axis.
- Rolling. Angular momentum and torque. Oscillations.
- Law of Universal Gravitation. Fluid mechanics.

10YKO02. PHYSICS II

1st Part: Kinetic theory of gases-Thermodynamics (6.5 weeks)

- Temperature. Heat. First law of thermodynamics. Thermodynamic potentials.
- Ideal gas. Kinetic theory of gases. Maxwell distribution. Specific heat.
- Reversible processes. Second law of thermodynamics. Entropy. Thermal engines.

2nd Part: Waves-Optics (6.5 weeks)

- The concept of mechanical waves. Wave equation.
- String vibrations. Types of waves (transverse, longitudinal, plane, spherical).
- Superposition. Interference. Standing waves.
- Reflection. Refraction. Geometrical optics. Wave polarization.

10YKO03. PHYSICS III

- Electric charge. Coulomb's law. Electric field. Field lines. Electric potential. Potential difference. Isolated conductor. Gauss's law: Examples and applications. Method of images. Inversion method.
- Capacitance. Capacitors. Electric current. Resistance. Ohm's law. Magnetic field. Laplace force. Force on a conductor. Applications.
- The electric current as a source of magnetic field. The Biot-Savart law. Ampère's law. Applications.
- Induction. Faraday's law. Coefficient of self-induction. RL, RC, RLC circuits. Mechanical oscillator analogues. Alternating current circuits.
- Maxwell's equations in integral and differential form. Energy of electromagnetic field. Poynting vector.
- Qualitative explanation of the propagation of an electromagnetic field perturbation.

Electromagnetic waves.

10YKO04. PHYSICS IV

- Relativistic energy and momentum of particles. Four-vector momentum-energy. Invariant mass. Black body radiation. Photoelectric effect. Compton effect. Pair production. Breaking radiation.
- de Broglie waves. Heisenberg's uncertainty principle. Two-slit experiments. Wave function. Probability amplitude. Schrödinger equation.
- Simple one-dimensional problems: Infinite and finite square well potentials, reflection from and transmission through barriers, tunneling effect.
- The Bohr atomic model. Quantum mechanical model of the atom. The hydrogen atom. Angular momentum and spin. Fine structure. Many-electron atoms.
- Selected topics from molecular, nuclear and particle physics.

10YKO05. BASIC PHYSICS LABORATORY I

Introductory lectures:

- Experimental uncertainty. Mean value. Variance. Normal distribution.
- Error propagation. Experimental process. Analysis of experimental data. Method of least squares and applications to the experimental data.
- Introduction to Monte Carlo methods. Applications and virtual experiments. Presentation in the amphitheater.

Laboratory experiments:

- Mathematical pendulum.
- Measuring g on an inclined plane with sensors. Photogates. Instantaneous and average velocity.
- Electric circuits. Ohm's και Kirchoff's laws.
- Measurement with a micrometer. Estimation of material density. Buoyancy. Archimedes' principle.
- Monte Carlo exercise.

10YKO06. BASIC PHYSICS LABORATORY II

- Study of statistical distributions.
- Study of motion with constant acceleration using Atwood engine.
- Study of viscosity of fluids.
- Rigid body rotation, moments of inertia, static and kinetic friction.
- The Cavendish experiment.
- 2nd and 3rd Newton's laws of motion, impulse and collisions.
- Natural and rotational pendulum.

- Verification of Hook’s law.
- Preparation, presentation and teaching of laboratory experiments, as well as the basic principles of experimentation in physics, by Physics Department students to other university students and high-school pupils, for the acquisition of pedagogical and educational competence by the students of the Department.

10YKO07. BASIC PHYSICS LABORATORY III

- Prism and grating spectrometers.
- Study of isothermal process of a gas and the Otto cycle.
- Measurement of the speed of longitudinal waves and elastic constants in solids.
- Measurement of convex lenses focal distance and relevant aberration errors.
- Study of polarized light. Measurement of rotation capacity by polarimeter.
- Measurements with Michelson interferometer.
- Study of wave phenomena with microwaves (reflection, refraction, polarization, interference, diffraction, standing waves.
- Interference and diffraction using laser light on adequate gratings.
- Preparation, presentation and teaching of laboratory experiments, as well as the basic principles of experimentation in physics, by Physics Department students to other university students and high-school pupils, for the acquisition of pedagogical and educational competence by the students of the Department.

10YKO08. BASIC PHYSICS LABORATORY IV

- Magnetic field of circular conductors and coils. The Biot-Savart law.
- Study of RLC resonance circuit. Use of oscilloscope.
- Power generation. Lenz’s law. Motor. Generator. Use of stroboscope.
- Motion of electrons in a homogeneous magnetic field. Measurement of charge-to-mass ratio
- Hall effect in conductors. Carriers calculation.
- Spectroscopy. Spectral lines and Bohr theory.
- Photoelectric effect.
- Operation and current-voltage characteristics of transformers.
- Preparation, presentation and teaching of laboratory experiments, as well as the basic principles of experimentation in physics, by Physics Department students to other university students and high-school pupils, for the acquisition of pedagogical and educational competence by the students of the Department.

Mathematical Education

10YKO10. BASIC MATHEMATICAL METHODS

- Complex numbers. Geometrical representation. De Moivre's theorem. Connection with geometry.
- Vectors and vector operations (addition-subtraction, inner and outer product) with applications to kinematics and geometry. Use of indices and summation convention.
- Matrices. Matrix operations. Matrices as transformations in two or three dimensions. The determinant as volume ratio. Operations on determinants and solution of linear algebraic systems. Inverse matrices. Rotation matrices in two dimensions.
- Eigenvectors and eigenvalues of 2×2 and 3×3 matrices. Matrix diagonalization. Invariance of the trace and determinant.
- Vector spaces as an algebraic structure. Linear independence. Basis. Dimension. Subspaces.
- Metric spaces. Vector orthogonalization.

10YKO11. ANALYSIS I AND APPLICATIONS

- Numbers (natural, rational, irrational). Mathematical induction. Basic inequalities. Bound of a set. Supremum and infimum of of a set.
- The field of real numbers. Bounded sets of numbers. Upper and lower bound. Completeness.
- Sequences. Series. Radius of convergence of power series.
- Continuous functions and their properties.
- Differentiation. The mean value theorem. Extrema of functions and Taylor theorem. Fundamental functions.
- Riemann integral (upper and lower bound of an integral). Integration techniques. Approximation of definite integrals.

10YKO12. ANALYSIS II AND APPLICATIONS

- Vectors. Vector functions on the plane and in space. Inner and outer product. Lines. Planes. Surfaces. Arc length. Unit tangent vector. Multivariable functions. Derivatives. Limit. Continuity.
- Partial derivatives. Chain differentiation. Directional derivative. Gradient vectors. Tangent planes. Linearization. Differentials. Extrema. Saddle points.
- Lagrange multipliers. Partial derivatives of functions under constraints. Taylor's theorem for multivariable functions.
- Curvilinear coordinate systems. Norm. Gradient. Divergence. Curl.

- Multiple (double, triple) integrals, in cartesian and other coordinates. Applications to the evaluation of areas, moments of inertia, centers of mass. Change of variables (jacobian determinant).
- Integration of vector fields. Line and surface integrals. Path independence. Potential functions and conservative fields. Green's, Gauss's, Stokes' theorems and applications.

10YKO13. PROBABILITY THEORY

- Combinatorial analysis. Stirling's formula.
- Axiomatic foundation of the Theory of Probability. Independence. Conditional probability. Bayes theorem.
- Discrete random variables. Continuous random variables.
- Random walk. Diffusion as random walk.
- Estimate of a random variable. Least mean square error.
- Weak law of large numbers. The central limit theorem.

10YKO14. ORDINARY DIFFERENTIAL EQUATIONS

- Autonomous scalar differential equations of first order: Well-posed initial value problems.
- Autonomous scalar differential equations of first order: Equilibrium points, stability, introduction to bifurcations.
- First-order linear differential equations in one and two dimensions, with constant and variable coefficients.
- Second-order linear differential equations, homogeneous and inhomogeneous.
- Power series solution of second-order linear differential equations.

10YKO15. MATHEMATICAL METHODS IN PHYSICS I

- Complex numbers. Elementary functions of a complex variable. Multivalued functions. Branches.
- Continuity. Derivative of a complex function. Analytic functions and Cauchy – Riemann equations. Harmonic functions.
- Mapping by elementary functions. Conformal mapping and applications in physics.
- Complex power series. Taylor and Laurent series. Classification of singularities.
- Cauchy theorem and residue theorem. Evaluation of integrals.
- Fourier transform. Applications to partial differential equations. Stationary phase method.

10YKO16. MATHEMATICAL METHODS IN PHYSICS II

- Introduction to partial differential equations, with examples from physics (wave equation, diffusion equation, Laplace equation, etc.). Classification of partial differential equations. Initial and boundary conditions. Solution methods.
- Inner product spaces: Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization. Complete infinite-dimensional functional spaces: Bessel's inequality, Parseval's theorem, basis of an infinite-dimensional space.
- Fourier series. Linear operators in complete spaces: Self-adjoint operators, eigenvalue problems, spectral theorem of self-adjoint operators. Sturm-Liouville systems.
- Study of the wave equation and the diffusion equation on the line, the half line and a finite interval. Fundamental solutions and Green's functions. Reflections and sources.
- Boundary value problems with homogeneous and inhomogeneous boundary conditions for the wave equation and the diffusion equation. Problems in cartesian, cylindrical and spherical coordinates.
- The Laplace equation. Basic properties of harmonic functions. Solution of Laplace equation in special geometries in two and three dimensions.

Introductory Courses: Computer Science

10YKO20. COMPUTER SCIENCE

- Operating systems. Algorithms. Structure of a program.
- Programming in the C language.
- Controlling program flow. Conditions. Loops.
- Arrays. Files. Pointers. Functions.
- Recursive sequences. Numerical integration. Differentiation.
- Pseudorandom numbers. Applications.
- Introduction to Python.
- Laboratory exercises.

10YKO21. COMPUTATIONAL PHYSICS

- Algorithms and their implementation on computers. Numerical calculations and uncertainties. Truncation and rounding errors in numerical solutions. Frequency diagrams (histograms).
- Random number generators. Inverse transform method. Rejection sampling. Introduction to the Monte-Carlo method for integration and simulation of stochastic physical problems.
- Solution of algebraic equations of one variable and linear systems of equations. Applications to simple physics problems.

- Fitting using the least squares method, polynomial interpolation, and their applications in laboratory measurements.
- Numerical differentiation, numerical integration, and their applications to problems in basic physics.
- Numerical solution of ordinary differential equations of 1st order, 2nd order, and systems. Applications to simple physics problems.

Basic Physics I

10YKO31. MECHANICS I

- Kinematics of a point object. Inertial systems. Newton's laws.
- Conservation laws. Conservative forces. Integrals of motion.
- Systems with one degree of freedom: Motion boundaries, study of equilibrium points with perturbation methods and phase diagrams, harmonic oscillator.
- Impulsive forces. Collisions. Moving coordinate systems: Motion in a non-inertial system and applications.
- Central forces: Limits, integrals of motion, circular orbits and their stability, inverse square law forces, Kepler's laws.
- Two-body problem. The gravitational field. Gravitation from extended bodies. Tidal forces.
- Lagrangian and hamiltonian formalism.

10YKO32. ELECTROMAGNETISM I

- Conductors. Capacitors. General properties of the solutions of Laplace's equation. Uniqueness theorems.
- Solution methods: Boundary-value problems in cartesian, spherical, and cylindrical coordinates.
- Multipole expansion. Dielectrics. Polarization. Bound charges. Polarization mechanisms.
- Electric displacement. Boundary conditions. Linear/non-linear dielectrics and capacitors. Solution of Laplace's equation in dielectrics. Energy and forces in dielectrics.
- Magnetostatics. Ampère's law. Vector potential. Boundary conditions. Techniques for determining the vector potential. Magnetostatic fields in matter.
- Paramagnetic and diamagnetic materials. Magnetization. Bound currents. Magnetic field. Boundary conditions. Linear/non-linear magnetic materials. Magnetic scalar potential. Ferromagnetism.
- Induction law. Maxwell's equations.

10YKO33. QUANTUM MECHANICS I

- Principles of quantum mechanics. Observables in quantum mechanics. Measurement of observables, expectation values and uncertainty.

- Schrödinger equation. Time evolution of systems and observables.
- Continuous spectrum. Position and momentum space.
- Uncertainty relations. Energy-time uncertainty.
- Particle binding in one-dimensional potentials. Harmonic oscillator. Scattering in one dimension.
- Schrödinger equation for N particles. Three-dimensional motion. Angular momentum.
- The hydrogen atom.

10YKO34. STATISTICAL PHYSICS I

- Foundations of classical statistical physics.
- Isolated system. Microcanonical ensemble.
- System in a thermal bath. Canonical ensemble.
- Thermal system in the presence of generalized external forces: Pressure, chemical potential. Gibbs distribution. Grand canonical ensemble.
- Interacting systems. Phase transitions. Mean field theory: Lattice gas model.
- Quantum statistics. The Bose-Einstein and Fermi-Dirac distributions.
- Ideal quantum gases: Degenerate Fermi gas, Bose-Einstein condensation.

10YKO35. SPECIAL THEORY OF RELATIVITY

- Elements of the theory of tensors: Covariant and contravariant four-vectors, metric.
- Spacetimes: Space-like, light-like and time-like four-vectors.
- Relativistic kinematics and dynamics: Lorentz transformations, invariant quantities, four-velocity, four-acceleration, four-momentum.
- Classical paradoxes in special relativity and their analysis.
- Relativistic particle reactions: Conservation of four-momentum.
- Special relativity and electrodynamics: Covariant formulation of Maxwell's equations, electric and magnetic field transformations.

Core Elective Courses

10EKO01. MECHANICS II

- The principle of least action.
- Calculus of variations. Euler-Lagrange equations. Lagrangian of a charged particle in an EM field.
- Symmetries and Noether's theorem. Lagrange multipliers and constraints.
- Dynamics of the rigid body.
- Normal modes of an oscillating system.
- Legendre transformation. Hamilton equations. Phase space flow. Poisson brackets.

- Symmetries and conserved quantities in hamiltonian mechanics. Canonical transformations.

10EKO02. ELECTROMAGNETISM II

- Applications of Maxwell’s equations. Introduction of the concept of electromagnetic potentials and gauges.
- The Maxwell stress tensor. Energy-momentum conservation of the EM field.
- EM waves in non-conducting and conducting media. Reflection and refraction of EM waves. Total reflection. Brewster angle.
- Dispersion of waves.
- Waveguides, resonant cavities and transmission lines.
- Electromagnetic radiation. Electric and magnetic dipole radiation. Liénard-Wiechert potentials. Fields from moving charges. Radiative power. Larmor formula.
- Radiation reaction.

10EKO03. QUANTUM MECHANICS II

- Dirac notation. Solution of the simple harmonic oscillator using creation and annihilation operators. The Schrödinger and Heisenberg pictures.
- Angular momentum and spin. Addition of angular momenta. Identical particles and Pauli exclusion principle.
- Interaction of charged particles with electromagnetic fields. Zeeman effect.
- Time-independent perturbation theory. The real hydrogen atom.
- Time evolution in time-dependent potentials. Elements of time-dependent perturbation theory. The Fermi golden rule.
- Introduction to three-dimensional scattering.
- Transitions between energy levels.

10EKO04. STATISTICAL PHYSICS II

- Linear response to an external time-dependent excitation. Fluctuation-dissipation theorem.
- Ferromagnetism. Exchange interaction. Ising model. Weiss theory.
- The Bragg-Williams approximation. Applications.
- The Bethe approximation. Bethe lattices. Applications.
- Symmetry. The concept of order parameter. Construction of the Landau functional.
- First- and second-order phase transitions. Critical points. Critical exponents. Correlation length. Scaling laws. Perturbations. Response functions.
- Phase transitions in quantum systems: Superfluids, Stoner magnetism.

10EKO05. FLUID DYNAMICS

- Introduction. Kinematics and conservation laws. Euler and Navier-Stokes equations.
- Bernoulli's equation. Hydrostatic equilibrium. Gravity waves.
- The concept of instability. Rayleigh–Taylor instability. Kelvin-Helmholtz instability.
- Introduction to turbulence. Turbulent flows and the law of conservation of turbulent kinetic energy.
- Geophysical fluids: Coordinate systems and the effect of the Earth's rotation. Scaling analysis. Vorticity conservation.
- Circulation in geophysical fluids in the presence of rotation: Geostrophic flow. Ekman layers. Linear barotropic waves.
- The influence of stratification in geostrophic fluids: Geophysical flows, waves and instabilities in the presence of stratification and rotation.

Introductory Specialization Courses - Research in a Specialization

10EKA01. INTRODUCTION TO ASTROPHYSICS

- Introduction: Radiation, flux, luminosity, brightness, magnitudes, distance ladder in the Universe.
- Stars: Radiation transfer, black body, stellar temperature, spectral classification, HR diagram, stellar interiors, stellar evolution of solar-type stars.
- Interstellar space and star formation: Jeans criterion, homologous collapse, protostars, protoplanetary disks.
- Sun: Solar activity, solar system.
- Galaxies: Types, kinematics, formation, evolution, active galaxies.
- Cosmology: Distance ladder expansion of the Universe, Newtonian Cosmology, cosmic microwave background radiation, dark matter.
- Laboratory exercises: Solar radiation. Calculating basic physical parameters of stars - stellar evolution. Star clusters. Age determination - estimating distances. The expansion of the Universe and the Hubble constant.

10EKA02. INTRODUCTION TO ELECTRONIC PHYSICS

- Introductory concepts of signals and systems. Circuit analysis and quadrupole theory.
- Time and frequency domain analysis of circuits. Introduction to operational amplifiers.
- Introduction to semiconductor physics. Diodes. The dipole transistor. The field effect transistor: Characteristics, operation, circuits.
- Basic principles of continuous and discrete time signals. Information signals transmission.
- Introduction to filters. Digital signals and circuits: Basic principles, operation.
- Analog to digital signal conversion: Methods, objectives, procedure.

- Laboratory experiments: Introduction to measuring devices in electronics, basic concepts and elements of electronic physics, electrical and electronic circuits. Signals and systems, introduction to operational amplifiers and their applications in physics. Basic concepts of semiconductors and semiconductor devices, elements from semiconductor physics, p-n junction and applications in physics. Bipolar junction and field effect transistors in linear and non-linear operation mode, and applications in physics.

10EKA03. INTRODUCTION TO ATMOSPHERIC PHYSICS

- Composition and structure of the atmosphere.
- Atmospheric thermodynamics. Application of the laws of ideal gases in the atmosphere. Thermodynamic laws and application in the atmosphere. Clausius–Clapeyron equation. Thermodynamic variations of air masses.
- Physical and chemical processes in the atmosphere. Depletion of stratospheric ozone.
- Balance of four cycles: Radiation balance, water vapour balance, energy balance, atmospheric motion. Equations of motion. Continuity equation. Energy equation.
- Nature and characteristics of solar radiation, Earth radiation and atmospheric radiation. Spectrum signature.
- Basic principles and transmission mechanisms of electromagnetic radiation in the atmosphere. Reflection, absorption, scattering, emission.
- Radiation budget at the top of the atmosphere and the Earth's surface. Greenhouse phenomenon.
- Forces exerting in the atmosphere. Winds.
- Planetary scale motion: Hadley cell, Ferrel cell, polar cell.
- Laboratory experiments: Long- and short-wavelength radiation. Air temperature and humidity. Surface wind. Vertical thermal and moisture profile of the atmosphere and static stability. Thermodynamic diagrams.

10EKA04. INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS

- Object of the course and introductory concepts. Characteristic scales and units. The Standard Model: Quarks & leptons. Basic conservation principles. Relativistic kinematics.
- The field concept. Interactions via boson exchange. Yukawa theory. Feynman diagrams. Virtual particles. Antiparticles. EM and weak interactions and their unification.
- Chromodynamics. Strong interactions. Symmetries: Parity, charge conjugation, time reversal. Static quark model. Hadron classification.
- Nuclide chart και properties of nuclei. Valley of β-stability. Semi-empirical formula. Mirror nuclei.
- Charge distribution. Scattering of electrons from nuclei. Radioactivity, α-decay. Tunneling effect.
- Nuclear potentials. Deuterium. Mean field. Independent particle model. L-S coupling. Shell structure.

- Laboratory experiments: Geiger-Müller detectors, detection and absorption of β radiation, detection and absorption of γ radiation. Scintillator detectors, interaction of γ radiation with matter, dosimetry.

10EKA05. INTRODUCTION TO SOLID STATE PHYSICS

- The structure of solid matter. Bravais lattices. Unit cell.
- Reciprocal lattice. Diffraction from periodic structures. Bragg's law.
- Attractive and repulsive interactions in solids, cohesion. Inert-gas crystals, ionic crystals, metals.
- Lattice vibrations. Exact solution of the monoatomic and diatomic linear chain. Phonons.
- Electron states in a periodic potential. The Kronig-Penney model. Metals, semiconductors and insulators.
- Semiclassical electron dynamics in a crystal. Crystal momentum, effective mass. Relaxation time, electric conductivity tensor.
- Laboratory experiments: The energy gap of germanium (Ge) semiconductor. Electron diffraction by pollycrystalline graphite.

10EKA06 & 10EKA07. FINAL-YEAR DISSERTATION I & II

- The Final-Year Dissertation (FYD) is optional and pertains to the field chosen by the student. It lasts for two semesters and is usually carried out during the final (4th) year of studies under the supervision of a faculty member from the Department Section that serves the specific field. The FYD corresponds to a total of 14 ECTS credits, equally distributed over the two semesters.
- In special cases, the FYD can be supervised by any faculty member of the Department of Physics, provided that the relevant Section approves that the topic falls within its field. Conducting an undergraduate thesis outside the Department of Physics (within another Department of NKUA or research center in Greece) is also possible with the approval of the relevant Department and the appointment of a co-supervisor, who will submit the grade.
- Students are strongly encouraged to choose to undertake a FYD: the knowledge benefits and skills it offers are numerous. Additionally, for many students, the FYD is their first exposure to research and research methodology, and it also serves as a precursor to potential postgraduate studies.
- Despite the aforementioned benefits, students who choose not to undertake a FYD must select the other two introductory specialization courses (in addition to the three that all students are required to take).

Compulsory Courses of the 1st Specialization (Astrophysics)

10YK101. STELLAR ASTROPHYSICS

- Radiative transfer: Specific intensity, flux, pressure, equation of radiative transfer, simple case solutions, optical depth, scattering, mean free paths, black-body properties, thermodynamical equilibrium, Einstein coefficients.
- Stellar interiors. Post main-sequence evolution. Massive Stars. Variable Stars.
- Star formation. Protostars. Hayashi Track.
- Stellar Atmospheres.
- Binary Stars. Mass determination and evolution. Examples of evolved binary stars.
- Compact stars: White dwarfs, neutron stars, pulsars, interior and magnetospheres, supernova explosions and remnants, black holes, X-ray binary systems.

10YK102. ASTROPHYSICAL FLUIDS

- Introduction. Equations and conservation laws for compressible fluids.
- Lane-Emden equation. Static atmosphere. Laval nozzle. Parker wind.
- Bondi accretion. Accretion disks.
- Description of plasma. Plasma parameters.
- Magnetohydrodynamic equations. Magnetic pressure and tension.
- Dynamo equation: Diffusion and advection of magnetic flux.
- Magnetohydrodynamic waves. Shock waves.
- Fluid interaction. Blast waves.

10YK103. ASTROPHYSICS LABORATORY

- Introduction: Photometry, spectroscopy, interferometry, particle detection, MATLAB. Two (2) out of the following five (5) exercises:
- Determination of the mass of the black hole at the center of our galaxy.
- Gerostathopoulio Observatory.
- Radio.
- X – γ rays.
- Van Allen belts: Variability of energetic electrons and electromagnetic oscillations in Earth’s magnetosphere.
- Laboratory project and presentation.

Elective Courses of the 1st Specialization (Astrophysics)

10EK101. HIGH ENERGY ASTROPHYSICS

- Introductory concepts: Sources of high-energy radiation, non-thermal photon spectra, X-ray and γ-ray astronomy.

- Cosmic rays: Observations, hadronic interactions.
- Photon-photon pair production: Energy threshold, cross section, optical depth, astrophysical applications.
- Radiation fields: Larmor equation, Thomson scattering.
- Compton scattering: Kinematics, energy losses, radiation spectrum, astrophysical applications.
- Synchrotron radiation: Basic principles, energy losses, radiation spectrum, astrophysical applications.
- Particle acceleration to high energies: Fermi acceleration, electrostatic gap acceleration, astrophysical applications.
- Relativistic magnetohydrodynamics: Basic concepts, application to astrophysical jets.
- Plasma effects on high-energy radiation processes: Cherenkov radiation, Razin effect.

10EK102. SPACE AND SOLAR PHYSICS

- Characterization of a plasma, plasmas in space, charged particle motion in electromagnetic fields, adiabatic invariants.
- Main features of the Sun, structure of the Sun, solar magnetic field, solar corona.
- The active Sun: Sunspots, flares, coronal mass ejections, high speed streams, corotating interaction regions, solar energetic particles, solar cycle, cosmic rays.
- Planetary magnetism, terrestrial magnetosphere, geomagnetic field, topology of the magnetosphere, plasma populations and currents, plasma sources and sinks, solar-terrestrial coupling, open and closed magnetosphere models.
- Geospace disturbances: Magnetospheric substorms, aurora, geomagnetic storms.
- Energetic particles in geospace: Ring current, Van Allen radiation belts, particle acceleration and loss mechanisms.
- Outer planets: magnetosphere and moons of Jupiter, magnetosphere, rings and moons of Saturn, magnetospheres of Uranus and Neptune.
- Inner planets: Magnetic field of Mars, ionosphere of Venus, magnetosphere of Mercury.

10EK103. GALAXIES

- Interstellar medium. Phases of the interstellar gas. Cooling and heating functions. Mass measurement (optically thin/thick conditions), 2 level approach. Initial mass function και scaling laws of molecular clouds.
- Galaxy formation. Gas collapse and galaxy masses.
- Morphology of galaxies. Analytic light profiles. Scaling laws.
- Galaxy evolution. Detection of various galaxy populations. Changes in the morphology (inflows, gas depletion, mergers). Mass function evolution. Stellar population synthesis models.
- Active galactic nuclei. Unified model. Diagnostics of AGN identification. Duty cycle.
- Formation of first black holes. Luminosity function of black holes and its time evolution,

derivation of mass enclosed in black holes.
- Dark matter and galaxies. Detection methods. Profile. Masses in galaxies vs. halos.
- Large-scale structure. Early Universe and formation of first structures. Detection of large scales structure.
- Observational cosmology. Cosmological parameters. Distances. Evolution of observable quantities with epoch.

10EK111. GENERAL THEORY OF RELATIVITY (postgraduate)

- Spacetime curvature, metric, and geodesics.
- Physical implications of spacetime curvature: perihelion precession of Mercury, light bending, and gravitational redshift.
- Christoffel connection, Riemann, Ricci, and Weyl tensors, and scalar curvature.
- Einstein–Hilbert action, Einstein field equations in vacuum and in the presence of matter, Newtonian limit.
- Normal coordinates and geodesic deviation (Jacobi) equations.
- Geometric symmetries of spacetime, Killing vector fields, and their application to the study and solution of the Einstein equations.
- Fundamental examples of black hole metrics: Schwarzschild and Reissner–Nordström solutions.
- Weak-field limit and gravitational waves.
- Basic elements of cosmology.
- Energy conditions and their role in General Relativity.

10EK112. OBSERVATIONAL TECHNIQUES AND DATA ANALYSIS IN ASTROPHYSICS (postgraduate)

The course provides intensive training in astronomical observing techniques, covering the entire cycle from strategic observation planning to data reduction, analysis, and extraction of physical results. The material includes the principles of radiation detection across all wavelengths, highlighting both common features and differences among telescopes and detectors at different wavelengths, for both ground-based and space-based observatories. It also covers fundamental principles of instrumentation, coordinate systems, and observing techniques (such as photometry, spectroscopy, integral Field Unit spectroscopy – IFU, radiometry, interferometry, polarimetry). As part of the course, relevant laboratory exercises are offered using the Department of Physics' own facilities (Gerostathopoulio Observatory, radio telescopes), as well as laboratory exercises in calibration and data processing from major international telescopes using both provided and custom codes.

Compulsory Courses of the 2nd Specialization (Electronics, Computers, Telecommunications and Control)

10YK201. SIGNALS AND SYSTEMS

- Introduction to signals and systems.
- Convolution.
- Fourier analysis in the continuous time domain and applications.
- Laplace transform: Properties and applications.
- Sampling.
- Fourier analysis in the discrete time domain and applications.

10YK202. COMPUTER SYSTEM ORGANIZATION

- Introduction to Discrete Mathematics: Combinations, permutations, series, recurrent relations, Pascal triangle, graphs, binary trees.
- Arithmetic systems: Representation of binary numbers, computer arithmetic, floating point numbers.
- Digital circuit design, Register Transfer Level (RTL): Gates, combinatorial and sequential circuits, processor design, control and finite state machines.
- Computer systems organization: Machine language, addressing modes, peripherals, stack and subroutines.
- Introduction to data structures and algorithms: Linked lists, trees and implementation in C, algorithms, time complexity, proof of correctness.

10YK203. ELECTRONICS, COMPUTERS, TELECOMMUNICATIONS AND CONTROL LABORATORY

- Introduction to simulation tools of telecommunication systems. Continuous and discrete signals. Fourier transform.
- Convolution. Autocorrelation and heterocorrelation of signals.
- Continuous time Fourier transform. Sampling.
- Design, implementation and measurement of filters.
- Field effect transistor. Timing circuits.
- Signal processing: Execution time improvement with the use of parallelization and an FPGA implementation example.
- Laboratory project and presentation.

Elective Courses of the 2nd Specialization (Electronics, Computers, Telecommunications and Control)

10EK201. ADVANCED TOPICS IN ELECTRONICS

- Design thinking on electronic functions, devices, circuits and systems.
- Problem solving supported by circuit analysis/design software.
- Application on power conversion/power supplies: Linear, switching.
- Application on wave-shaping: Signal conversion/processing.
- Application on amplification. Amplifiers: Discrete, integrated.
- Application on analog/digital signal management. Digital circuits.

10EK202. OPTOELECTRONICS AND OPTICAL COMMUNICATIONS

- Introduction. General description of optoelectronic systems and applications.
- Light propagation in optical fibers.
- Light detectors: Photoconductive detector, typical photodiode structures, phototransistor, MSM.
- Optoelectronic sources: LED, LASER.
- Optical amplifiers: EDFA, RAMAN, SOA.
- Optical communication systems: Optical links design.

10EK203. TELECOMMUNICATIONS

- General description of a telecommunication system.
- Amplitude and frequency modulation. FM emitter and receiver. Multiplexing by frequency division.
- Sampling. Pulse modulation (amplitude, width, position) and pulse code modulation systems.
- Digital modulation techniques (ASK, FSK, PSK, QPSK).
- Propagation channel characteristics.
- Laboratory experiments.

10EK204. MICROELECTRONICS

- Development and fields of application of microelectronics in the realization of integrated circuits of silicon or compound semiconductors.
- Semiconductor materials (Si, GaAs).
- Growth of Si and GaAs crystals.
- Epitaxy. Lithography. Diffusion. Ion implantation and oxidation.
- Etching processes and material deposition methods (metallization).

- Structure of basic devices and physical design of integrated circuits: p-n diodes, bipolar transistor, MOSFET and CMOS transistors, realization of logic gates.

10EK211. INTRODUCTION TO CONTROL SYSTEMS (postgraduate)

- Basic concepts. Laplace transform. Inverse transform. Applications.
- Transfer function (of s). Feedback. Errors.
- State equations: Electrical, mechanical, electronic systems.
- Matrix exponential. Solution of LTI in time and complex frequency domains.
- Stability SISO, Nyquist, MIMO in state space.
- Bode plots. Phase lag and lead networks and design.
- Discrete time. Z transform. Inverse transform. Stability.

10EK212. COMPUTER SYSTEMS (postgraduate)

- Types of operating systems, their structure, processes and system calls, processes and threads.
- Memory management. Virtual memory and paging and implementation issues.
- Directories. Input/output, device handlers, and I/O software design principles.
- Deadlocks and recovery. Avoidance. Deadlock prevention.
- Security and cryptographic principles.
- Principles of multiprocessor operating systems.
- Implementation in C and C++ code of relative example applications.

Compulsory Courses of the 3rd Specialization (Environmental Physics)

10YK301. ATMOSPHERIC DYNAMICS

- Basic concepts. Forces. Equations of motion, energy, mass conservation and simplified forms: Incompressible, anelastic, Boussinesq approximation. Equation of state.
- Reference systems, coordinate systems. The pressure and potential temperature as vertical coordinate. Pressure gradient.
- Characteristic scales of atmospheric motions. Scale analysis. Simplified forms of the basic equations. Thermal wind. Ekman spiral.
- Vorticity, conservation of vorticity (absolute and relative). Vorticity advection.
- Atmospheric stability (thermodynamic). Dynamic stability/instability. Small perturbations. Kelvin-Helmholtz, Raleigh-Taylor, Rossby waves.
- Taylor-Goldstein equation. Internal/external gravity waves, acoustic and Lamb waves. Wave trapping in the atmosphere.

10YK302. PHYSICS OF THE ATMOSPHERIC BOUNDARY LAYER

- Introduction. Structure and development. The role of the synoptic scale system.
- Laminar and turbulent flows. Semi-empirical theories of turbulence.
- Boundary conditions. Soil heat and momentum transfer at the surface. Development of mixing layer. Entrainment mechanism at the top.
- Turbulent kinetic energy. Stability indices.
- The homogeneous turbulent atmospheric boundary layer.
- The marine atmospheric boundary layer.
- Non-homogeneous atmospheric boundary layers. Internal boundary layer. Urban boundary layer.
- Complex terrain. Flow over a hill, katabatic-anabatic winds.

10YK303. ENVIRONMENTAL PHYSICS LABORATORY

- Meteorological charts analysis.
- Vertical wind distribution of wind.
- Applications of satellite remote sensing in environmental studies.
- Mixing height calculation.
- Air pollution distribution.
- Laboratory project and presentation.

Elective Courses of the 3rd Specialization (Environmental Physics)

10EK301. QUALITY OF ATMOSPHERIC ENVIRONMENT

- Anthropogenic and natural sources of air and particle pollutants. Troposphere photochemistry. Troposphere chemistry.
- Chemical equilibrium. Enthalpy. Entropy. Free energy of chemical reactions. Chemical kinetics. Reaction rate. Reaction mechanisms.
- Basic definitions of air pollution estimation. Theories of atmospheric diffusion. The Gauss equation. Diffusion equation.
- Introduction to pollutant diffusion and dispersion models: Principles, basic parameters, input data, applications.
- Methodology of measuring physical parameters and atmospheric pollutants. Measurements of atmospheric parameters. Measurements of atmospheric pollution.
- Cleaning mechanisms of the atmosphere. Air pollution in urban areas.
- Quality of atmospheric environment and urban microclimate.

10EK302. PHYSICAL OCEANOGRAPHY

- Seawater properties. Surface and vertical distribution of physical oceanography parameters in the world ocean.
- Equations of motion in the ocean. Conservation laws.
- Currents without friction, shallow ocean equations and the concept of vorticity.
- Currents with friction: Wind-driven circulation, Ekman theory and the westward intensification of ocean circulation.
- Waves at the surface of the ocean. Internal waves. Tides. Ocean waves in the presence of Earth's rotation.
- Thermohaline circulation.

10EK303. CLIMATE-CLIMATE CHANGE

- General atmospheric circulation.
- Planetary energy budget. Water balance. Hydrological cycle. Carbon cycle.
- Climate categorization.
- The greenhouse gases and air particles: Sources and their role.
- The atmosphere and the climate system. Chemical and physical processes related with the balance of the four cycles (radiation balance, water vapor balance, energy balance, atmospheric motion).
- Natural variability of the atmosphere and oceans. Anthropogenic changes.
- Mechanisms and time of atmosphere-ocean-land interaction. Climatic Climatic coercion.
- Potential of global warming.
- Basic equations of climate simulations. Initial and boundary conditions. Feedback mechanisms.

10EK311. SYNOPTIC METEOROLOGY (postgraduate)

- Vertical structure of atmosphere. Isobaric analysis. Surface charts and charts with height.
- Air masses. Fronts. Depressions and anticyclones. Tropical cyclones.
- 850 και 750 hPa chart. Temperature advection.
- 500 hPa chart. Vorticity and vorticity advection. Vertical motion. Thickness.
- 300 hPa chart. Jet stream. Rossby waves. Divergence/convergence.
- Structure and motion of synoptic scale systems. Cyclogenesis and anticyclogenesis.
- Characteristic weather types in Greece related with extreme events.

Laboratory experiments:

- Surface charts (2 weeks).
- 850 και 700 hPa chart.

- 500 hPa chart.
- 300 hPa chart.
- Satellite data associated with the analysis of weather charts.
- Thermodynamic structure of atmosphere. Tephigrams.
- Combined analysis of weather charts (case studies).
- Verification of forecasts (case studies).

10EK312. RENEWABLE ENERGY SOURCES (postgraduate)

- Forms of energy. Principles of conversion and conservation of energy. Storage and transfer of energy.
- Solar Energy: Earths' radiation balance. Physical principles for power generation, energy content and conversion in photovoltaics. Applications.
- Wind energy: Physical principles for power generation, energy content and forms of conversions. Wind turbines. Applications.
- Biomass: Biophysical principles for power generation, energy content and forms of biomass. Applications
- Geothermal energy: Physical principles for power generation, energy content and forms of conversions. Applications.
- Energy from waves, tides and osmosis: Principles for power generation, energy content and forms of conversions. Applications.
- Other forms of energy (hydroelectric energy, hydrogen).
- Principles of bioclimatic and sustainable building design. Innovative materials (cool, thermochromic etc.). Energy efficiency.
- Solar and wind energy potential in Greece.

Compulsory Courses of the 4th Specialization (Nuclear and Particle Physics)

10YK401. NUCLEAR PHYSICS

- Elements of the physics of nucleons and their interactions.
- Nucleon-nucleon strong interaction.
- Quantum many-body theory. Mean field approach. Models of nuclear structure.
- Experimental methodology and instrumentation in nuclear physics.
- Theoretical approach to nuclear decays (α-, β-, γ-decay).
- Exotic nuclei. Elements of nuclear astrophysics.

10YK402. ELEMENTARY PARTICLES

- Introduction: Natural units, summary of elementary particles and interactions.

- Experimental devices: Kinematics. Accelerators-colliders. Large detectors.
- Symmetries in particle physics: Groups SU(2) of spin and isospin, SU(3) of flavor and color. Symmetries C and P. Representations of SU(3). Classification of mesons and baryons. Magnetic moments of baryons.
- Relativistic quantum mechanics: Klein-Gordon equation. Dirac equation. Free-particle solutions. Antiparticles. Massless fermions.
- Scattering: Non-relativistic perturbation theory, Fermi golden rule. Spinless electron in electromagnetic field. Electron-muon scattering. Feynman diagrams. Scattering amplitude and cross section. Electron with spin in electromagnetic field. Møller scattering.
- Weak interactions: Fermi theory for β-decay. Parity violation. The Wu experiment. Unification of electromagnetic and weak interactions. The W and Z bosons. Muon and pion decay. Cabibbo angle. CKM matrix. CP symmetry violation.
- Neutrino physics: neutrino mass, neutrino oscillations.

10YK403. NUCLEAR AND PARTICLE PHYSICS LABORATORY

- Measurement of hadronic and muonic components of the cosmic radiation.
- γ-γ angular correlation.
- Study of Compton scattering.
- Study of environmental radioactivity.
- Real event analysis from LHC measurements.
- Laboratory project and presentation.

Elective Courses of the 4th Specialization (Nuclear and Particle Physics)

10EK401. ASTROPARTICLE PHYSICS AND COSMIC RAYS

- Introduction: What is astroparticle physics. The role of elementary particle physics in understanding the universe. The discovery of cosmic particles.
- Cosmology. The early universe.
- Expansion of the universe. Hubble law. Thermodynamics of the early universe. Big bang. Cosmic Microwave Background (CMB). Neutron to proton ratio. Primitive nucleosynthesis. Neutrino decoupling.
- CMB measurements and consequences to cosmology. Recent experimental results on cosmic ray physics (WMAP dark matter). Dark energy.
- Cosmic rays (CR). Primary cosmic rays. Properties of primary CR: Energy spectra, density, isotropy. Neutrinos, γ rays, and neutrons from cosmic sources. Secondary cosmic rays. Cosmic ray cascades. Origin and mechanisms of cosmic rays acceleration.
- Cosmic rays detection methods and devices: Hadronic shower, high-energy γ-ray, neutrinos, and neutron detection experiments.
- Recent results from hadronic shower, neutrinos, γ-ray, and dark matter experiments.

10EK402. MEDICAL PHYSICS

- Radiation physics. Production of ionizing and non-ionizing radiation. Interaction of photons with matter. Interaction of charged particles with matter. Bragg curve.
- Biological effects of radiation. Radiation protection. Dosimetry.
- Medical imaging. Diagnostic radiology.
- Principles of computed tomography. Sinogram. The tomographic problem as an inverse transformation. Radon transform.
- Computed Tomography (CT). Single-Photon Emission Computed Tomography (SPECT). Positron Emission Tomography (PET).
- Non-ionizing imaging techniques: Magnetic Resonance Imaging (MRI), ultrasound imaging.
- Radiotherapy. Brachytherapy. Heavy-ion therapy.

10EK403. CONTEMPORARY QUANTUM PHYSICS AND APPLICATIONS

- Time-dependent perturbation theory. Matter-radiation interaction. Applications.
- Open quantum systems, Density matrix.
- Quantum coherence-decoherence.
- Quantum entanglement. Elements of measurement theory. The EPR paradox. Bell inequalities.
- Elements of quantum information and quantum computers.

10EK411. MATHEMATICAL PHYSICS (postgraduate)

- Special functions and orthogonal polynomials. Expansion in eigenfunctions. Laplace, diffusion, Helmholtz, Poisson equations.
- Hilbert transform. Dispersion relations. Advanced complex integration techniques and their applications.
- Saddle point and stationary phase approximations. Asymptotic expansions.
- Green's functions: Construction of Green's functions for the Helmholtz, Poisson, Laplace equations and for the wave equation.
- Problems in Cartesian, spherical and cylindrical coordinates with homogeneous and inhomogeneous boundary conditions. Expansion in orthogonal polynomials. The importance of propagator and Green's function in quantum mechanics.
- Integral equations: Fredholm and Volterra equations. Relation to Green's equations. Exact solution techniques through expansion in orthogonal polynomials and through integral transformations (Fourier, Laplace, Mellin, Hankel). Solving through iterative approaches.

10EK412. ELEMENTARY PARTICLES (postgraduate)

- Review: Klein-Gordon equation, Dirac equation. Antiparticles and spin. Algebra of Dirac matrices. Feynman diagrams and invariant amplitude of a physical process. Decays, scattering, cross section. Phase space and its integration.
- Leptons and Quantum Electrodynamics: Interactions, gauge theories, “discovery” of electromagnetism. Electrodynamics of spinless particles: interaction of a pion with the electromagnetic field. Feynman diagrams and rules, photon propagator. The scattering processes $\pi^+K^+ \to \pi^+K^+$, $\pi^+\pi^+ \to \pi^+\pi^+$, $\pi^+\pi^- \to \pi^+\pi^-$. Electrodynamics of particles with spin: interaction of an electron with the electromagnetic field. Feynman diagrams and rules. The processes $e^+e^- \to \mu^+\mu^-$, $e^+e^- \to e^+e^-$, $e^-\mu^+ \to e^-\mu^+$. Compton scattering.
- Higher order corrections: Qualitative analysis of charge and mass renormalisation. The “running” coupling constant.
- Hadrons and Quantum Chromodynamics: Nucleon and meson phenomenology. Electron-proton scattering. Deep inelastic scattering. Parton model and structure functions. Scale evolution equations and fragmentation functions. Colour and SU(3). Feynman diagrams and rules. Parton scattering, the processes $qq \to qq$, $qg \to qg$, $gg \to gg$. Drell-Yan process. Qualitative description of hadronic reactions.
- Weak interactions: Parity violation and V−A form of the weak current. Fermi model and weak decays of leptons and hadrons. Modern picture via W boson exchange. Lepton flavour universality. β decay. Partially conserved axial currents. Neutrino-quark scattering. Neutrino deep inelastic scattering. Weak currents. Elastic neutrino-electron scattering.
- The Standard Model: Electroweak theory: $SU(2)\times U(1)$, $W^\pm$, Z and γ bosons. Spontaneous symmetry breaking, Nambu-Goldstone and Brout-Englert-Higgs mechanisms. The complete Standard Model, physics of W and Z bosons. Production and decay of b and t quarks. Discovery of the Higgs boson.
- CP and CPT symmetries: Heavy neutral meson mixing. Discovery of CP violation in neutral kaons. CP violation in other neutral mesons.
- Masses of neutrinos: Neutrino oscillations. Nature of neutrinos (Dirac/Majorana) and masses.

10EK413. NUCLEAR PHYSICS (postgraduate)

- Study of hadronic structure: Introduction to hadronic structure. Experimental evidence for the existence of quarks. The standard model and properties of hadrons. Symmetries and classification of hadrons.
- Nucleon physics: Nucleon properties. Nucleon structure models. Quantum chromodynamics and nucleon structure.
- The nuclear interaction: Review of basic features of nuclear interaction. Nucleon-nucleon scattering. Phenomenological potentials and meson exchange theories. Nuclear potentials inspired by quantum chromodynamics and its active theories.
- Microscopic description of nucleon systems: Deuterium, light nuclei and nuclear matter. Nuclear mean field. Correlation theories. Shell theory and active potentials. Nucleus

pairing and polarization. Description of nuclei based on the Hartree-Fock theory.

- Collective effects: TDA-RPA theories. Relativistic mean field pattern. Mesons and quarks in nuclei. Nuclear equation of state and properties of nuclear matter. Phases of strongly interacting matter.
- Elements of Nuclear Astrophysics: Neutron stars, stellar nucleosynthesis, etc.
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Compulsory Courses of the 5th Specialization (Condensed Matter Physics)

10YK501. QUANTUM OPTICS AND LASERS

- Black body. Planck, Rayleigh-Jeans, Wien, Stefan-Boltzmann laws.
- Electromagnetic (EM) waves: Boundary conditions, normal modes in a cavity.
- Discrete spectrum. Two-level system (2LS) or multi-level system (mLS): Atom, quantum dot, color center. Stimulated – spontaneous absorption and emission processes.
- EM radiation - 2LS or mLS interaction, semi-classically. Dipole approximation. Time-dependent perturbation theory. Rabi frequency. Rotating wave approximation. Allowed transitions.
- EM radiation - 2LS or mLS interaction, quantum mechanically. EM field quantization. Spinors. Commutators. Anticommutators. Transition dipole moment. Photon absorption-emission. The density matrix.
- LASER: Pumping, population inversion, rate equations, longitudinal and transverse EM modes, LASER types.

10YK502. SOLID STATE PHYSICS

- Motion of charged carriers in periodic potentials: Bloch theorem, energy bands, tight binding approximation, Kronig-Penney model.
- Metals-transport phenomena: Boltzmann transport equation, Fermi-Dirac statistics, Fermi energy, density of states, Drude, Lorentz, Sommerfeld models, Ohm law, temperature dependence of the electric conductivity, thermal conductivity, Wiedemann-Franz law.
- Semiconductors-characteristics and transport phenomena: Effective mass, band bending, statistics of carriers in equilibrium, transport phenomena-drift-diffusion, Hall effect.
- Magnetism: Diamagnetism, paramagnetism, ferromagnetism.

10YK503. CONDENSED MATTER PHYSICS LABORATORY

- Cycle A: (α) Theory of voltage-current characteristics of the p-n semiconductor junction. Experimental apparatus and measuring procedure. (β) Theory of linear lattice vibrations. Experimental apparatus and measuring procedure.

- Cycle B: (α) Theory of low-T_c and high-T_c superconductivity. Experimental apparatus and measuring procedure. (β) Theory of thermal and electrical conductivity in metals. Experimental apparatus and measuring procedure.
- Laboratory experiment: The p-n junction.
- Laboratory experiment: Linear lattice vibrations.
- Laboratory experiment: High-temperature superconductors.
- Laboratory experiment: Relationship between electrical and thermal conductivity in metals.
- Laboratory project and presentation.

Elective Courses of the 5th Specialization (Condensed Matter Physics)

10EK501. CORRELATED QUANTUM SYSTEMS

- Quantum theory of magnetism. The magnetic hamiltonian and the electron spin. Diamagnetism and paramagnetism.
- Second quantization formalism. The origin of spontaneous magnetization and of magnetic interactions.
- Models for the description of magnetic systems. Forms of magnetic order: Ferromagnetism, antiferromagnetism, diamagnetism. Magnons. Magnetization correlations and magnetic phase transitions.
- Attractive electron interaction. Cooper pairs.
- Microscopic theory of superconductivity: BCS and Valatin-Bogoliubov theory. Isotope effect.
- Order parameter correlations and superconducting phse transition. Landau-Ginzburg theory of phase transitions.

10EK502. PHYSICS OF MOLECULES AND NANOMATERIALS

- Electronic structure of molecules. The hydrogen molecular ion: Method of linear combination of atomic orbitals. The hydrogen molecule: Molecular orbitals-valence bond method.
- Diatomic molecules: Homonuclear-heteronuclear. Polyatomic molecules. Delocalization. Hybridization.
- Nuclear motion of a diatomic molecule. Rotation. Vibration. Vibration-rotation. Molecular spectra. Raman effect. Electronic transitions: Franck-Condon principle.
- Tight binding method with many orbitals/unit cell. Electronic structure of polyacetylene. Graphene: π and σ energy bands, dispersion relation.
- Carbon nanotubes: Electronic structure (band folding, metallicity condition). Density of states. Energy transitions. Size effects.

- Imaging methods for nanomaterials: Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Scanning Near-field Optical Microscopy (SNOM).

10EK503. SOFT MATTER PHYSICS

- What is soft matter. Intermolecular interactions. Interfaces.
- Mesophasesç. Mesogens. Order. Disclinations. Elasticity. Anchoring. Phase transitions. Physical properties. Fredericks transition. Liquid crystal displays.
- Amphiphiles. Micelles. Shape factor. Supramolecular organization. Membranes. Vesicles. Curvature elasticity.
- Solutions. Electrolytes. Double layer. Screening potential. Poisson-Boltzmann theory. Debye-Huckel approximation.
- Colloids. Brown motion. Langevin equation. DLVO theory. Stabilization. Aggregation kinetics. Osmotic pressure with interactions. Electrokinetic effects.
- Polymers-macromolecules. Chain models. Energy. Entropy. Radius of gyration. Kahn length. Persistence length. Flory - Huggens theory. θ-temperature. Self-avoidance. Self-similarity. Flory exponents. Proteins. Coil-globule and helix-coil transitions.

10EK511. PHYSICS OF THE EARTH'S SOLID CRUST (postgraduate)

- Introduction to elasticity theory: Mechanical stress and strain. The elastic region as a necessary limit of thermodynamic equilibrium. Lamé measures. Equations of elasticity. The body waves P and S as solutions of these equations with the corresponding scalar and vector potentials.
- Introduction to Physics of the rocks: Introduction to Physics of the Earth. Grüneisen theory. Harmonicity-anharmonicity. Melting. Porous materials. Heterogeneity and transfer phenomena. Effect of fluid infiltration on the elastic parameters of rocks.
- Strength, imperfections and breakage of crystalline materials and rocks: Effect of point and line defects on the strength of crystalline materials and fracture processes, theoretical models. Mechanical properties of materials of the Earth. Critical phenomena and dynamic instability during the fracture preparation process. Theoretical models relating mechanical processes preceding rock fracture to the emission of wide-frequency electromagnetic signals.
- Seismic waves and structure of the Earth's Solid Crust: Seismic waves. Structure of the Earth's Solid Crust. Thermal and pressure gradients in Earth's interior. Earthquakes and tectonics of lithospheric plates, faults. Body waves. Surface waves. Seismic wave velocities. Constitution of the Earth.
- The temperature field in the Solid Crust of the Earth: Fourier theory. The first scientific calculation for the age of the Earth (Lord Kelvin 1862).
- The electromagnetic field in the Solid Crust of the Earth: Electromagnetic properties of the materials of the Earth's Solid Crust. Dispersion relations. The semi-static approximation of Maxwell's equations for their application to the Earth's Solid Crust.

Transmission of electromagnetic disturbances in the Earth's Solid Crust: Diffusion-propagation.
- Electric and electromagnetic prospecting methods: Electrical methods (DC resistivity method). Magnetotelluric method (MT method).
- Introduction to the Physics of preseismic electric signals: The VAN method of short-term earthquake prediction. Physical properties of Seismic Electric Signals (SES).

10EK512. PHYSICS OF SEMICONDUCTOR DEVICES (postgraduate)

- The semiconductor in equilibrium.
- Carrier transport phenomena.
- Non-equilibrium excess carriers in semiconductors.
- The p-n junction.
- Metal-semiconductor junction: Ohmic, Schottky.
- Heterojunctions: Formation of quantum well.
- MIS and MOS junctions.
- Field effect transistor (JFET, MESFET).
- MOSFET transistor.

Free Elective Courses

From the Department of Physics

10ΕΛΕ01. ATOMIC AND MOLECULAR PHYSICS

- The hydrogen atom. The electron spin and the interaction with an external magnetic field. Coupling with orbital angular momentum. Spectra. Fine structure.
- Multi-electron atoms. Helium spectrum. Pauli exclusion principle. Hartree theory. L–S and J–J coupling. Magnetic moments.
- Many-electron atoms. Spectra. Interaction with an external magnetic field. Multiple excitations. Hyperfine structure. LASER.
- Fundamental principles of molecular physics. Born-Oppenheimer approximation and two-atom molecules.
- Linear Combination of Atomic Orbitals (LCAO). Energy level diagram and molecular spectra. Symmetries in molecules.
- Experimental methods in molecular spectroscopy.

10ΕΛΕ02. STOCHASTIC PROCESSES IN PHYSICS

- Introduction: Random variables, distributions, moments, moment generating function, Bayes theorem.
- Estimation theory: Hypothesis testing, estimation of random variables.
- Central limit theorem: Proof, Levy processes.
- Discrete random walks: Fundamental equation, Polya theorem, mean number of distinct sites visited.
- Diffusion equation: Properties, probability current, boundary conditions, first passage time calculation.
- Brownian motion. It Itô-Stratonovich stochastic differential equations.
- Fokker-Planck equation. Langevin equation.
- Classical Caldeira-Leggett model.
- Introduction to Brownian path integrals: Feynman-Kac formula (derivation, applications).

10ΕΛΕ03. APPLIED OPTICS

- First- and third-order optical imaging theory. Ray tracing. Optical aberrations of lenses and mirrors. Optical aberration correction.
- Optical systems. Image quality criteria.
- Interference. Interferometry. Diffraction (near and far field). Spectrographs.
- Holography. Optical waveguides. Optical materials. Optics of solids.
- Polarization. Polarimetry. Fourier optics.
- Laboratory experiments.

10ΕΛΕ04. GROUP THEORY AND APPLICATIONS

- Groups: definition, categories and examples. Multiplication table. Construction of groups. Mapping between groups. Conjugacy classes. Subgroups. Permutation groups. Point symmetry groups.
- Representations of finite groups. Orthogonality theorems. Character tables. Reducible and irreducible representations. Reduction of representations. Examples from physics. Partial diagonalization in eigenvalue problems using symmetry. Degeneracy. Degeneracy lifting induced by a perturbation.
- Topological groups and Lie groups. Continuous rotation groups and their representations. The O(2), SO(3), O(3), SU(2) groups. Examples from atomic physics. SU(N) groups with N>2. Young diagrams. Isospin. Nucleon-nucleon scattering.
- Irreducible tensor operators. Selection rules in optical transitions. Projection operators. Construction of symmetrized eigenfunctions in electronic structure and molecular vibration problems. Crystal harmonics. The group of lattice translations. Bloch theorem.
- Time reversal symmetry. Kramers degeneracy. Non-unitary groups and their applications in magnetism.

10ΕΛΕ05. STATES AND PROPERTIES OF MATTER

- Solids: Periodic and quasi-periodic crystals, amorphous and fractal solids. Self-similarity. Bose- Einstein condensates. Real gases and liquids. Mesophases.
- Symmetry types, operations, groups. Crystals and crystal lattices in 1, 2, 3 dimensions.
- Atomic bonding. Hybridization.
- Linear elasticity. Viscoelasticity. Elastic waves.
- Surface tension and wetting.
- Transport phenomena.

10ΕΛΕ06. NON-LINEAR DYNAMICAL SYSTEMS

- Dynamical systems as continuous flows in phase space and as maps. Equilibrium points and stability. Bifurcations in one-dimensional systems.
- Two-dimensional dynamical systems. Linear dynamics in two dimensions. Poincaré-Bendixson theorem. Limit cycles. Hopf bifurcation. Stability of limit cycles. Parametric instability.
- Non-linear oscillations. Perturbation methods. Method of multiple time scales.
- Introduction to chaotic dynamics. Lorenz system. Lyapunov exponents.
- Quasi-linear 1st order partial differential equations. Characteristics and formation of shock waves and applications. Burgers equation.
- Non-linear waves. Boussinesq equations. Korteweg-de Vries and non-linear Schrödinger equations. Introduction to soliton theory.

From the Department of Mathematics

10ΕΛΕ11. REAL ANALYSIS

- Set theory, countability. Metric spaces. Topological notions. Equivalent metrics. Bounded sets.
- Continuity of functions on metric spaces. Isometries. Lipschitz functions. Uniform continuity.
- Completeness. Fixed point theorems and applications to differential equations. Cantor theorem, Baire theorem and applications.
- Compactness. Separability. Cantor set.
- Sequences and series of functions: Pointwise and uniform convergence, Weierstrass criterion, uniform convergence and continuity, integration and differentiation.
- Continuous real functions in compact metric spaces: Weierstrass approximation theorem. The structure of the C(X) metric space.

10ΕΛΕ12. GEOMETRY II

- Regular curves. Arc length. Parametrization with respect to arc length. Curvature and torsion. Frenet-Serret frame. Fundamental theorem of curves.
- Regular surfaces. Tangent plane.
- Gauss map and shape operator.
- Second fundamental form. Principal curvatures. Gauss curvature and mean curvature. Isometries.
- Gauss Theorema Egregium. Intrinsic geometry. Geodesics.
- Gauss-Bonnet theorem.

From the Department of Informatics and Telecommunications

10ΕΛΕ22. PATTERN RECOGNITION – MACHINE LEARNING

- Introduction to pattern recognition and machine learning; data representation (images, audio, text), feature extraction and the statistical learning framework.
- Regression: loss functions, optimization algorithms, regularization and model evaluation (over-/under-fitting).
- Classical methods for data classification.
- Unsupervised learning: clustering, dimensionality reduction and feature selection.
- Local methods, kernel methods and support vector machines (SVMs).
- Neural networks and deep learning: building blocks, training algorithms and network architectures.

From the Department of Geology and Geoenvironment

10ΕΛΕ31. THEORETICAL GEOPHYSICS

- Introduction to the physical principles and mathematical methods in geophysics.
- Elements of Earth’s structure and its constituents. Variation of the seismic velocities with depth. Density, pressure and temperature in the Earth’s interior.
- Thermodynamics. Heat in the Earth’s interior. Thermal flux from the Earth’s interior. Heat sources in the Earth’s interior. Temperature in the Earth’s interior. Elements of thermodynamics in the Earth’s interior. Convection currents in the mantle.
- Seismology. Propagation of seismic waves. Faults mechanics and earthquake generation mechanism. Elements of elasticity theory and elastic waves. Seismic waves and their propagation in the Earth’s interior. Earthquake magnitude and energy. Non-linear phenomena in lithosphere. Lithosphere is a self-organized critical (SOC) system.
- Dynamic fields. Gravitational and magnetic field of the Earth. Measurements of the gravitational field. Local variations of the gravitational field. Isostasy. Elements of the

Earth's magnetic field. The main magnetic field of the Earth. Bipolar and non-bipolar field. Variations of the Earth's magnetic field.

- Geoelectromagnetism. Maxwell equations. Electromagnetic induction. Electromagnetic induction in the Earth's interior. Electromagnetic source above a homogeneous conductive Earth. Magnetotellurics. Methods of geophysical exploration.
- Deformations of the Earth's crust.
- Fluids in geophysics.

From the Department of Chemistry

10ΕΛΕ41. CHEMISTRY

- Atoms. Periodic table of elements.
- Chemical bond. Molecules. Molecular interactions.
- States of matter.
- Chemical thermodynamics.
- Chemical equilibrium.
- Chemical kinetics.
- Solutions. Acids. Bases.
- Redox reactions.
- Elements of spectroscopy.

10ΕΛΕ42. CHEMISTRY LABORATORY

- Chemical laboratory utensils.
- Preparation of aqueous salt solutions by weighting solid and solution.
- Study of the dependence of the solubility of KNO_3 in water on temperature.
- Heat of neutralization reaction of strong acid with strong base and weak acid with strong base.
- Study of chemical equilibrium.
- pH. Buffer solutions. Weak acid pk_a determination.
- Redox reactions. Volume measurement of $KMnO_4$.

From the Department of Biology

10ΕΛΕ51. CURRENT ISSUES IN CELL BIOLOGY

- Introduction. Structural elements. Cellular organization.
- Biological membranes. Separative functional double layers.
- First step of genetic information flow: Levels of DNA organization.
- Second step of genetic information flow: Protein synthesis.

- Post-translational modification. Protein sorting, targeting and cellular polarity.
- Cellular organelles producing and converting energy: Mitochondria and chloroplasts.
- Organelles processing and degrading biomolecules: Peroxisomes, lysosomes.
- Cellular fibrils. Cytoskeleton.
- Cellular communication and conjunction.
- Extracellular matrix.
- Cell cycle. Reproduction.

From the Department of History and Philosophy of Science

10ΕΛΕ61. HISTORY OF PHYSICAL SCIENCES

- Introduction to the history and philosophy of physical science. The physical sciences and society. The physical sciences and philosophy.
- Physics in the late 19^{th} century. The Newtonian heritage. New discoveries (X-rays, electrons, radioactivity, blackbody radiation) and the end of classical physics.
- The revolutions in early 20^{th} century physics. Einstein and relativity. Quantum mechanics and the Weimar Republic. The interpretation of quantum theory.
- The emergence of big physics. The Manhattan Project for the making of the atomic bomb. The founding of big laboratories (Brookhaven, CERN, Dubna, Fermilab, etc.).
- Physics after World War II. The role of the Cold War. Reductionism and emergent phenomena: from elementary particle physics to solid state physics.
- Contemporary concerns. The problem of pseudoscience: from Velikosvky to climate change. The relationship between theory and experiment: the case of string theory. Ethical issues in scientific research: from Millikan to cold fusion.

From the Department of Primary Education

10ΕΛΕ71. PHYSICS TEACHING METHODS

- Scientific literacy.
- Learning theories in physical sciences.
- Students' ideas.
- Teaching models.
- Inquiry-based learning in physics: The scientific processes.
- Teaching tools.
- The role of history and philosophy of physical sciences in the didactics of physical sciences.
- Informal and informal learning resources in physical sciences.
- Lesson plans: Lesson planning guide and examples for mechanics, heat, electricity, and optics.

5.3 Courses per Semester

It is clarified that, for the granting of the Housing Allowance, students must have successfully passed at least five (5) courses in the reference year, regardless of how many courses they choose to enroll in based on their choices in "Introductory Specialization Courses" and "Elective Core Courses".

SEMESTER A'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO01	6	7	Physics I
10YKO05	3	4	Basic Physics Laboratory I
10YKO10	4	6	Basic Mathematical Methods
10YKO11	6	7	Analysis I and Applications
10YKO13	4	6	Probability Theory

SEMESTER B'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO02	6	7	Physics II
10YKO06	3	4	Basic Physics Laboratory II
10YKO12	5	7	Analysis II and Applications
10YKO14	4	6	Ordinary Differential Equations
10YKO20	2 + 2 Lab	6	Computer Science

SEMESTER Γ'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO03	6	7	Physics III
10YKO07	3	4	Basic Physics Laboratory III
10YKO15	5	7	Mathematical Methods in Physics I
10YKO21	2 + 2 Lab	6	Computational Physics
10YKO31	5	7	Mechanics I

SEMESTER Δ'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO04	6	7	Physics IV
10YKO08	3	4	Basic Physics Laboratory IV
10YKO16	5	7	Mathematical Methods in Physics II

INTRODUCTORY SPECIALIZATION COURSES

10EKA01	5 + 1 Lab	7	Introduction to Astrophysics
10EKA03	5 + 1 Lab	7	Introduction to Atmospheric Physics

ELECTIVE CORE COURSES

10EKO01	5	7	Mechanics II
10EKO05	5	7	Fluid Dynamics

SEMESTER E'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO32	5	7	Electromagnetism I
10YKO33	5	7	Quantum Mechanics I
10YKO34	5	7	Statistical Physics I
10YKO35	4	6	Special theory of Relativity

SEMESTER ΣΤ'

INTRODUCTORY SPECIALIZATION COURSES

Code	Hours/week	ECTS	Course
10EKA02	5 + 1 Lab	7	Introduction to Electronic Physics
10EKA04	5 + 1 Lab	7	Introduction to Nuclear and Particle Physics
10EKA05	5 + 1 Lab	7	Introduction to Solid State Physics

ELECTIVE CORE COURSES

10EKO02	5	7	Electromagnetism II
10EKO03	5	7	Quantum Mechanics II
10EKO04	5	7	Statistical Physics II

SEMESTER Z'

COMPULSORY SPECIALIZATION COURSES

Code	Hours/week	ECTS	Course
1st Specialization: Astrophysics			
10YK101	4	6	Stellar Astrophysics
10YK102	4	6	Astrophysical Fluids
10YK103	4	6	Astrophysics Laboratory
2nd Specialization: Electronics, Computers, Telecommunications and Control			
10YK201	3 + 1 Lab	6	Signals and Systems
10YK202	3 + 1 Lab	6	Computer Systems Organization
3rd Specialization: Environmental Physics			
10YK302	4	6	Physics of the Atmospheric Boundary Layer
4th Specialization: Nuclear and Particle Physics			
10YK401	4	6	Nuclear Physics
10YK402	4	6	Elementary Particles
10YK403	4	6	Nuclear and Particle Physics Laboratory
5th Specialization: Condensed Matter Physics			
10YK502	4	6	Solid State Physics

ELECTIVE SPECIALIZATION COURSES

1st Specialization: Astrophysics			
10EK101	4	6	High Energy Astrophysics
10EK102	4	6	Space and Solar Physics
10EK111	4	6	General Theory of Relativity (postgraduate)
2nd Specialization: Electronics, Computers, Telecommunications and Control			
10EK201	3 + 1 Lab	6	Advanced Topics in Electronics
10EK202	4	6	Optoelectronics and Optical Communications
3rd Specialization: Environmental Physics			
10EK301	4	6	Quality of Atmospheric Environment
10EK302	4	6	Physical Oceanography
4th Specialization: Nuclear and Particle Physics			
10EK401	4	6	Astroparticle Physics and Cosmic Rays

10EK111	4	6	General Theory of Relativity (postgraduate)
10EK411	4	6	Mathematical Physics (postgraduate)
5th Specialization: Condensed Matter Physics			
10EK502	4	6	Physics of Molecules and Nanomaterials
10EK503	4	6	Soft Matter Physics

FREE ELECTIVE COURSES

From the Department of Physics			
10EΛE05	4	6	States and Properties of Matter
From the Department of Geology and Geoenvironment			
10EΛE31	4	6	Theoretical Geophysics
From the Department of Biology			
10EΛE51	4	6	Current Issues in Cell Biology
From the Department of History and Philosophy of Science			
10EΛE61	4	6	History of Physical Sciences

FINAL-YEAR DISSERTATION

10EKA06	3	7	Final-Year Dissertation I

SEMESTER H'

COMPULSORY SPECIALIZATION COURSES

Κωδικός	‘Ωρες/εβδ.	ECTS	Μάθημα
2nd Specialization: Electronics, Computers, Telecommunications and Control			
10YK203	4	6	Electronics, Computers, Telecommunications and Control Laboratory
3rd Specialization: Environmental Physics			
10YK301	4	6	Atmospheric Dynamics
10YK303	4	6	Environmental Physics Laboratory
5th Specialization: Condensed Matter Physics			
10YK501	4	6	Quantum Optics and Lasers
10YK503	4	6	Condensed Matter Physics Laboratory

ELECTIVE SPECIALIZATION COURSES

1st Specialization: Astrophysics			
10EK103	4	6	Galaxies
10EK112	4	6	Observational Techniques and Data Analysis in Astrophysics (postgraduate)
2nd Specialization: Electronics, Computers, Telecommunications and Control			
10EK203	3 + 2 Lab	6	Telecommunications
10EK204	4	6	Microelectronics
10EK211	4	6	Introduction to Control Systems (postgraduate)
10EK212	3 + 1 Lab	6	Computer Systems (postgraduate)
3rd Specialization: Environmental Physics			
10EK303	4	6	Climate – Climate Change
10EK311	2 + 2 Lab	6	Synoptic Meteorology (postgraduateó)
10EK312	4	6	Renewable Energy Sources (postgraduate)
4th Specialization: Nuclear and Particle Physics			
10EK402	4	6	Medical Physics
10EK403	4	6	Contemporary Quantum Physics and Applications
10EK412	4	6	Elementary Particles (postgraduate)
10EK413	4	6	Nuclear Physics (postgraduate)
5th Specialization: Condensed Matter Physics			
10EK501	4	6	Correlated Quantum Systems
10EK511	4	6	Physics of the Earth's Solid Crust (postgraduate)
10EK512	4	6	Physics of Semiconductor Devices (postgraduate)

FREE ELECTIVE COURSES

From the Department of Physics			
10EΛE01	4	6	Atomic and Molecular Physics
10EΛE02	4	6	Stochastic Processes in Physics
10EΛE03	4	6	Applied Optics
10EΛE04	4	6	Group Theory and Applications
10EΛE06	4	6	Non-linear Dynamical Systems
From the Department of Mathematics			
10EΛE11	6	9	Real Analysis
10EΛE12	6	9	Geometry II

From the Department of Informatics and Telecommunications			
10ΕΛΕ22	4	6	Pattern Recognition-Machine Learning
From the Department of Chemistry			
10ΕΛΕ41	4	6	Chemistry
10ΕΛΕ42	4	6	Chemistry Laboratory
From the Department of Primary Education			
10ΕΛΕ71	4	6	Physics Teaching Methods

FINAL-YEAR DISSERTATION

10EKA07	3	7	Final-Year Dissertation II

5.4 Academic Calendar 2026-27

Start of the Academic Year: Monday, September 28, 2026

Winter Semester

First Day of Classes: Monday, September 28, 2026

Class Period: Monday, September 28, 2026, until Friday, January 8, 2027
(*1st and 3rd semester intermediate exams*: 23/11/26 – 27/11/26)

Examination Period: From Monday, January 18 to Friday, February 5, 2027

Official Holidays:

- Wednesday, October 28, 2026 (national holiday)
- Tuesday, November 17, 2026 (anniversary of the Athens Polytechnic uprising)
- Thursday, December 24, 2026, until Wednesday January 6, 2027 (Christmas holidays)
- Saturday, January 30, 2027 (Three Hierarchs holiday)

Spring Semester

First Day of Classes: Monday, February 8, 2027

Class Period: Monday, February 8, until Friday, May 21, 2027
(*2nd and 4th semester intermediate exams*: 16/3/27 – 19/3/27)

Examination Period: Monday, May 31, until Friday, June 18, 2027

Official Holidays:

- Sunday, February 21, 2027 (anniversary of the NKUA School of Law occupation)
- Monday, March 15, 2027 (Ash Monday)
- Thursday, March 25, 2027 (national holiday)
- Monday, April 26, until Friday, May 7, 2027 (Easter holidays)
- Saturday, May 1, 2027 (1st May holiday)
- Monday, June 21, 2027 (Holy Spirit holiday)
- No classes are held on student election day and the day after

September Examination Period

Examination Period: From Monday, August 30, to Friday, September 24, 2027

APPENDIX

European Credit Transfer and Accumulation System (ECTS)

The European Credit Transfer and Accumulation System (ECTS) is a system of awarding and transferring academic credits, which has been developed experimentally and is already being deployed very widely. Its purpose is to strengthen and facilitate academic recognition processes between Europe's collaborating Universities through the use of real and generally applicable mechanisms. ECTS provides a code of good practice for organizing academic recognition by enhancing the transparency of curricula and student achievement. ECTS itself in no way regulates the content, structure or parity of academic programs and courses. These quality issues are defined by the same Universities to lay the groundwork for cooperation agreements, bilateral or multilateral.

The basic principles on which ECTS is based are the following:

- Distribute the academic credits to courses so as to indicate the workload required to complete the course.
- Indicate the amount of work required for a single course or laboratory in relation to the total amount of work deemed necessary to complete a full academic year.
- Include teaching, internships, seminars, homework, laboratory, library work and exams or other forms of assessment.
- The workload of one academic year corresponds to 60 ECTS units; the workload of one semester to 30 unit; and for one quarter, 20 units.
- Credits are also allocated for internships and the preparation of dissertations, provided that they are part of regular curricula of the respective host institution and the institution of origin.
- Credits are awarded to students only when they have successfully attended and have successfully passed all examinations in the specific courses.
- Universities should present a full range of courses offered to visiting students, clearly indicating the academic credits corresponding to each course.
- Prior to the student's departure to an institution abroad, a formal "learning agreement" must be signed between the home University, the host University and the student, which will describe the student's study program abroad and will be accompanied by a "grade certificate", listing the student's previous academic performance.
- For all courses successfully completed abroad, the host University should grant students, an official "grade certificate", which includes the titles and ECTS credits corresponding to each course completed.

- The home University should recognize the ECTS credits that students received at partner institutions for the courses they attended there, so that the ECTS credits of courses taken by students abroad replace the ECTS credits that would be awarded to them from the University of origin, in an equivalent period of study.

ECTS is a system for the accumulation and transfer of credits, which is based on the transparency of learning outcomes and learning processes. It aims at facilitating the planning, delivery, evaluation, recognition and validation of diplomas and learning modules acquired by students as well as at improving students' mobility opportunities between the Universities participating in ECTS.

ECTS credits are based on the workload that students have to make to achieve the expected learning outcomes, which describe what the learner is expected to know, understand and be able to do after the successful completion of the learning process.

ECTS credits are awarded to students upon completion of the learning activities required by a standard University curriculum and successful assessment of the learning outcomes.

ECTS credits, awarded under a university degree program, can be transferred to another program offered by another Institution that the student may attend. This transfer can only take place if the University awarding the degree recognizes the credits, and therefore the learning outcomes associated with respective ECTS credits.