NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS
School of Science

DEPARTMENT OF PHYSICS UNDERGRADUATE STUDIES GUIDE

Academic Year

2021-2022

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1. PREFACE

The Department of Physics of the National and Kapodistrian University of Athens has a leading position in the field of physics, both in Greece and internationally. This is the result of the pioneering work of its research and teaching staff as well as the high level of its graduates and its undergraduate, postgraduate and doctoral students.

Beginning with the 2021-2022 academic year, the Department is deploying a new, modern undergraduate curriculum, with a flexible structure that allows students to adapt course sequences to their interests, providing opportunities both in terms of breadth and in terms of specialization in specific areas. The current guide provides some general information regarding the University, as well as more detailed information regarding the structure and operation of the Department and its undergraduate curriculum. Further information as well as news and announcements can be found on the Department's website at the following URL: https://www.phys.uoa.gr.

Despite the difficulties posed by current times, the primary goals of all the staff of the Department are: (a) maintain and improve the quality of the provided education at both the undergraduate and postgraduate level; (b) highlight the importance of research and support the participation of undergraduate and postgraduate students in research projects; (c) develop interdisciplinary and inter-institutional collaborations, both nationally and internationally. The above constitute the threefold set of activities that have been demonstrated to support the principles and values of a Greek Public University.

With the beginning of the new academic year, we wholeheartedly wish all the members of the Department and students good health and success in their personal goals.

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 and Religious Affairs.

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 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 Rector and Vice-Rectors, the Rector's Council, and the Senate. 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 undegraduate 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.

Rector and Vice Rectors of the Natinal and Kapodistrian University of Athens (NKUA)

- **Rector**
  Professor Meletios-Athanasios Dimopoulos
  Tel.: 210 368 9770, 9771, e-mail: rector@uoa.gr
- **Vice Rector of Administrative Affairs**
  Professor Athanasios Tsakris
  Tel.: 210 368 9777, e-mail: vrec-admin@uoa.gr
- **Vice Rector of Research and Lifelong Learning**
  Professor Nikolaos Voulgaris
  Tel.: 210 368 9760, e-mail: vrec-rd@uoa.gr
- **Vice Rector for Academic and Student Affairs**
  Professor Dimitrios Karadimas
  Tel.: 210 368 9766, e-mail: vrec-acafir@uoa.gr
- **Vice Rector of Finance, Operations and Development**

Professor Dimitrios Tousoulis
Tel.: 210 368 9786, e-mail: vrec-fin@uoa

School of Science

- **Dean**

Professor Ioannis Emmanouil
Tel.: 210 727 4045 e-mail: deansos@uoa.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 fullfilment 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

In the course of their studies, students are entitled to a range of benefits including facilities and services offered by the University. These include, sometimes depending on the students’ financial situation, subsidies for nutrition, housing, health, educational, cultural activities, as well as access to sports venues and participation in sports activities. 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 Registration Number (ID). Holders of a valid Student ID apply to the University for an institutional computer account that grants access to NKUA online services.

Obtaining an Institutional Account

Students should visit the website https://webadm.uoa.gr/ and select "Αίτηση Νέου Λογαριασμού" → "Προπτυχιακοί Φοιτητές".

The registration process requires the following information:

- The full university ID (this is a 13 digit number consisting of the Department's code, the year of admission and a 5-digit individual identification number.
- The number of the identity card or passport that was declared during the registration process to the system of the Ministry of Education and Religious Affairs (please note that the ID number must be entered without spaces and in Greek capital letters, and the passport in Latin capital letters).

Upon admission into the NKUA information technology system, students must provide their names using Greek and Latin characters. The full precise name appearing in the corresponding national ID/passport document, and not a diminutive, must be provided. Upon the correct completion and submission of this information, students are notified of the protocol number of their application, as well as a PIN number that is necessary for the activation of their account.

The data provided in the application are checked and subsequently accepted by the Secretariat of the Department during working hours. The progression of the application can be monitored through the link "Ενεργοποίηση Λογαριασμού (PIN)" on the URL https://webadm.uoa.gr. Once the application is approved, students are asked to supply an initial code and are subsequently notified of the username assigned to them in the NKUA online services system.

Online Secretariat (my-studies)

Students need to access the website https://my-studies.uoa.gr in order to:

- Apply for a student card (PASO).
- Declare the courses to be taken during each semester.
- Select and register for free delivery of the textbooks for each course.
- Access the "Online Secretariat" for various tasks, including monitoring course grades and requests for various certificates.

After successful activation of their NKUA computer account, students can accesss my-studies and all its services with their username and password.

Online Application for Student Card (PASO)

All students qualify for reduced-price tickets for all national means of transportation. These are secured through usage of a student card (PASO), which is obtained online (following pre-registration and identity verification) at https://academicid.minedu.gov.gr.

The online application for the PASO requires the username and password obtained for my-studies. In the event of non-reception of the relevant codes or of any other access problems, students should contact the Department's Secretariat.

After successfully logging in, new users must confirm the correctness of the information in the system and then complete the registration process by providing some additional personal information required by the system. If any errors or mismatches are identified in any of the fields in the registration form, or at any stage in the registration process, the Department's Secretariat should be contacted.

Obtaining an e-mail Account

New users should visit the website https://webadm.uoa.gr/ and select "Υπηρεσίες Διαχείρισης Λογαριασμού" → "Διαχείριση Υπηρεσιών".

Entering the my-studies username and password results in the display of various services, some of which are inactive (and diplayed in red color). To activate the e-mail account, the link "Υπηρεσία Ηλεκτρονικού Ταχυδρομείου", which appears in red letters as "Κατάσταση: Ανενεργή" should be pressed.

Normally, this results in the message "The page at webadm.uoa.gr says: Η υπηρεσία ενεργοποιήθηκε!" is displayed. Users should acknowledge by pressing "OK".

Selecting "Συνέχεια" at the bottom of the page then results in the message "Επιτυχής Μεταβολή" which indicates the successful creation of the e-mail account. The e-mail address is of the following form, sph1234567@uoa.gr.

To use NKUA e-mail, users should visit https://webmail.noc.uoa.gr, enter their username (sph1234567) and password, and then "Συνέχεια". In the e-mail environment, in the bottom left, the following folders appear ("Διαμοιραζόμενοι Φάκελοι"):

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

Web Service for Textbooks

The process of selecting textbooks is done through the online service EUDOXUS. Visiting the site https://service.eudoxus.gr/public/departments#12, students can be informed about the suggested textbooks for the courses of the Department of Physics.

To use the eudoxus site students should visit www.eudoxus.gr, select "Φοιτητές" and "Επιλογή Συγγραμμάτων", and enter their username and password for my-studies.

All curriculum courses and their corresponding textbooks are listed. For each textbook, a preview of the cover, table of contents and an excerpt is provided.

Students are entitled to select textbooks corresponding to courses in which they are enrolled by entering a mobile phone number and e-mail.

Selecting "Επιβεβαίωση", a unique personal PIN code is sent to the mobile phone number or e-mail account.

With this personal PIN and student ID, students can visit the book distribution points and pick up the textbooks they have requested.

It is noted that, if the verification process by the EUDOXUS service and the Department's Secretariat indicates that textbooks have been obtained without concurrent registration in the respective courses (through my-studies), then these should be returned promptly.

Websites

Some indicative websites with useful information related to undergraduate studies in the Physics Department of NKUA (such as dates of academic year/semesters/exam periods, assignments, basic regulations, course outlines, student topics, nutrition, medical services, services for the disabled, insurance/health care, internship program, the Erasmus+ program, sports facilities, scholarships and legacies, etc.) are the following:

- NKUA: http://www.uoa.gr/
- School of Science (deanship): http://deansos.uoa.gr/
- Department of Physics: http://www.phys.uoa.gr/

E-class

The e-class NKUA platform (https://eclass.uoa.gr/) is a course management system that supports modern e-learning services accessible through any common web browser. Its goal is the incorporation and constructive use of the Internet and web technologies in the educational process. The eclass system supports the electronic management, storage and presentation of educational material along with other teaching services for each course.

Library of the School of Science

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

The Library's collection includes books, scientific journals (in printed and electronic form), BSc and MSc theses, doctoral dissertations and other material. The Library has five reading rooms and four group study rooms for up to six people, a room where the latest issues of magazines are exhibited, as well as special areas with computer workstations for accessing bibliographic databases. Users can also use their personal laptops, with the possibility of wireless connection in the reading rooms and wired connections in the group study rooms. Students of the School of Science have the right to borrow Library items via use of a Library loan card, which is issued upon presentation of a national ID card and a student ID card.

Contact:

Information desk: 210 727 6599
Secretariat: 210 727 6525
Fax: 210 727 6524
URL: http://sci.lib.uoa.gr/
e-mail: sci[at]lib.uoa[dot]gr

Opening Hours:

Monday – Friday: 08.30 - 19.00, Saturday: 09.00 - 14.00.

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. Students can transfer to institutions that have signed bilateral agreements with the NKUA Department of Physics, and are listed in the table below. The duration of these studies cannot exceed one academic semester per student, while their minimum duration is three months.

COUNTRY	UNIVERSITY	PROFESSOR IN CHARGE	NR. OF STUDENTS	TEACHING LANGUAGE
FRANCE	Université Grenoble Alpes	T. Mertzimekis	2	FR/EN
GERMANY	Rheinische Friedrich-Wilhelms-Universität Bonn	T. Mertzimekis	6	EN/DE
ITALY	Università degli Studi di Milano	T. Mertzimekis	1	IT/EN
POLAND	University of Zielona Góra	T. Mertzimekis	2	EN/PL
FRANCE	Université de Lille	A. Papathanassiou	2	FR/EN

The prerequisites for participation of undergraduate students in the Erasmus+ program are (a) enrollment in at least the 2nd year of study at the time of submission of the application and (b) successful completion of at least eight (8) courses and two (2) laboratories. Students in their final year of study and students who have completed the four years of study are eligible to participate only if they have sufficient number of courses corresponding to at least 30 ECTS (see Appendix), to ensure a greater choice of courses from the University's curriculum and corespondingly their recognition by NKUA. A proficiency certificate in the language of instruction of the host University, at least at a B2 level according to the language proficiency scale of the Common European Framework of Reference for Languages of the Council of Europe, is required. More information is available on the Erasmus+ website: en.interel.uoa.gr/erasmus.html.

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 eight 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).

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

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 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 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 thirty (30) faculty members elected by the Sections for a one-year term, the Chair, the Vice Chair, the Section Directors, representatives of the undergraduate and postgraduate students at a rate of 15% of the Assembly, and three (3) representatives, one per category of special staff, i.e., special teaching staff, the laboratory teaching staff and the special technical staf, who are elected along with their alternates for a one-year term.

- **Chair**: Professor Nikolaos Stefanou
- **Vice Cair**: Professor Paraskevas Sphicas

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: Associate Professor Dimosthenis Stamopoulos

- **Section B'**: Section of Nuclear and Particle Physics
  Director: Associate Professor Konstantinos Vellidis
- **Section Γ'**: Section of Astrophysics, Astronomy, and Mechanics
  Director: Professor Nektarios Vlachakis
- **Section Δ'**: Section of Environmental Physics – Meteorology
  Director: Professor Helena Flocas
- **Section E'**: Section of Electronic Physics and Systems
  Director: Professor Hector-Emmanouil Nistazakis

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 Spiros Gardelis
- **Laboratory of Nuclear and Particle Physics** (Section B')
  Director: Associate Professor Efstathios Stiliaris
- **Laboratory of Astronomy** (Section Γ')
  Director: Professor Theocharis Apostolatos
- **Laboratory of Astrophysics** (Section Γ')
  Director: Professor Nektarios Vlachakis
- **Laboratory of Environmental Physics – Meteorology** (Section Δ')
  Director: Professor Constantinos Cartalis
- **Laboratory of Electronic Physics** (Section E')
  Director: Professor George Tombras

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: Associate 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: Emeritus Professor Panayotis Varotsos

- **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	00, 01
Cartalis Constantinos	Δ'	6774	ckartali	07, 08
Daglis Ioannis	Γ'	6857	iadaglis	05, 06
Flocas Helena	Δ'	6706	efloca	30, 31
Frantzeskakis Dimitrios	A'	6714	dfrantz	32, 33
Hatzidimitriou Despina	Γ'	6721	deshatzi	34, 35
Manousakis Efstratios	A'	6783	emanous	—
Mastichiadis Apostolos	Γ'	6909	amastich	09
Mavropoulos Phivos	A'	6893	fmavrop	10, 11
Nistazakis Hector-Emmanouil	E'	6710	enistaz	12, 13
Reisis Dionysios	E'	6708	dreisis	14, 15
Sarlis Nikolaos	A'	6736	nsarlis	16, 17
Stefanou Nikolaos	A'	6762	nstefan	18, 19
Sfetsos Konstantinos	B'	6938	ksfetsos	20, 21
Sphicas Paraskevas	B'	6883	sphicas	22, 23
Tetradis Nikolaos	B'	6907	ntetrad	24, 25
Tigelis Ioannis	E'	6860	itigelis	26, 27
Tombras George	E'	6784	gtombras	28
Tombrou-Tzella Maria	Δ'	6935	mtombrou	29

Varotsos Constantinos	Δ'	6838	covar	02
Vlahakis Nektarios	Γ'	6903	vlahakis	03, 04

ASSOCIATE PROFESSORS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Aidinis Constantinos	E'	6875	caidinis	36
Assimakopoulos Margarita-Niki	Δ'	6922	masim	37, 38
Diakonos Fotios	B'	6952	fdiakono	46, 47
Diamandis George	B'	6970	gdiam	48
Fasouliotis Dimitrios	B'	6955	dfassoul	75, 76
Gardelis Spyros	A'	6985	sgardelis	43, 44
Georgalas Vasilios	B'	6971	vgeorgal	45
Lelidis Ioannis	A'	6818	ilelidis	51, 52
Likodimos Vlassios	A'	6824	vlikodimos	53, 54
Mertzimekis Theodoros	B'	6953	tmertzi	55, 56
Moustakas Aris	E'	6775	arislm	57, 58
Saoulidou Niki	B'	6879	nsaoulid	59, 60
Simserides Constantinos	A'	6810	csimseri	61, 62
Skordas Efthimios	A'	6735	eskordas	63, 64
Sofianos Sarantis	Δ'	6932	sofianos	65, 66
Spanos Vassilis	B'	6967	vspanos	67, 68
Stamopoulos Dimosthenis	A'	6823	densta	69, 70
Stiliaris Efstathios	B'	6885	stiliaris	71, 72
Theofilatos Konstantinos	B'	6904	ktheofi	49, 50
Tzanakaki Anna	E'	6862	atzanakaki	73, 74
Vasileiou Maria	B'	6880	mvasili	39, 40
Vellidis Constantinos	B'	6946	cvellid	41,42

ASSISTANT PROFESSORS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Alexakis George	E'	6867	galexaki	—
Bossioli Elissavet	Δ'	6836	ebossiol	84, 85
Dasyra Kalliopi	Γ'	6815	kdasyra	79, 80

Giannakaki Eleni	Δ'	6928	elina	77, 78
Kazantzidis Stylianos	Γ'	6898	skazantzidis	81, 82
Manousakis-Katsikakis Arkadios	Β'	6950	amanousak	83
Papathanassiou Antonios	Α'	6730	antpapa	86, 87
Petropoulou Maria	Γ'	6894	mpetropo	88, 89
Roditi Eugenia	Ε'	6868	eroditi	90, 91
Tzanis Christos	Δ'	6937	chtzanis	92, 93
Tsakmakidis Kosmas	Α'	6821	ktsakmakidis	94, 95
Tyrlis Evangelos	Δ'	6934	etyrlis	96, 97

LECTURERS	SECTION	TEL. 210727 ####	Email [at] phys.uoa.gr	ADVISOR to: Last two digits of student's ID
Gazeas Kosmas	Γ'	6892	kgaze	98, 99

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 2021-22, is assigned based on the last two (2) digits of the student's ID, as shown in the last column of the above tables.

RESEARCH ASSISTANTS	TEL. 210727 ####	Email [at] phys.uoa.gr
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LABORATORY TEACHING STAFF	TEL. 210727 ####	Email [at] phys.uoa.gr
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Georgaki Chrisoula	6870	cgeorgakis
Gerontidou Maria	6901	mgeront
Giannouri Maria	6771	mgiannouri
Kapoyannis Athanasios	6881	akapog
Karatasou Stavroula	6995	ckarat
Konstantopoulos Panagiotis	6718	pkostan
Latsas Georgios	6865	glatsas

Mamalougkos Nektarios	6958	nektar
Mantziafou Anneta	6849	amant
Mitsakou Eleftheria	6854	emitsaku
Prosalentis Evangelos	6996	eprosaled
Protonotariou Anna	6813	aprot
Tsetseri Maria	6782	mtsetse
Tsochantzis Ioannis	6984	etsochantzis
Vlastou Georgia	6808	gvlastou

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Dimitropoulos Vasilios	6741	vdimitrop
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
Zarbouti Sofia	6715	szarbouti

ADMINISTRATIVE STAFF	TEL. 210727 ####	Email
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Psoma Paraskevi	6799	vpsoma [at] uoa.gr
Rizou Maria	6990	m_rizou [at] uoa.gr
Spyropoulou Konstantina	6754	nsprirop [at] phys.uoa.gr

Stefanatou Polixeni	6825	pstefan [at] phys.uoa.gr
Tzigos Spiridon	6741	spitz [at] phys.uoa.gr
Zografaki-Toga Eftychia	6804	ezografaki [at] phys.uoa.gr

Departmental Committees

INTERNAL EVALUATION
D. Hatzidimitriou (Chair), N. Stefanou, D. Stamopoulos, C. Vellidis, N. Vlahakis, H. E. Nistazakis, S. Gardelis, F. Diakonos, P. Sphicas, T. Apostolatos, K. Gazeas, E. Flocas, C. Tzanis, A. Moustakas, G. Vlastou, G. Latsas, E. Mitsakou, A. Manziafou, I. Tsochantzis, M. Tsetseri

UNDERGRADUATE STUDIES
P. Sphicas (Chair)
D. Frantzeskakis
T. Apostolatos
E. Flocas
A. Moustakas
D. Hatzidimitriou
H. E. Nistazakis
A. Dandou

POSTGRADUATE PROGRAM IN "PHYSICS"
Director: V. Spanos, Deputy Director: D. Hatzidimitriou
N. Saoulidou
T. Apostolatos
V. Likodimos
C. Simserides

POSTGRADUATE PROGRAM IN "APPLIED PHYSICS"
Director: M. Tombrou-Tzella, Deputy Director: S. Sofianos
E. Flocas
M. N. Assimakopoulos
C. Tzanis
E. Giannakaki

INTERDEPARMENTAL POSTGRADUATE STUDIES PROGRAM IN "Electronics and Radioelectrology" and "Control and Computing"
D. Reisis (Director)
I. Tigelis
A. Tzanakaki
A. Paschalis
E. Chadjiefthymiadis

DOCTORAL STUDIES
D. Stamopoulos (Chair)
V. Spanos
I. Daglis
M. N. Assimakopoulos
A. Moustakas

STUDENT PRACTICE PROGRAMME
H. E. Nistazakis, C. Simserides (substitute)
Evaluation Commitee: 1) D. Hatzidimitriou, 2) A. Tzanakaki, 3) G. Latsas

PHYSICS COLLOQUIUM
K. Dasyra (Chair)
K. Tsakmakidis
C. Vellidis
H. Flocas
A. Moustakas

DISABLED STUDENTS
M. Petropoulou (Chair), M. Rizou, P. Kotoula

COURSE TIMETABLE, EXAMINATIONS AND SUPERVISION COMMITTEE
M. Vasileiou
E. Flocas
H. E. Nistazakis

3.4 Buildings and Infrastructure

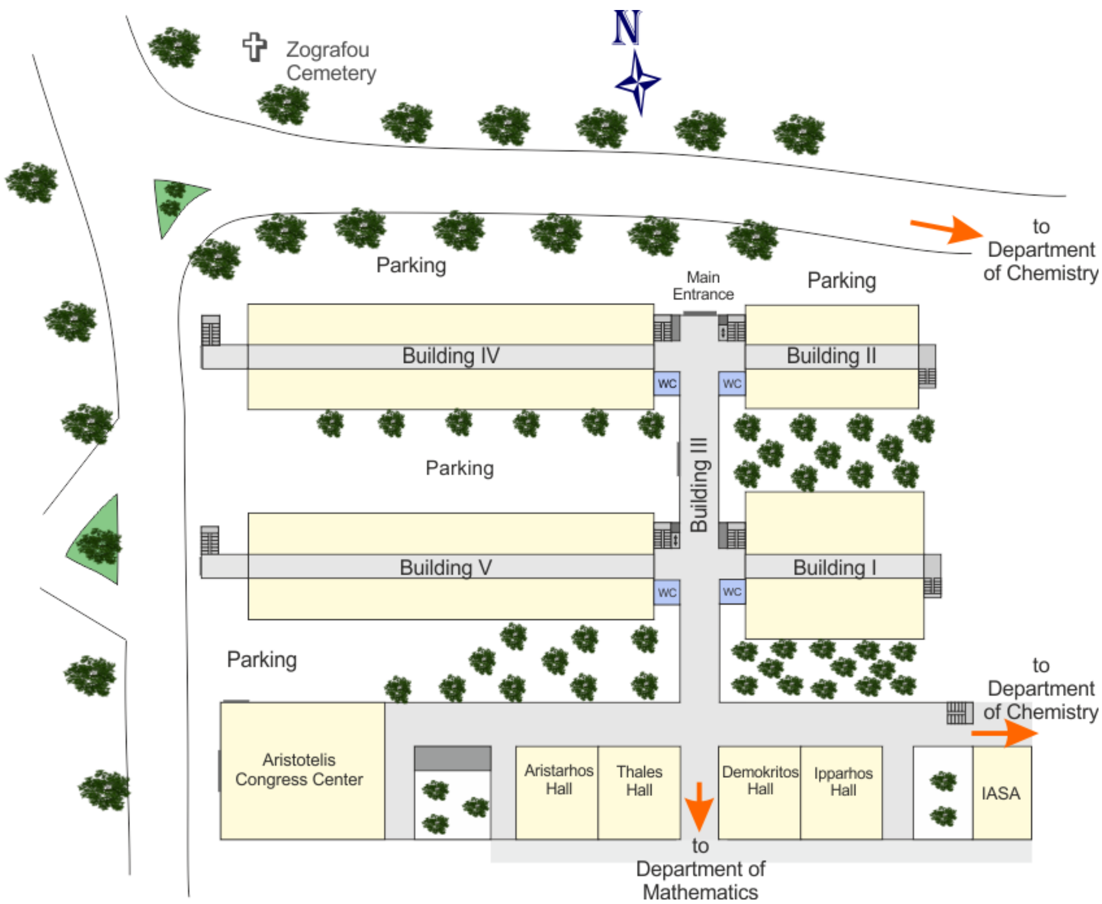
The Department of Physics disposes of a congress hall, lecture halls, classrooms, conference room, reading room, laboratories with modern equipment and high-speed internet connection. Specifically, the Department's infrastructure consists of:

- Four (4) lecture halls with live streaming and recording equipment:
  "Hipparchus" (208 seats)
  "Demokritus" (208 seats)
  "Thales" (208 seats)
  "Aristarchus" (242 seats)
- Seven (7) central classrooms:
  "Karapiperis" (49 seats)
  "Hondros" (49 seats)
  "Heron" (50 seats)
  "Kotsakis" (63 seats)
  "Anastasiadis" (63 seats)
  "Heraclitus" (70 seats)
  "Archimedes" (90 seats)
- Classrooms/seminar rooms and libraries in the five Departmental Sections

- Congress Hall "Aristotle" (285 seats) with live streaming and recording equipment
- Conference room
- Reading room
- 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**: Christos Kyrkos
- **Building Vice Superintendent**: Nikolaos Kaltsounidis

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-Toga

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 Univerity 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, which was approved by the Physics Department and the NKUA Senate, 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 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 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.

Carreer 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 240 ECTS credit points. Each year of study is divided into two semesters, each of which lasts 13 weeks. The average daily attendance by students ranges between 4 and 5 hours, corresponding to an average of 21-22 hours per week. In the beginning of the fourth year, students select a thematic area for specialization. The Department offers five such 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)

The choice of specialization is possible only after a student has successfully completed a minimum of 15 courses and the 4 basic physics laboratories.

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 (YKn) and 2 elective specialization courses (EKn) selected from about 4-5 offered in each specialization area n=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 inculed in some theoretical courses as well, e.g. in the five introductory specialization courses, in the Computer Science course, 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 second semesters, students also attend introductory seminars, in which the Department's five thematic areas and the corresponding directions of study are presented. These seminars are not graded.

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 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. 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.
- 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 2nd 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 ΣΤ', 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.

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.

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

The degree of the Department of Physics also grants pedagogical and didactic competence certification.

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.

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. Students are invited to contact and get acquainted with their respective advisor. They are also encouraged to consult with their advisor on any issues arising in the context of their studies. Based on the current number of faculty members and the number of incoming students, each faculty member is assigned as mentor to about 5-6 students each year. Beginning with the students admitted in the 2021-22 academic year, the appointment is made based on the last two (2) digits of the students’ ID, as listed in the last column of the tables of the faculty members of the Department, in section 3.3.

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 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	2.5	4
10YKO06	Basic Physics Laboratory II	2.5	4
10YKO07	Basic Physics Laboratory III	2.5	4
10YKO08	Basic Physics Laboratory IV	2.5	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	4	6
10YKO21	Computational Physics	4	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	7
10EKA02	Introduction to Electronic Physics	5	7
10EKA03	Introduction to Atmospheric Physics	5	7
10EKA04	Introduction to Nuclear and Particle Physics	5	7
10EKA05	Introduction to Solid State Physics	5	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
10EK304	Renewable Energy Sources – Efficient-Energy Building Design	4	6
10EK311	Synoptic Meteorology (postgraduate)	2 + 2 Lab	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
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 (ΕΛΕ), 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			
10ΕΛΕ01	Atomic and Molecular Physics	4	6
10ΕΛΕ02	Stochastic Processes in Physics	4	6
10ΕΛΕ03	Applied Optics	4	6
10ΕΛΕ04	Group Theory and Applications	4	6
10ΕΛΕ05	States and Properties of Matter	4	6
10ΕΛΕ06	Non-linear Dynamical Systems	4	6
From the Department of Mathematics			
10ΕΛΕ11	Real Analysis	6	9
10ΕΛΕ11	Geometry II	6	9
From the Department of Informatics and Telecommunications			
10ΕΛΕ21	Information Theory and Coding	4	6
From the Department of Geology and Geoenvironment			
10ΕΛΕ31	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 Exercise		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 excercise.

10YKO06. BASIC PHYSICS LABORATORY II

Introductory lectures:

- Hypothesis testing. Testing mean value and variance of a sample. Testing mean value and variance of two independent samples. Testing mean value and variance differences in correlated samples.
- Correlation. Significance of linear correlation coefficient. Γραμμική παλινδρόμηση. Linear regression. Significance testing and confidence levels of regression variables.

Laboratory experiments:

- Study of harmonic oscillator.
- Study of Atwood engine (using photogates).
- 2^{nd} and 3^{rd} Newton laws. Impulse. Collisions.
- The Cavendish experiment.
- Study of rigid body rotation. Moments of inertia. Static and kinetic friction.
- Natural and rotational pendulum.
- Ideal gas processes using sensors and computers.

- Study of statistical distributions: Testing mean value and variance of a sample. Testing mean value and variance of two independent samples.

10YKO07. BASIC PHYSICS LABORATORY III

- Spectrometer: gratings and prisms.
- Study of isothermal processes in gasses and the Otto cycle.
- Measurement of the speed of longitudinal waves and elastic constants in solids.
- Measurement focal distance and relevant aberration errors of convex lenses.
- Study of polarized light. Measurement of optical activity by polarimeter.
- Measurements with Michelson interferometer.
- Study of wave phenomena with microwaves. Reflection. Refraction. Interference. Diffraction. Polarization. Standing waves.
- Study of the Doppler effect in air.
- Preparation, presentation and teaching of laboratory experiments and the basic principles of experimentation in physics, by Physics Department students to high-school pupils.

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 high-school pupils.

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.
- Qualitative theory of differential equations in the plane. Local techniques and introduction to global techniques.

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.

10YKO21. COMPUTATIONAL PHYSICS

- Algorithms and their computer implementation. Numerical calculations and uncertainties. Random number generators. Inverse transform method. Rejection sampling. Frequency diagrams (histograms).
- Least squares method.
- Solution of equations in one variable. Solution of algebraic systems.
- Polynomial interpolation. Numerical differentiation. Numerical integration.
- Solution of ordinary differential equations.
- Introduction to numerical integration and simulation of physical phenomena by the Monte-Carlo method.

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. Dynamics of the rigid body.

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.
- 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 in-stabilities in the presence of stratification and rotation.

Introductory Specialization Courses

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. Green house 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.

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)

- Metric. Christoffel connection. Riemann curvature tensor. Einstein equations.
- Lagrange formulation (Einstein-Hilbert action).
- Transformation symmetries of geometrical objects. Killing vector fields.
- Spacetime symmetries and their application to Einstein equations. Spatially homogeneous space-times (Bianchi models).
- Black hole solutions. Gravitational waves.
- Primary-secondary constraints. First class constraints and gauge theories. Second class constraints and Dirac brackets. Proposals for canonical quantization.

10EK112. OBSERVATIONAL TECHNIQUES AND DATA ANALYSIS IN ASTROPHYSICS (post-graduate)

- Radiation detectors. Practical issues of astronomical observations. Methods of astronomical observation.
- Attenuation of stellar radiation. Reduction and processing of astronomical observations (in optical wavelengths).
- Observational calculations. Photometry with CCD. Photometry in the infrared. Applications in astronomical photometry.

- Astronomical spectroscopy. Light dispersion optical instruments. Categories of astronomical spectrographs. Construction and characteristics of astronomical spectrometers. Spectrum calibration. Spectral classification. Astronomical spectroscopy applications. Processing of spectroscopic observations.
- Methods of analysis in other regions of the EM spectrum (infrared, X-rays, radio waves). Other observation techniques: Astrometry, polarimetry, solar observations, magnetograms, magnetic field measurements.
- Astrostatistics. Modern astronomical databases: Data-mining, virtual observatories, astronomical data archives.
- Practical exercise: Photometric and spectroscopic data processing with the astronomical software IRAF.

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 Specializatio (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

- Meterological 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 micro climate.

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 intesification 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 vapour 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.

10EK304. RENEWABLE ENERGY SOURCES — EFFICIENT-ENERGY BUILDING DESIGN

- Solar energy: Solar radiation characteristics near the surface, passive and active solar systems, solar systems of electric energy production, photovoltaics, storage of thermal energy.
- Wind energy: Wind physical characteristics and parameters, wind potential, aerodynamics and strength of materials of wind systems, wind turbines and their performance, wind farms.
- Bioenergy: Biomass sources, energy crops, biofuels, biomass processing technologies, products, biomass management, principle of operation of fuel cells.
- Geothermal energy: Geothermal potential, classification of geothermal fields, geothermal energy systems of high, medium and low enthalpy, hybrid systems, applications of geothermal energy, energy co-production.
- Bioclimatic and sustainable efficient-energy building design. Energy saving. Storage of electric energy. Energy footprint of carbon in buildings. Basic principles of circular economy of building materials.

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).

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 component 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 4^{th} 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, neutrino, and neutron detection experiments.
- Recent results from hadronic shower, neutrino, 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 Resonancs 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. Eigenfunction expansion. Laplace, Helmholtz, Poisson equations, diffusion equation.
- Conformal transformations and applications in electrostatics and fluid mechanics.
- Green functions. Propagators in quantum mechanics. Lippmann-Schwinger και Klein-Gordon equations. Path integral calculation of Green functions.
- Hilbert transform. Dispersion relations. Advanced complex integration techniques and their applications.
- Saddle point and stationary phase approximations. Asymptotic expansions.

10EK412. ELEMENTARY PARTICLES (postgraduate)

- Review: The Klein-Gordon and Dirac equations, antiparticles and spin, Feynman diagrams.
- Leptons and quantum electrodynamics (QED).
- Higher order corrections.
- Hadrons and quantum chromodynamics (QCD).
- Weak interactions.
- Electroweak theory: $SU(2) \cdot U(1)$, the $W^{\pm}$, Z^0 and γ bosons. Spontaneous symmetry breaking. Brout-Englert-Higgs mechanism.
- The full Standard Model. The physics of W and Z. Production and decay of b and t quark. Discovery of Higgs boson.
- CP, CPT symmetry. Mixing of neutral kaons and B mesons. Discovery of CP violation in the kaon system. CP violation in other systems. Neutrino oscillations. Nature of neutrinos (Majorana/Dirac) and masses.

10EK413. NUCLEAR PHYSICS (postgraduate)

- Hadronic structure. Experimental evidence for the existence of quarks. The Standard Model and properties of hadrons. Symmetries and classification of hadrons. Nucleon properties. Models of the nucleon structure. Quantum chromodynamics and nucleon structure.
- The nuclear interaction. Nucleon-nucleon scattering. Phenomenological potentials and meson exchange theories. Nuclear potentials inspired from quantum chromodynamics and its effective theories.
- Microscopic description of nucleonic systems. The deuterium. Light nuclei and nuclear matter. The nuclear mean field. Correlation theories. Shell theory and effective potentials. Pairing and polarization of the nucleus. Description of nuclei by the Hartree-Fock theory. Collective phenomena. TDA-RPA theories. Relativistic mean field model. Mesons and quarks in nuclei.
- Equation of state and properties of nuclear matter. Phases of the strongly interacting matter.
- Elements of nuclear astrophysics (neutron stars, etc.)
- Basic experimental techniques in nuclear physics.

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. Stmulated – 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-emissionDensity matrix.
- LASER: Pumping, population inversion, rate equations, longitudinal and transverse EM modes, LASER types.

10YK502. SOLID STATE PHYSICS

- Motion of charged cariers 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 the spontaneous magnetization and of the 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 Earth physics. Thermal and pressure gradients in Earth's interior. Grüneisen theory. Harmonicity-anharmonicity. Melting.
- Heterogeneity and transport phenomena.
- Mechanical properties of materials of Earth.
- Seismic waves and structure of the Earth's solid crust.
- The electromagnetic field in the Earth's solid crust.
- Electromagnetic properties of materials of the Earth's solid crust.
- Electric and electromagnetic monitoring methods.
- Introduction to the physics of preseismic electric signals.

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 abberation 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 1^{st} 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

10ΕΛΕ21. INFORMATION THEORY AND CODING

- C.E. Shannon: His life, work and influence on modern communications.
- Information measures and basic properties: Entropy, reciprocal information, KL divergence, convexity.
- Typicality and asymptotic equipartition property.
- Stationary (ergodic) sources and entropy rate.
- Lossless source compression. Prefix codes. Fundamental compression limits based on the entropy rate. Shannon codes. Hufman codes.
- Channel capacity. Examples (binary symmetric channel, binary erasure channel) and properties. Formulation and proof of the channel coding theorem for discrete memoryless channels. Feasibility. Joint typicality.
- Fano inequality and converse to the coding theorem. Feedback capacity.
- Continuous-time sources and channels. Differential entropy. Reciprocal information and properties. Entropy of a normal random vector.
- The additive gaussian channel. Typicality, coding theorem. AWGN channel capacity. Bandlimited channel capacity.
- Parallel gaussian channels. Channel with colored noise. Power allocation for rate maximization. Water-filling method.
- Sequential source coding. Arithmetic coding and Lempel-Ziv coding.
- Introduction to rate-distortion theory and lossy compression.
- Linear codes. Description and coding. Hamming codes.
- Convolutional trellis codes. Viterbi algorithm and decoding.
- Turbo codes. Iterative decoding and BCJR algorithm.
- LDPC codes. Factor graphs and Tanner graphs. Decoding with the message-passing algorithm.

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 history and philosophy of physical science. The physical sciences and society. The physical sciences and philosophy.
- Physics in the late 19th century. The Newtonian heritage. New discoveries (X-rays, electrons, radioactivity, blackbody radiation) and the end of classical physics.
- The revolutions in early 20th 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

SEMESTER A'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO01	6	7	Physics I
10YKO05	2,5	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	2,5	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	2,5	4	Basic Physics Laboratory III
10YKO15	5	7	Mathematical Methods in Physics I
10YKO21	4	6	Computational Physics
10YKO31	5	7	Mechanics I

SEMESTER Δ'

COMPULSORY CORE COURSES

Code	Hours/week	ECTS	Course
10YKO04	6	7	Physics IV
10YKO08	2,5	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
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
10EK304	4	6	Renewable Energy Sources – Efficient-Energy Building Design
10EK311	2 + 2 Lab	6	Synoptic Meteorology (postgraduateó)
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			
10EΛE21	4	6	Information Theory and Coding
From the Department of Chemistry			
10EΛE41	4	6	Chemistry
10EΛE42	4	6	Chemistry Laboratory
From the Department of Primary Education			
10EΛE71	4	6	Physics Teaching Methods

FINAL-YEAR DISSERTATION

10EKA07	3	7	Final-Year Dissertation II

5.4 Academic Calendar 2020-21

Start of the Academic Year: Monday, October 11, 2021.

Winter Semester

First Day of Classes: Monday, October 11, 2021.

Class Period: Monday, October 11, 2021 until Friday, January 21, 2022 (1st and 3rd semester intermediate exams: 6/12/21 – 10/12/21).

Examination Period: From Monday, January 31 to Friday, February 18, 2022.

Official Holidays:

- Thursday, October 28, 2021 (national holiday)
- Wednesday, November 17, 2021 (anniversary of the Athens Polytechnic uprising)
- Friday, December 24, 2021 until Friday, January 7 2022 (Christmas holidays)
- Sunday, January 30, 2022 (Three Hierarchs holiday)

Spring Semester

First Day of Classes: Tuesday, February 22, 2022.

Class Period: Tuesday, February 22, until Friday, June 3, 2022 (2nd and 4th semester intermediate exams: 28/3/22 – 1/4/22).

Examination Period: Tuesday, June 14, until Friday, July 1, 2022.

Official Holidays:

- Monday, February 21, 2022 (anniversary of the NKUA School of Law occupation)
- Monday, March 7, 2022 (Ash Monday)
- Friday, March 25, 2022 (national holiday)
- Monday, April 18, until Friday, April 29, 2022 (Easter holidays)
- Sunday, May 1, 2022 (1st May holiday)
- Monday, June 13, 2022 (Holy Spirit holiday)
- No classes are held on student election day and the day after.

September Examination Period

Examination Period: From Monday, August 29, to Friday, September 30, 2022.

APPENDIX A

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.