ΠΑΝΕΠΙΣΤΗΜΙΟ
ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF PHYSICS

UNDERGRADUATE STUDIES GUIDE

2023-2024

Created by: K.N. Gourgouliatos, Associate Professor
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Contents

Department of Physics

The Department of Physics of the University of Patras was founded in 1964 and is among the oldest Departments of our University. It is located at the University of Patras campus, about 8 km north of downtown Patras.

Divisions

Currently it is divided in four Divisions, namely:

- Applied Physics
- Condensed Matter Physics
- Electronics and Computers, and
- Theoretical & Mathematical Physics, Astronomy & Astrophysics.

The faculty of the Department offer undergraduate and graduate courses not only at the Department but also in other Departments of the University of Patras and other Greek and foreign Universities.

Research

Research is a key activity as demonstrated by the number of papers published annually in peer reviewed international scientific journals and also by the number of international research programs in which our faculty participate. Our faculty has built along the years close collaborations with universities, research institutes and industries in Europe, the USA and Asia. Senior faculty members of the Department are internationally recognized scientists in their fields.

The main research fields of the Department are

- Applications in Organic Electronics - Design, fabrication and characterization of optoelectronic and photonic devices such as solar cells and light emitting diodes
- Astronomy – Observational Astrophysics
- Astroparticle Physics
- Atmospheric & Environmental Physics
- Composite Materials
- Computational Physics
- Design of Analog & Digital Integrated Circuits
- Design of Embedded Digital Signal Processing Systems
- Digital Information Processing (Signal & Image, Biometrics, Computer Vision)
- Gravity Theory
- Inorganic semiconductors and oxides - Electrical and photoelectric
- properties
- Lasers, Non-linear and Quantum Optics

- Organic semiconductors and conjugated polymers - Optoelectronic,
- structural and charge transport properties
- Physics of Polymers and Liquid Crystals
- Quantum Foundations and Quantum Information
- Renewable Energy Sources
- Semiconductor Physics – Microelectronics

Laboratories

The Department of Physics includes the following laboratories and research groups:

- Applied Physics Division
    - Laboratory of Atmospheric Physics
      http://www.atmosphere-upatras.gr
    - Renewable Energy Laboratory
      http://rel.physics.upatras.gr/

- Theoretical & Mathematical Physics, Astronomy & Astrophysics Division
    - Laboratory of Astronomy
      http://www.astro.upatras.gr/el/mythodea
    - Molecular Engineering Group
      http://moleng.upatras.gr

- Condensed Matter Division
    - Solid State Physics Laboratory
      http://ssp.physics.upatras.gr
    - Laser, Nonlinear and Quantum Optics
      http://nam.wpnet.upatras.gr

- Electronics and Computers Division
    - Electronics Laboratory
      http://www.ellab.physics.upatras.gr
    - Laser Laboratory
      http://www.laserlab.physics.upatras.gr
    - Computer Vision Group

Faculty and Staff

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Department Library		
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Administration

Department Administration (1.9.2022-31.8.2024)	
Department Head	Prof. A. Kazantzidis
Department Deputy Head	Prof. K. Psychallinos

Divisions (1.9.2023-31.8.2025)	
Director of Applied Physics Division	-
Director of Electronics and Computers Division	Assoc. Prof. M. Fakis
Director of Theoretical & Mathematical Physics, Astronomy & Astrophysics Division	Assoc. Prof. C. Anastopoulos
Director of Condensed Matter Division	Assoc. Prof. D. Anastasopoulos

Secretariat	
Secretary	Petta Thekli

Undergraduate Studies

Courses Index

CODE	COURSE NAME	ECTS	LECTURERS
1st Semester			
PCC101	Mechanics and Fluid Mechanics	8	C. Krontiras P. Karahaliou
MCC103	Calculus	6	A. Argiriou
MCC105	Linear Algebra - Analytical Geometry	3	K. Gourgouliatos
GCC307N	Chemistry	4	N. Lalioti (Chemistry Dept.)
CLC109	Computer Programming I	5	D. Bakalis
PLC111	Physics Laboratory I	4	D. Korfiatis
2nd Semester			
PCC102	Heat – Waves – Optics	8	M. Fakis
MCC104	Vector Analysis	8	I. Kioutsioukis
MCC106	Ordinary Differential Equations	6	A. Argiriou
PLC108	Physics Laboratory II	4	K. Andrikopoulos (Coordinator)
CLC110	Computer Programming II - Laboratory	4	V. Anastassopoulos
3rd Semester			
PCC201	Electromagnetism I	8	V. Anastassopoulos N. Spiliopoulos
MCC203	Mathematics for Special Applications	7	V. Loukopoulos
ECC205	Electronics	5	C. Psychalinos S. Vlassis
CCC207	Introduction to Probability and Statistics	6	Z. Psillakis
PLC211	Physics Laboratory III	4	M. Fakis (Coordinator)
4th Semester			
PCC202	Modern Physics	5	D. Skarlatos
PCC204	Elementary Particles and Theory of Relativity	3	S. Lola
PCC206	Waves	5	D. Kotopoulis
PCC208	Classical Mechanics	8	V. Loukopoulos
ELC210	Electronics Laboratory	5	C. Psychalinos (Coordinator)
PLC212	Physics Laboratory IV	4	D. Skarlatos (Coordinator)
5th Semester			
PLC301	Physics Laboratory V	5	N. Spiliopoulos (Coordinator)
PLC303	Quantum Physics I	8	An. Terzis
PLC305	Thermal and Statistical Physics	8	L. Palilis
ACC307	Introduction to Environmental Physics	4	An. Kazantzidis
ACC309	Introduction to Astronomy and Astrophysics	5	E. Christopoulou

6th Semester			
PCC302	Quantum Physics II	9	C. Anastopoulos
PCC304	Solid State Physics	7	D. Anastassopoulos
PCC306	Electromagnetism II	9	K. Gourgouliatos
EEC422	Atomic and Molecular Physics	5	K. Andrikopoulos L. Palilis

Specialization in: Physics of Technological Materials			
7th Semester			
	Compulsory		
MSC401	Special Topics on Solid State Physics	5	D. Anastassopoulos
MSC407	Materials Science	5	P. Karahaliou
MSC409	Materials' Characterization Techniques Laboratory	5	P. Karahaliou (Coordinator)
	Elective		
MSE417	Bachelor Thesis	10	
8th Semester			
	Elective		
MSE402	Special Topics in Statistical Physics	6	L. Palilis
MSE404	Physics of Polymers, Polymer Composites and Liquid Crystals	6	P. Karahaliou
MSE406	Microelectronics Materials and Devices	6	D. Skarlatos L. Palilis
MSE417	Bachelor Thesis	6	

Specialization in: Energy and Environment			
7th Semester			
	Compulsory		
EEC419	Renewable Energy Sources	5	G. Syrrokostas
EEC427	Fluid Mechanics	5	V. Loukopoulos
EEC421	Physics of the Atmosphere I – Meteorology (+Laboratory)	5	I. Kioutsioukis A. Argiriou
	Elective		
EEE423	Atmospheric Pollution	5	*Not offered in 2023-2024*
EEE425	Bachelor Thesis	10	
8th Semester			
	Compulsory		
EEC424	Renewable Energy Sources Laboratory	6	G. Syrrrokostas
EEE428	Physics of the Atmosphere II (+Laboratory)	6	G. Kosmopoulos
	Elective		

EEE430	Solar Energy Systems	6	G. Kosmopoulos
EEE425	Bachelor Thesis	6	

Specialization in: Photonics			
7th Semester			
	Compulsory		
PHC431	Optoelectronics	5	E. Paspalakis
PHC433	Applied Optics	5	M. Fakis
PHC435	Laser Physics	5	S. Couris
	Elective		
PHE439	Bachelor Thesis	10	
8th Semester			
	Elective		
PHE436	Introductory Quantum Optics	6	E. Paspalakis
PHE438	Lasers and Applications (Lasers' Laboratory)	6	S. Couris M. Fakis
PHE440	Fiber Optics and Communications	6	*Not offered in 2023-2024*
PHE439	Bachelor Thesis	6	

Specialization in: Theoretical, Computational Physics and Astrophysics			
7th Semester			
	Compulsory		
TAC445	Nuclear Physics and Particle Physics	5	S. Lola
TAC447	Astrophysics I	5	E. Christopoulou
TAC449	Computational Physics	5	V. Loukopoulos
	Elective		
TAE 451	Laboratory Astronomy	5	E. Christopoulou
TAE469	Special Topics of Quantum Physics	5	E. Paspalakis
TAE503	Selected Topics in Probability and Statistics	5	*Not offered in 2023-2024*
TAE473	Dynamical Systems & Complexity	5	I. Kioutsioukis
TAE467	Bachelor Thesis	10	
8th Semester			
	Compulsory		
TAC446	Cosmology	6	K. Gourgouliatos
TAC448	Modern Physics	6	C. Anastopoulos
	Elective		
TAE454	Astrophysics II	6	E. Christopoulou
TAE458	Special topics of elementaray particle Physics and fields	6	*Not offered in 2023-2024*
TAE450	Astrophysics' Laboratory	6	E. Christopoulou

TAE506	Special Topics on Mechanics	6	D. Kotopoulis
	General Theory of Relativity	6	A. Terzis
TAE467	Bachelor Thesis	6	

Specialization in: Electronics, Computers and Signal Processing			
7th Semester			
	Compulsory		
ELC471	Theory of Signals and Circuits	5	K. Giannakopoulos
ELC475	Analog Electronics	5	C. Psychalinos S. Vlassis
ELC470	Digital Electronics	5	V. Anastasopoulos
	Elective		
ELE483	Introduction to Telecommunications	5	G. Economou
ELE485	Bachelor Thesis	10	
8th Semester			
	Compulsory		
ELC472	Digital Signal Processing	6	V. Anastassopoulos
ELC473	Introduction to Microcomputer Architecture	6	D. Bakalis
	Elective		
ELE474	Analog Electronics Laboratory	6	C. Psychalinos S. Vlassis K. Giannakopoulos C. Kassimis
ELE481	Digital Electronics Laboratory	6	V. Anastasopoulos
ELE478	Microelectronics	6	S. Vlassis C. Phychalinos
ELE485	Bachelor Thesis	6	

Specialization in: Generic
7th + 8th Semester: At least five compulsory courses are selected along with elective courses from all majors.

Additional List of Electives			
7th Semester			
NME491	Demonstration Experiments in Physics I	5	N. Ksanthopoulos P. Karahaliou C. Krontiras
NME503	School Counselling	5	S. Vassilopoulos (Primary Education Dpt.)

NME497	Introduction to Geophysics	5	Z. Roumelioti P. Paraskevopoulos (Geology Dpt.)
NME499	Physical Chemistry	5	A. Koliadima (Chemistry Dpt.)
8th Semester			
NME492	Demonstration Experiments in Physics II	5	N. Ksanthopoulos C. Krontiras
NME494	Physics Education	5	P. Metafas
NME495	General Biology	5	D. Vlastos (Biology Dept.)
NME500	Medical Physics	5	G. Panagiotakis G. Sakellaropoulos G. Kagadis (Medicine Dpt.)
NME504	History and Philosophy of Physical Sciences	5	P. Metafas
NME502	Practical Training (Students are selected after an open call – The course is not accounted for the ECTS required for the remittance of the diploma, but it is listed to the Diploma Appendix)		

Courses Contents (Fall 2023 – Spring 2024)

1st Semester

PCC101	Mechanics and Fluid Mechanics
Course Contents	1. Units,Physical quantities, Vectors 2. Motion along a straight line 3. Motion in two and three dimensions 4. The Newton's laws 5. Applying Newton's laws 6. Work and Kinetic Energy 7. Potential Energy and Conservation of Energy 8. Linear Momentum, Impulse and Collisions 9. Rigid Body Rotation 10. Rotation Dynamics 11. Equilibrium and Elasticity 12. Gravitation 13. Periodical Motions 14. Fluid Mechanics
Recommended Reading	1. University Physics, H.D.Young 2. Physics for scientists & engineers Serway 3. PHYSICS, Halliday-Resnick-Krane 4. PHYSICS, OHANIAN 5. FUNDAMENTAL UNIVERSITY PHYSICS, ALONSO-FINN 6. MECHANICS, BERKELEY PHYSICS COURSE

MCC103	Calculus
Course Contents	1) Numbers. 2) Function of one Independent Variable. 3) Limits and Continuity of Functions. 4) Derivatives. 5) Applications of Derivatives in the Study of Functions. 6) Series. 7) Indefinite and Definite Integrals. 8) Applications.
Recommended Reading	1. Γεωργίου Δημήτριος, Ηλιάδης Σταύρος, Μεγαρίτης Αθανάσιος Πραγματική Ανάλυση, ΕΚΔΟΣΕΙΣ Α. ΤΖΙΟΛΑ & ΥΙΟΙ Α.Ε., 2021 2. Ζαφειρόπουλος Βασίλειος, Μαθηματική Ανάλυση, Εταιρεία Αξιοποίησης και Διαχείρισης Περιουσίας Πανεπιστημίου Πατρών, 2012 3. Briggs William, Cochran Lyle, Gillett Bernard, Απειροστικός Λογισμός, Κριτική, 2018 4. George B. Thomas, Jr., Joel Hass, Christopher Heil, Maurice D. Weir , THOMAS Απειροστικός Λογισμός, ΙΤΕ-ΠΑΝΕΠΙΣΤΗΜΙΑΚΕΣ ΕΚΔΟΣΕΙΣ ΚΡΗΤΗΣ, 2018

MCC105	Linear Algebra and Analytical Geometry
Course Contents	**A. Linear Algebra** 1. Algebraic Structures 2. Algebra of Matrices – Determinants 3. Linear Systems 4. Vector Spaces 5. Inner product Spaces 6. Linear Operators and Transformations 7. Eigenvalues and eigenvectors **B. Analytical Geometry** 1. Points in 3-D space 2. Lines in 3-D space 3. Planes in 3-D space 4. 2nd degree curves on 2-D plane 5. Lines descrived by the 2nd degree equation 6. Polar coordinates 7. 2-D surfaces 8. Introduction to classical differential geometry
Recommended Reading	A. Linear Algebra 1. «Γραμμική Άλγεβρα και Αναλυτική Γεωμετρία», Δημητρίου Σουρλά, Εκδόσεις Πανεπιστημίου Πατρών 2012, ISBN: 978-960-530-141-5. 2. «Γραμμική Άλγεβρα» S. Lipschutz and M. Lipton, Σειρά Schaum Εκδόσεις Τζιόλα 2005. 3. «Γραμμική Άλγεβρα και Εφαρμογές» Gilbert Strang, Πανεπιστημιακές Εκδόσεις Κρήτης 1995 B. Analytical Geometry 1. «Αναλυτική Γεωμετρία», Σ. Α. Ανδρεαδάκης, (Συμμετρία, 1993) 2. «Γραμμική 'Αλγεβρα και Αναλυτική Γεωμετρία», Α. Φελλούρης, Αθήνα 1989

GCC307N	Chemistry
Course Contents	1. Calculations with Chemical Formulas and Equations Molecular weight and formula weight. The mole concept. Mass percentages from the formula. Elemental analysis: Percentages of carbon, hydrogen and oxygen. Determining formulas. Molar interpretation of a chemical equation. Amounts of substances in a chemical reaction. Limiting reactant: Theoretical and percentage yields. 2. Chemical Reactions: An Introduction Ionic theory of solutions. Molecular and ionic equations. Precipitation reactions. Acid – base reactions. Oxidation – reduction reactions. Balancing simple oxidation – reduction reactions. Molar concentration. Diluting solutions. Gravimetric analysis. Volumetric analysis. 3. Thermochemistry

	Energy and Its Units. Heat of reaction. Enthalpy and Enthalpy Change. Thermochemical Equations. Applying Stoichiometry to Heats of Reaction. Measuring Heats of Reaction. Hess's Law. Standard Enthalpies of Formation. Fuels-Foods, Commercial Fuels and Rocket Fuels. 4. Ionic and Covalent Bond Describing ionic bonds. Electron configuration of ions. Ionic radii. Describing covalent bonds. Polar covalent bonds. Electronegativity. Writing Lewis electron-dot formulas. Delocalized bonding – Resonance. Exceptions to the octet rule. Formal charge and Lewis formulas. Bond length and bond order. Bond energy. 5. Molecular Geometry and Chemical Bonding Theory The VSEPR model. Dipole moment and molecular geometry. Valence bond theory. Description of multiple bonding. Principles of molecular orbital theory. Electron configurations of diatomic molecules of the second-period elements. Molecular orbitals and delocalized bonding. 6. Solutions Types of solutions. Solubility and the Solution Process. Effects of Temperature and Pressure on Solubility. Ways of Expressing Concentration. Vapor Pressure of a Solution. Boiling-Point Elevation and Freezing-Point Depression. Osmosis. Colligative Properties of Ionic Solutions. Colloids. 7. Rates of Reaction Definition of Reaction Rate. Experimental Determination of Rate. Dependence of Rate on Concentration. Change of Concentration with Time. Temperature and Rate; Collision and Transition-State Theories. Arrhenious Equation. Elementary Reactions. The Rate Law and the Mechanism. Catalysis. 8. Chemical Equilibrium Chemical Equilibrium-A dynamic Equilibrium. The Equilibrium Constant. Heterogeneous Equilibria; Solvents in Homogeneous Equilibria. Qualitatively Interpreting the Equilibrium Constant. Predicting the Direction of Reaction. Calculating Equilibrium Concentations. Removing Products of Adding Reactants. Changing the Pressure and Temperature. Effect of a Catalyst. 9. Acids and Bases Arrhenius concept of acids and bases. Brønsted–Lowry concept of acids and bases. Lewis concept of acids and bases. Relative strengths of acids and bases. Molecular structure and acid strength. Self ionization of water. Solutions of a strong acid or base. The pH of a solution. 10. Acid-Base Equilibria Acid-Ionization Equillibria. Polyprotic Acids. Base-Ionization Equillibria. Acid-Base Properties of Salt Solutions. Common-Ion Effect. Buffers. Acid-Base Titration Curves.
Recommended Reading	1. «General Chemistry», Darrell D. Ebbing & Steven D. Gammon Houghton Mifflin Company, New York, 1999 (6th Edition). Translated into Greek by N. Klouras Publisher: P. Travlos, Athens 2007 (3rd Edition). 2. «Basic Inorganic Chemistry», N. Klouras Publisher: P. Travlos, Athens 2003 (6th Edition). 3. «Inorganic Chemistry – Basic Principles», G. Pnevmatikakis, X. Mitsopoulou, K. Methenitis Publisher: A. Stamoulis, Athens 2005

	4. «General Chemistry», Darrell D. Ebbing & Steven D. Gammon Houghton Mifflin Company, New York, 2009 (9th Edition). 5. «General Chemistry: Principles and Modern Applications», Ralf H. Petrucci, William S. Hawood, Geoff E Herring, & Jeffry Madura, Prentice Hall, 2006 (9th Edition). 6. «General Chemistry: The Essential Concepts», Raymond Chang McGraw-Hill Science Engineering, 2007 7. «Chemistry: The Central Science»,Theodore E. Brown, Eugene H. LeMay, & Bruce E. Bursten, Prentice Hall, 2006 (10th Edition) 8. «Chemistry», John McMurry, Robert C. Fay, & Logan McCarty Prentice Hall, 2003 (4th Edition) 9. «Chemistry», Steven S. Zumdahl, Houghton Mifflin College Div 2007 (7th Edition).

CLC109	**Computer Programming I**
Course Contents	Structured Programming with Fortran/C++: Programming Fundamentals. Data Types. Data Structures. Constants and Variables. Data Processing. Control Statements. Repetition Statements. Arrays. Subprograms (Functions, Subroutines). File I/O. Laboratory Exercises on Structured Programming with Fortran and C++.
Recommended Reading	1) H. Schildt, "C++ Step by Step", M. Giourdas, 2005. (A textbook translated in Greek language) 2) H. Schildt, "Learn C++ from zero", Kleidarithmos, 2004. (A textbook translated in Greek language) 3) V. Geroyannis, “The Programming Language Fortran”, Lecture Notes, University of Patras, 2007. (in Greek language) 4) Al. Karakos, "Fortran 77/90/95 & Fortran 2003 (2nd ed)", Kleidarithmos, 2007. (A textbook in Greek language) 5) N. Karampetakis, "Introduction to Fortran 90/95", Zhth, 2002. (A textbook in Greek language) 6) D. Bakalis, "Computer Programming I – Laboratory Exercises", 2018. (A textbook in Greek language)

PLC111	**Physics Laboratory I**
Course Contents	• THE MEANING OF ERROR – RANDOM AND SYSTEMATIC ERRORS-MEAN VALUE OF A SERIES OF MEASURMENTS • ABSOLUTE AND RELATIVE ERROR • SIGNIFICANT DIGITS • STANDARD DEVIATION OF A SERIES OF MEASUREMENTS AND OF THEIR MEAN VALUE • DRAWING OF A CURVE: Decimal, Semilogarithmic and Logarithmic Axes • LEAST SQUARES METHOD • LENGTH MEASUREMENT WITH CALLIPER AND MICROMETER. EXPERIMENTAL METHODS FOR THE CALCULATION OF DENSITY • MEASUREMENT OF THE GRAVITY ACCELERATION WITH THE SIMPLE PENDULUM • MEASUREMENT OF THE CONSTANT k OF A SPRING • MEASUREMENT OF THE ELECTRICAL RESISTANCE – OHM’S LAW. • MEASUREMENT OF THE TIME CONSTANT $\tau=RC$ OF AN R-C CIRCUIT.

Recommended Reading	“Εργαστήριο Φυσικής Ι”, e-class (Μαθήματα ανοικτού τύπου), Παν/μιο Πατρών “Ανάλυση πειραματικών δεδομένων - Θεωρία σφαλμάτων“ Σωτ.. Σακκόπουλου, Παν/κές Παραδόσεις, Παν/μιο Πατρών “Εργαστήριο Φυσικής Ι”, Σωτ. Σακκόπουλου, Παν/κές Παραδόσεις, Παν/μιο Πατρών. “Probability and Statistics”, Murray Spiegel (Greek translation) “ Leçons de Marie Curie”, Ed. Bénédicte Leclercq (Greek translation)

2nd Semester (Spring)

PCC102	Heat – Waves – Optics
Course Contents	1 Heat • Temperature and Heat • Thermal properties of matter • 1st Law of Thermodynamics • 2nd Law of Thermodynamics 2 Waves • Mechanical Waves • Sound and Acoustics 3 Optics • Nature and propagation of light • Geometrical optics and optical instruments • Interference • Refraction
Recommended Reading	1. Young H.D, Πανεπιστημιακή Φυσική, Εκδόσεις Παπαζήση, Αθήνα, 1994. 2. Serway R.A., Physics for Scientists and Engineers, (Ελληνική έκδοση), Βιβλιοπωλείο Κορφιάτη, Αθήνα, 1992. 3. Resnik R., Halliday D., Krane K.S., Φυσική, Έκδοση Γ. & Α. Πνευματικός, 2009.

MCC104	Vector Analysis
Course Contents	1. Algebra of vectors. 2. Vector functions. 3. Scalar fields – Directional derivative – Gradient. 4. Vector fields – Diverge – Rotation. 5. Linear integrals. 6. Double integrals. 7. Volume integrals. 8. Surface integrals. 9. Green, Stokes και Gauss's theorems. 10. Maximum and minimum.
Recommended Reading	1. "Vector Analysis»", D. Sourlas, Press Symmetry, 2010, (A text book in Greek language). 2. "Vector Calculus", J. Marsden, A. Tromba, Press University of Creta,2005 (in Greek translation). 3. "Vector Calculus", G. Thomas, R. Finney, Press of University of Creta 1997, (in Greek translation). 4. "Calculus one and several variables", S. Salas, E. Hille, J. Anderson, Press John Wiley 1986

MCC106	Ordinary Differential Equations
Course Contents	1. Basic concepts of Differential Equations 2. Existence and Uniqueness of a solution of differential equations 1s order. 3. Differential Equations 1s order. 4. Integrated factor. Γραμμικές Δ.Ε. n τάξης.

	5. Laplace transform and its applications. 6. Some cases of Differential Equations. 7. Euler Equations. 8. Methods of Series. 9. Systems of Differential Equations. 10. Difference Equations.
Recommended Reading	1. Δημήτρης Σουρλάς, Συνήθεις Διαφορικές Εξισώσεις, Εταιρεία Αξιοποίησης και Διαχείρισης Περιουσίας Πανεπιστημίου Πατρών, 2020 2. Nagle R. Kent, Saff Edward B., Snider Arthur David (Συγγρ.) - Αργυρίου Αθανάσιος, Κεχαγιάς Αθανάσιος (Επιμ.) Διαφορικές εξισώσεις, Κριτική, 2021 3. Cengel Y.A., Palm III W.J., Διαφορικές Εξισώσεις,Τζιόλας, 2016 4. Τραχανάς Στέφανος, Συνήθεις Διαφορικές Εξισώσει, ΙΤΕ-ΠΑΝΕΠΙΣΤΗΜΙΑΚΕΣ ΕΚΔΟΣΕΙΣ ΚΡΗΤΗΣ, 2008 5. Σταυρακάκης Νικόλαος, Διαφορικές Εξισώσεις: Συνήθεις και Μερικές. Θεωρία και Εφαρμογές από τη Φύση και τη Ζωή, Τσότρας, 2019

PLC108	**Physics Laboratory II**
Course Contents	1. Gravity acceleration calculation. 2. Mechanical conservation of energy and Maxwell disk moment of inertia calculation. 3. Torsion modulus of a metallic bar. 4. Viscosity measurement of a liquid with the Ostwald viscometer. 5. Investigation of the relationship between flow resistance and the shape and the shape of the surface condition of a body. 6. Investigation of the pressure distribution on an aerofoil in an air current. 7. Study of elastic and inelastic collition. 8. Free damped vibrations and damped vibrations with a driving force.
Recommended Reading	Mechanics R. Serway Mechanics D. Halliday-R.Resnick Mechanics H.Young Mechanics K. Αλεξόπουλος (in Greek)

CLC110	**Computer Programming II - Laboratory**
Course Contents	Object-Oriented Programming with C++: Structs. Classes and Objects. Function Overloading. Operator Overloading. Class Inheritance. Polymorphism. Laboratory Exercises on Structured Programming with Fortran and C++ and on Object-Oriented Programming with C++.
Recommended Reading	D. Bakalis, «Computer Programming II – Laboratory Exercises», 2013 (A textbook in Greek language)

3rd Semester (Fall)

PCC201	**Electromagnetism I**
Course Contents	1. Electric interaction – Electric charge and Coulomb's law 2. The static electric field in vacuum (vector and scalar description) –Gauss's law-Electric dipole 3. Conductors in electrostatic equilibrium –Capacitance and Capacitors 4. Dielectrics - Polarization of dielectrics - Gauss's law in the presence of polarized dielectrics 5. Electric current – Conductivity of solid conductors - Resistance and Ohm's law 6. Electromotive force and direct current circuits 7. Magnetic interaction and its origin 8. The static magnetic field in vacuum - Biot / Savart law – Ampere's law - Gauss's law in Magnetism -Magnetic dipole 9. Magnetisation of matter 10. Electromagnetic induction – Faraday's law 11. Inductance and Mutual Inductance 12. Alternating currents (general properties) – Alternating current circuits 13. Maxwell's equations .and introduction to Electromagnetic Waves
Recommended Reading	1) R.A.Serway "Physics for scientists & engineers", 3rd Edition (translation in Greek) 2) H.D.Young "University Physics" ,8th Edition (translation in Greek) 3) Lecture notes on advanced topics

MCC203	**Specific Mathematics (Mathematics in Physics)**
Course Contents	Partial Differential Equations – Fourier Series–Fourier Integral– Fourier Transforms– Complex Analysis : 1. Basic definitions. 2. The one-dimensional wave equation. 3. Transverse oscillations of an elastic membrane. 4. Heat flow in a specific direction. 5. Continuity equation. 6. The method of separation of variables. 7. The wave equations in polar and spherical system of coordinates. 8. The eigenvalue problem Ly=λy. The theorem of Sturm-Liouville. 9. Laplace equation in Cartesian, polar, cylindrical and spherical system of coordinates. Dirichlet's problem. 10. Fourier Series. Fourier Integral. Applications. 11. Wave propagation along an elastic chord of infinite length. 12. Poisson equation. Helmholtz equation. 13. Fourier Transforms. 14. Complex numbers.

	15. Complex functions. 16. Derivative of complex function. 17. Complex integration. 18. Integral types of Cauchy and theorems. 19 Taylor-Laurent Series and Integral residuals. 20. Conformal mapping.
Recommended Reading	1. Farlow, S.J., " Partial Differential Equations for Scientists and Engineers", Dover,1993. 2. Sokolnikoff, I.S, και Redheffer, R.M., "Mathematics in Physics and Modern Engineering", McGraw Hill, New York 1966. 3. Tikhonov, A.N. και Samarskii, A.A., " Equations of Mathematical Physics", Dover, New York 1990.

ECC205	**Electronics**
Course Contents	• Ohm law, Kirchhoff's rules, electrical network basic theory. • RC networks. • Introduction to semiconductor theory. • Silicon diodes, structure and operation, equivalent circuits. • Application of diodes (rectifiers, clamp circuit). • Bipolar transistor (BJT), structure and operation, electrical equivalent circuits. • Elementary amplifier circuits with BJT transistors, common-emitter and common-collector amplifier. • Introduction to MOS transistors, structure and operation, equivalent circuits
Recommended Reading	1. I. Haritantis: «Electronics », Arakinthos Pulications, 2013. 2. A. Malvino, D. Bates, «Electronics», 2016.

CCC207	**Introduction to Probability and Statistics**
Course Contents	Basic probability. Random variables. Distributions of random variables. Expected (mean) value and generating functions. Limit theorems. Distributions of sampling statistics. Point and interval estimation. Testing hypotheses. Curve fitting, regression and correlation.
Recommended Reading	(Greek Language) M. R. Spiegel, J. Schiller, R. A. Srinivasan. Probability and Statistics. 2nd ed. , Schaum's outlines M. R. Spiegel –Μετάφραση Σ.Κ. Περσίδης. Πιθανότητες και Στατιστική. Εκδόσεις ΕΣΠΙ, Αθήνα. Δ. Α. Ιωαννίδης. Στατιστική Μεθοδολογία. Εκδόσεις Ζήτη, Θεσσαλονίκη. Χ. Χ. Δαμιανού, Ν. Δ. Παπαδάτος, Χ. Α. Χαραλαμπίδης. Εισαγωγή στις Πιθανότητες και τη Στατιστική. Εκδόσεις Συμμετρία, Αθήνα. Ι. Α. Κουτρουβέλης. Εφαρμοσμένες Πιθανότητες και Στατιστική για μηχανικούς και θετικούς επιστήμονες. Εκδόσεις Gotsis, Πάτρα.

PLC211	**Physics Laboratory III**

Course Contents	This course consists of 8 experiments that help the students to understand better the course of Physics II: Thermodynamics, Waves and Optics that is based on the book of Serway, Physics for Scientists and Engineers, Vol III. The titles are: • Transverse and longitudinal waves. • Thermal expansion of insulators and conductors. • Measuring the ratio γ=cp/cv with the methods of Clements-Desormes, Ruchardt and Rinkel. • Visible spectroscopy with a prism and a grating spectrometer. • Visible spectroscopy with a spectrophotometer and a PC. • Polarization of light- Kerr effect. • Thin lenses- fiber optics and renewable energy sources. • Electromagnetic waves-Michelson interferometer.
Recommended Reading	1. H. D. Young, University Physics, Vol. A & B. (in Greek) 2. R.A. Serway, Physics for Scientists and Engineers, Vol. III (in Greek) 3. E. Hecht & A. Zajac, Optics, Addison-Wesley Publishing Co 4. K.D. Aleksopoulou, Optics (in Greek)

4th Semester (Spring)

PCC202	Modern Physics
Course Contents	I. Distinction between Classical and Modern Physics II. The origins of Old Quantum Theory (a) Particle-wave duality of light and the concept of photon (blackbody radiation, photoelectric effect, Compton effect). Key-experiments and explanations (b) Early atomic models. Atomic spectra and the Bohr model. The Frank-Hertz experiment (c) Wave-particle duality. Planck's constant and the Bohr-Wilson-Sommerfeld quantization rules (d) Critical review of Old Quantum Theory III. The principles of Modern Quantum Mechanics (a) Schroedinger equation. The physical meaning of the wave function (b) Applications to simple one-dimensional systems (c) Introduction to three-dimensional examples. Degenerate states (d) Qualitative presentation of the basic principles of Quantum Mechanics. Measurement in Quantum Mechanics. IV. Qualitative Schroedinger description of one-electron atoms. Comparison to Bohr model. Introduction of spin. Introduction to addition of angular momenta V. Qualitative description of many-electron atoms. The Periodic Table of the elements VI. Qualitative introduction to Moelecular Structure Practical applications of Modern Quantum Mechanics
Recommended Reading	"Modern Physics" by R. A. Serway, C. J. Moses, C. Moyer (in translation from Crete University press) "Introduction to Modern Physics", Lecture notes by Aristides D. Zdetsis. (Part of these Lecture notes, which also include a wide range and level of suggested reading, are included in the home page of prof. Zdetsis and the home page of the course

PCC204	Elementary Particles and Theory of Relativity
Course Contents	*SPECIAL THEORY OF RELATIVITY* I. Experimental facts which led to the Einstein's Principles of Relativity. 1. Analysis of the Michelson-Morley Experiment. 2. The Principles of Relativity. II. The Lorenz Transformation. 1. Construction of the Lorenz Transformation using the Einstein's gedanken experiments. 2. Transformation of velocities. III. The Minkowski Space 1. Geometric picture of the Lorenz Transformation. 2. The concept of fourvectors. 3. The fourvectors of velocity and momentum. 4. Transformation of momenta and energies. IV. Covariant formulation of Physical Laws. 1. Applications to scattering experiments. 2. Relativistic formulation of Electromagnetism. 3. A short presentation of Dirac's Equation.

	NUCLEAR PHYSICS I. 1. Scattering Experiments. 2. Rutherford's Experiment and the discovery of nuclei and nuclear forces. 3. Size and shape of nuclei. 4. Structure of nuclei and distribution of nucleons. II. Stability of nuclei. 1. Experimental curve of binding energy and of the neutron excess. 2. Proof of the semi-emperical nuclear mass formula. 3. Applications to fusion and fission. 4. Curves of stability of nuclei. III. Instability of nuclei and radioactivity. 1. The Law of radioactive decay. 2. Description of the properties of α, β, and γ rays. 3. Applications of radioactivity. IV. Nuclear forces. 1, The nature of nuclear forces- The Yukawa Potential. 2. Pions and rho mesons. *ELEMENTARY PARTICLE PHYSICS* I. A first classification of elementary particles. II. The four basic interactions. III. Leptons, mesons, baryons, hadrons. IV. The Parton Model. V. The Quark Model. VI. Quantum Chromodynamics. VII. Current questions and the Experiment at CERN.
Recommended Reading	1. "Introduction to Special Theory of Relativity, p 225, Wolfgang Rindler, Reader Books. 2. "Modern Physics", R.A. Serway, C.J. Moses, C.A. Moyer. Translation: G. Zoupanos, E. Liarocopis, S. Papadopoulos, K. Raptis, PEC. 3. Lecture Notes "Introduction to Special Theory of Relativity", Demetris P.K. Ghikas.

PCC206	**Waves**
Course Contents	1. The simple harmonic motion. Damped simple harmonic motion. 2. Forced oscillations. 3. Coupled Oscillations. 4. Transverse wave motion. 5. Waves in more than one dimension. 6. Waves on transmission lines. 7. Polarization in optical waves. 8. Interference and Diffraction of optical waves.
Recommended Reading	1. Κύματα και Ταλαντώσεις, του K. U. Ingard, Εκδόσεις ΕΜΠ. 2. Φυσική των Ταλαντώσεων και των Κυμάτων, του H. J. Pain, Εκδόσεις Συμμετρία (Μετάφραση ΕΜΠ) 3. Vibrations and Waves, French A. P. 4. ΚΥΜΑΤΙΚΗ, του F. S. Crawford, Τόμος ΙΙΙ της Σειράς Γενικής Φυσικής του Πανεπιστημίου του Berkeley, Εκδόσεις ΕΜΠ.

PCC208	Classical Mechanics
Course Contents	1. Kinematics of material point (particle) 2. The laws of Newtonian Mechanics 3. One dimension motions - Oscillations 4. Central force field 5. Systems of material points (particles) 6. Non inertial coordinate systems 7. Constraints – Principle of virtual work – D' Alembert' principle 8. Lagrange's equations 9. Hamilton theory. Poisson brackets. The principle of least action
Recommended Reading	1) Goldstein, H., " Classical Mechanics", Addison-Wesley, 1980 2) "Lagrangian Dynamics", by D.E. Wells, Schaum Publishing Company, 1967.

ELC210	Electronics Laboratory
Course Contents	1. Introduction to SPICE software. 2. Basic measurements using oscilloscope. 3. RC networks. 4. Applications of diodes (clippers etc). 5. Rectification using diodes. 6. I – V characteristics of BJTs. 7. Amplifiers with BJT transistors. 8. Basic amplification stages using opamps (inverting and non-inverting).
Recommended Reading	1. C. Psychalinos, S. Vlassis, G. Economou, «Laboratory exercises of electronics measurements» University of Patras press, 2008. 2. Haritantis : «Electronics», Arakynthos Press, Athens 2013. 3. A. Malvino, D. Bates, «Electronics», 2016.

PLC212	Physics Laboratory IV
Course Contents	A. Introduction Resistors -Voltmeters- Ammeters. (Compulsory supplement of all tasks) B. Tasks 1. Measurement of the frequency of alternating current. 2. Measurement of the magnetic field of cyclic loops and coils. 3. Finding the e/me ratio of the electron. 4. Study of electrostatic fields. 5. Calculation of the phase difference between voltage and current with a wattmeter. Phasor diagrams. 6. Study of magnetic hysteresis loop. 7. Study of circuits with alternating currents. 8. Characteristic curves of a transformer.
Recommended Reading	1. University Physics, H. D. Young, Τόμος Β: Ηλεκτρομαγνητισμός- Οπτική- Σύγχρονη Φυσική, Εκδόσεις Παπαζήση

	2. Physics, Halliday-Resnick, Μέρος Β, Γ.Α.Πνευματικός επιστημονικές και τεχνικές εκδόσεις 3. Berceley Physics Course, τόμος 2ος, E.M. Purcell, Πανεπιστημιακές Εκδόσεις ΕΜΠ 4. Fundamental University Physics,, Alonso/Finn, τόμος ΙΙ, Ρεσβάνης-Φίλλιπας 5. Electricity, K. Alexopoulos, τόμος Β.

5th Semester (Fall)

PLC301	Physics Laboratory V
Course Contents	ATOMIC PHYSICS 1. Study of electron beam diffraction 2. A. Stefan-Boltzmann law and determination constant σ B. Photoelectric effect 3. Frank-Hertz experiment 4. A. Electron spin resonance (ESR) B. Study of Balmer series of Hydrogen NUCLEAR PHYSICS 5. A. Rutherford scattering B. Study of radiation α 6. A. Attenuation of -β and- γ radiation through some materials B. α- rays spectroscopy 7. A. γ – rays spectroscopy with single- channel analyzer (SCA) B. γ – rays spectroscopy with multi- channel analyzer (MCA) 8. The technique of coincidence measurements
Recommended Reading	Laboratory guide and special literature for each experiments General: A.C. Melissinos, J. Napolitano, Experiments in Modern Physics, 2nd edition (Academic Press, N.Y. 2003) D.W. Preston and E.R. Deitz, The art of Experimental Physics (Wiley, N.Y. 1991), G.F. Knoll, Radiation Detection and Measurement (Wiley, N.Y. 1979)

PLC303	Quantum Physics I
Course Contents	• Matter waves. Schrödinger's equation. • Statistical interpretation of wavefunction/quantum mechanics. • Measurable properties and operators. • Measurmenet process in quantum mechanics. • Hermiticity and probability conservation. • Dynamics of quantum systems. • Basic postulates of Quantum Mechanics. • Hermitian, adjoint and unitary operators. • Matrix representation of operators. • Time evolution of a quantum system and conservation laws. • Ehrenfest's theorems. • Study of one dimensional scattering. Step potential &Rectangular potential barrier. • Rectangular piecewise potentials. • Infinite Square well potential. • Square well potential. • δ- function potential well. • Two level system. • Harmonic oscillator. • 2- και 3 dimensiona quantum systems.

	• Hydrogen atom.
Recommended Reading	(1) "QUANTUM MECHANICS II", Stefanos Trahanas, Crete University Press, 2009. (2) "Quantum Mechanics", Walter Greiner, Berndt Muller, New York, Springer, 1994. (3) "Quantum Mechanics", Eugen Merzbacher, New York, John Wiley & Sons, Inc., 1998. (4) "Quantum Mechanics: non-relativistic theory", L.D. Landau, E.M. Lifshitz, Oxford : Butterworth - Heinemann, 1977. (5) "Introduction to Quantum Mechanics", David J. Griffiths, Person Prentice Hall, London, 1995. (6) "Quantum Mechanics", B.H. Bransden and C.J. Joachain, , Person Prentice Hall, London, 2000. (7) "Quantum Mechanics", Nouredine Zettili, Person Prentice Hall New York, John Wiley & Sons, Inc., 2004. (8) "Applied Quantum Mechanics", A.F.J. Levi, Cambridge , Cambridge University Press, 2003. (9) "PROBLEMS IN QUANTUM MECHANICS", Stefanos Trahanas, Crete University Press, 2005. (10) "Problems in quantum mechanics" F. Constantinescu and E. Magyari, Oxford, Pergamon Press, 1978.

PLC305	**Thermal and Statistical Physics**
Course Contents	1. Introduction to the macroscopic theory of thermodynamics. Establishment of relations between macroscopic variables of a system. 2. Definition of the probability of a microstate. Thermodynamic equilibrium. Spontaneous transition to thermodynamic equilibrium of an isolated system. Statistical definition of entropy. Law of maximum entropy of an isolated system in equilibrium. Microcanonical ensemble. 3. Thermal equilibrium. Canonical ensemble, additivity of entropy. Thermodynamic fundamental Identity. Temperature. The condition of thermal stability. The law of minimum free energy. 4. Systems of independent and distinguishable particles. 5. Classical ideal gas. 6. The theory of paramagnetic system. Magnetic cooling. Negative temperature. 7. Theory of the heat capacity of non-conducting crystals. 8. Macroscopic systems with an infinite number of states - Harmonic oscillator 9. Macroscopic systems with a finite number of states - 2 energy state system 10. Open macroscopic systems with variable number of particles. Statistics of open systems. Chemical equilibrium. Grand Canonical ensemble. 11. Statistics of independent, distinguishable, particles - Maxwell Boltzmann statistics 12. Statistics of independent, non-distinguishable, particles with half-integer spin - Fermi Dirac statistics/distribution 13. Statistics of independent, non-distinguishable, particles with integer spin - Bose Einstein statistics/distribution

	14. Ideal fermion gas 15. Ideal boson gas - Bose Einstein condensation 16. Statistics of classical macroscopic systems - Microstates on phase space
Recommended Reading	**Textbooks in Greek language** S. J. Blundell, K. M. Blundell, "Thermal Physics", Crete University Press, Heraclion, 2017. I. D. Vergados, I. N. Remediakis, H. Triantafyllopoulos, "Statistical Physics & Thermodynamics", 4th edition, Symeon Editions, 2017. F. Mandl "Statistical Physics", 2nd Edition, A.G.Pneymatikos Editions, Athens, 2013. E. N. Economou "Statistical Physics and Thermodynamics", Crete University Press, Heraklion, 2002. H. Zenginoglou "Statistical Physics of Thermodynamic Equilibrium", Editions about Arts, Patras, 2004. **Textbooks in English** Reif F. "Berkeley Physics Course vol 5 : "Statistical Physics", McGraw-Hill, 1965. Reif F., "Fundamentals of Statistical and Thermal Physics", McGraw-Hill, 1965. Kittel C., Kroemer H., "Thermal Physics" 2nd ed., CBS Publishers & Distributors, 1980. L. D. Landau and E. M. Lifshitz, "Statistical Physics Part 1" 3rd ed., Pergamon. An Introduction to Thermodynamics and Statistical Mechanics, K. Stowe, 2nd Edition, Cambdridge University Press, 2007. Introduction to Statistical Physics, K. Huang, CRC Press, 2001. Statistical Physics I - Equilibrium Statistical Mechanics, M. Toda, R. Kubo and N. Saito, 2nd Edition, Springer, 1998. Statistical Mechanics, R. K. Pathria and P. D. Beale, 3rd Edition, Academic Press, 1996. Statistical Physics of Particles, M. Kardar, Cambdridge University Press, 2007.

ACC307	**Introduction to Environmental Physics**
Course Contents	1. Structure and Composition of the Atmosphere 2. Radiation in the Atmosphere 3. Air pollution 4. Atmospheric Turbulence and Diffusion 5. General Circulation in the Atmosphere
Recommended Reading	1. Introduction to Atmospheric Physics, C. Zerefos, Eds Papasotiriou, 2009 (A textbook in Greek language) 2. Introduction to Environmental Physics, A. Argiriou and M. Yiannouli, Eds Arakinthos (A textbook in Greek language) 3. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd Edition, John H. Seinfeld, Spyros N. Pandis

ACC309	**Introduction to Astronomy and Astrophysics**
Course Contents	1. Fundamental Concepts of astrophysics (i) (luminosity, magnitude, color, temperature, parallax) (ii) mechanics (gravity, Newton's laws, Kepler's laws) (iii) of the physics of light and (iv) physics of black body. Distances and masses 2. Telescopes. 3. Stellar Physics: The Sun (). Energy generation. Birth and evolution on the HR diagram. Stellar deaths

	4. The Sun . Parameters and activity 5. Physics of the Solar System: General characteristics. Morphology and Atmospheres of the Planets. Models of the Interior of the Planets. Satellites. Formation of the Solar System. (Asteroids. Comets. Meteorites. Kuiper Belt) 5. Cosmology: Our Galaxy, Galaxies, Clusters and superclusters of galaxies. Active galaxies. Quasars. Cosmological theories (the Early Universe and the Evolution of the Universe). Observational evidence of cosmological models.
Recommended Reading	Textbooks in Greek language. 1. (a) «Introduction to Modern Astronomy». X. Varvoglis & I. Seiradakis, 1994, Gartaganis editions, Thessaloniki. (2) Astrophysics Vol I Shu H. Frank 2003 Crete University Press a. «Introduction to Astronomy and Astrophysics» E-P Christopoulou & C. Goudis, Lecture Notes, Patras University Press (e-class) b. «Introduction to Cosmology» V. Geroyannis, Lecture Notes, Patras University Press

6th Semester (Spring)

PCC302	Quantum Physics II
Course Contents	1. Principles of quantum theory. Hilbert spaces, operators, operator spectra, quantum probabilities, time evolution and measurements. 2. Fundamental systems. Symmetries, rotations and the quantum description of angular momentum, composition of angular momenta, Glebsch-Gordan coefficients, Schrodinger equations in three dimensions for different potentials, interaction of particles with the EM field, particles with spin. 3. Composite systems. The quantum description of composite systems, fermions and bosons, Pauli's exclusion principle, Fermi gas. 4. Techniques and applications. Perturbation theory, the variational method, mean field theory. Applications to atomic systems (the real hydrogen atom, helium atom, Stark and Zeeman effects, orbital theory and the periodic table, Thomas-Fermi theory).
Recommended Reading	1. C. Anastopoulos, Quantum Mechanics (Lecture notes, University of Patras, 2016)---in Greek. 2. S. Trachanas, Quantum Mechanics II (Crete University Press, 2008).—in Greek. 3. S. Gasiorowitz, Quantum Physics (John Wiley, 2003).

PCC304	Solid State Physics
Course Contents	General properties of metals. The free electron gas. Classical approach. Drude model. Quantum approach. Sommerfeld model. Limits of the free electron model. Crystalline and amorphous materials. Crystal lattice. Crystal structure. The reciprocal lattice. X rays diffraction from lattice. Bragg condition. X rays diffraction from crystal (Laue theory). X rays diffraction from free electron and atom. Structure factor. Experimental determination of crystal structure using X rays, electrons and neutrons. Crystal bonding. Elastic and plastic deformation- Hooke's law. Failure of the static model. Lattice vibrations. Phonons. Energy density in lattice. Exact theory of molecular heat. Optical properties of lattice in the infrared. Ionic crystals. The non-armonic approach. Origin of energy bands. Electron wavefunctions in periodic potential. Nearly free electron theory approximation. The tight - binding approximation. Metals-insulators- semiconductors. Density of states. Fermi surface. Bloch electron. Effective mass. Holes. Experimental determination of energy bands. Structure of energy bands in semiconductors. Carrier concentration in doped semiconductors – in compensated semiconductors. Electric conductivity of semiconductors- mobility. Carrier scattering mechanisms. Hall effect in semiconductors.
Recommended Reading	G.D. Priftis, A.A. Vradis, D.L. Anastassopoulos: Introduction to Solid State Physics (Patra 2009, in Greek) M.ALI OMAR: Elementary Solid State Physics(Addison Wesley 1975) N. W. ASHCROFT and N. D. MERMIN, (1976): Solid State Physics Holt, Rinehart and Winston. J. C. BLAKEMORE, (1985): Solid State Physics, 2nd ed., Cambridge

	University Press, Cambridge,G. BURNS, (1985): Solid State Physics, Academic Press, London, R. H. BUBE, (1994): Electrons in Solids, 3rd ed., Academic Press, New York (1992). G. BUSCH and H. SCHADE, (1976): Lectures on Solid State Physics, Pergamon Press. J.R. CHRISTMAN, (1988): Fundamentals of Solid State Physics, J. Wiley, New York. R. J. ELLIOT and A. F. GIBSON, (1974): An Introduction to Solid State Physics, Macmillan. H. E. HALL (1974): Solid State Physics, "The Manchester Physics Series", J. Wiley. H. IBACH and H. LUTH, (1991): Solid State Physics: An introduction to Theory and Experiment, Springer-Verlag, Berlin. C. KITTEL, (1976): Introduction to Solid State Physics, J. Wiley. R. LEVY, (1978): Principles of Solid State Physics, Academic Press, London (1968).

PCC306	**Electromagnetism II**
Course Contents	1. Review of Electrostatics, Special Techniques for Calculating Electric Potentials Laplace equation, the method of images, separation of variables, multipole expansion. 2. Electrostatic Fields in Matter Polarization, the field of a polarized object, the electric displacement, linear dielectrics. 3. Magnetostatics The divergence and curl of B, magnetic vector potential. 4. Magnetostatic Fields in Matter Magnetization, the field of a magnetized object, the auxiliary field H. 5. Electrodynamics Electromotive force, Faraday's law, Maxwell's equations, potential formulation of electrodynamics, energy and momentum in electrodynamics. 6. Electromagnetic Waves The wave equation, electromagnetic waves in nonconducting and conducting media, the Fresnel equations, dispersion. 7. Electromagnetic radiation Retarded potentials, multipole expansion, electric and magnetic dipole radiation.
Recommended Reading	"Introduction to Electrodynamics", David J. Griffiths, (Prentice-Hall, 1989). "Electromagnetism", G. L. Pollack & D. R. Stump (Addison Wesley, 2002)

PCC308	**Atomic and Molecular Physics**
Course Contents	**Atomic Physics:** Classical approach of emission of radiation. Schrodinger equation and the Hydrogen atom. Transitions between energy states and emission of radiation. Quantum approach of radiating dipoles – Electric dipole transitions and higher order transitions. Average lifetime of atoms on an excited state. Linewidth and shape of spectral lines. Natural linewidth and reasons for its broadening. The shell model and alkali atoms. Central field approximation. Periodic table. Active potentials. Fine structure. Spit-orbit interaction. Total (spin and orbital) angular momentum (J).

	LS (orbital and spin angular momentum) coupling. JJ coupling. Hyper fine structure. Influence of external fiels on atoms. Zeeman, Paschen-Back & Stark effects. Examples. **Molecular Physics:** **I. Theory of chemical bond** Adiabatic (Born-Oppenheimer) approximation. Hellman – Feynman theorem. Virial theorem. Introduction to the quantum mechanical theory of the chemical bond. Ion of hydrogen molecule (H2+). Hydrogen molecule (H2). Heitler - London (Valence bond) theory and molecular orbital (MO) theory. Homonuclear diatomic molecules. Covalent bonding. Electrons in an axially symmetric field. Description of diatomic molecules with the molecular orbital and the valence bond theories. Symbolism of states of diatomic molecules. Total angular momentum of electrons. Heteronuclear diatomic molecules. Ionic bonding. Polyatomic molecules – Stater determinant. Hybridization of atomic orbitals. Conjugated molecules. Hydrogen bonding. Van der Waals interactions. London dispersion forces. **II. Molecular spectra** Rotation and vibration of diatomic molecules. Rotational spectra. Vibrational spectra. Rotational – vibrational spectra. Vibration modes of polyatomic molecules. Raman spectra. Molecular electronic states. Electronic spectra due to transitions between different electronic states. Franck – Condon principle. Excited state decay with emission of radiation. Ionization energy and electron affinity.
Recommended Reading	**Textbooks in Greek language** “Quantum Mechanics I”, S Trachanas, Crete University Press, 2005. "An Introduction on Molecular Physics", P. Giannoulis, University of Patras. “Molecular Quantum Mechanics”, P. W. Atkins, 2nd Edition, Papazisi Editions, Athens, 1999. “Physical Chemistry”, Peter Atkins and Julio De Paula, Crete University Press, Heraklion, 2014. **Textbooks in English** A.M. Fox. Atomic Physics, www.mark-fox.staff.shef.ac.uk/PHY332/ W. Demtroder: Atoms, Molecules & Photons, Springer-Verlang. 2006 "Structure of Molecules and the Chemical bond", Y. K. Syrkin and M. E. Dyatkina, N. Y. Dover. "Quantum Theory of Molecular Electronic Structure Benjamin", R. G. Parr. "Spectra of Diatomic Molecules" (I), G. Herzberg. "Infrared and Raman Spectra" (II), G. Herzberg. The Fundamendals of Atomic and Molecular Physics, R. L. Brooks, Springer, 2013. Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachain, 2nd Edition, Pearson Education Ltd, 2003.

7th Semester (Fall)

MSC401	Special Topics on Solid State Physics
Course Contents	Dielectric and optical properties of the materials. Dielectric constant and polarizability. Local field. Sources of polarizability. Piezoelectricity. Optical properties of ionic crystals. Plasmons, polarons and exitons. Diamagnetism. Paramagnetism. Magnetic dipole moment of an electron-Larmor's precessional motion. Total magnetic dipole moment of an atom. Rare-earth ions. Iron-group ions. Magnetic energy and magnetic susceptibility. Classification of materials.Classical theory of paramagnetism. Quantum theory of paramagnetism. Magnetism in metals. Paramagnetism in metals. Diamagnetism in metals. Adiabatic demagnetization. Ferromagnetism. General characteristics of ferromagnets. Ferromagnetism and Weiss theory. Basic principles of the quantum mechanical interpretation of Ferromagnetism. Ferromagnetism in Metals. Virgin magnetization curve and Magnetic hysteresis loop. Virgin magnetization curve and Weiss Domains. Magnetic bubbles. Antiferromagnetism and Ferrimagnetism. Magnetic scattering of neutrons. Superconductivity. Meissner-Ochsenfeld effect. London equation. Isotopic effect. BCS theory of superconductivity. Quantization of magnetic flux in superconducting ring. Tunneling effect in metal- superconductor and between superconductors (Josephson effect). Superconducting quantum interference device (SQUID). Superconducting materials. First and second order transitions. Landau Theory.
Recommended Reading	M.ALI OMAR: Elementary Solid State Physics(Addison Wesley 1975) N. W. ASHCROFT and N. D. MERMIN, (1976): Solid State Physics Holt, Rinehart and Winston. J. C. BLAKEMORE, (1985): Solid State Physics, 2nd ed., Cambridge University Press, Cambridge,G. BURNS, (1985): Solid State Physics, Academic Press, London, R. H. BUBE, (1994): Εισαγωγή στη Φυσική της Στερεάς Κατάστασης, ΕΣΠΙ, Αθήνα. Μετάφραση του Electrons in Solids, 3rd ed., Academic Press, New York (1992). G. BUSCH and H. SCHADE, (1976): Lectures on Solid State Physics, Pergamon Press. J.R. CHRISTMAN, (1988): Fundamentals of Solid State Physics, J. Wiley, New York. R. J. ELLIOT and A. F. GIBSON, (1974): An Introduction to Solid State Physics, Macmillan. H. E. HALL (1974): Solid State Physics, "The Manchester Physics Series", J. Wiley. H. IBACH and H. LUTH, (1991): Solid State Physics: An introduction to Theory and Experiment, Springer-Verlag, Berlin. C. KITTEL, (1976): Introduction to Solid State Physics, J. Wiley. R. LEVY, (1978): Principles of Solid State Physics, Academic Press, London (1968)(in Greek translation).

MSC407	Materials Science
Course Contents	1. Classification of Materials 2. Mechanical Properties 3. Thermal Properties 4. Electrical Properties 5. Optical Properties 6. Magnetic Properties 7. Lectures on selected materials with technological interest
Recommended Reading	- "Materials Science and Engineering: An Introduction", 9th Edition, William D. Callister, Jr., David G. Rethwisch, Wiley.

	- "Materials: Engineering, Science, Processing and Design", Michael Ashby, Hugh Shercliff, David Cebon, Butterworth-Heinemann Ltd - "Principles of Electronic Materials and Devices", S.O. Kasap, McGraw-Hill Education

MSC409	**Materials' Characterization Techniques Laboratory**
Course Contents	1. **Braodband Dielectric Spectroscopy (BDS)**, St. Georga-Ch. Krontiras 2. **Scanning Electron Microscopy (SEM)**, D. Kouzoudis, (Department of Chemical Engineering). 3. **Atomic Force Microscopy (AFM)** 4. **X-ray Diffraction (XRD)**, D. Anastassopoulos. 5. **Polarizing Optical Microscopy (POM),** P. Karahaliou 6. **Electrical Conductivity and Hall Effect** in metals and semiconductors, E. Vitoratos. 7. **Laser Induced Breakdown Spectroscopy (LIBS)**, S. Couris. 8. **Fourier-transform infrared Spectroscopy (FTIR)**, N. Spiliopoulos 9. **Ultraviolet-visible Spectroscopy (UV-Vis)**, L. Palilis
Recommended Reading	

EEC419	**Renewable Energy Sources**
Course Contents	Energy sources and needs. Energy conversions. Solar radiation. Wind energy. Geothermal energy. Hydroelectric, wave and tidal energy. Other renewable and "soft" energies. Nuclear energy. Solar Energy. Thermal conversion. Flat plate collectors. Selective surfaces. Concentrating systems. Solar ponds. Passive solar systems. Photovotaics. Photoelectric conversion. Photogalvanic elements. Conversion to electric energy with intervening thermal transformations. Wind energy. The nature of wind. Statistical representation. Wind potential. Types of wind turbines. Power coefficient and efficiency of horizontal axis machines. Calculation of losses. Use of wind turbines for the production of electricity. Energy calculations-sizing of turbines. Wind parks. Hydroelectric plants. Hydraulic potential. Flow duration curves. Design and construction of small hydroelectric stations. Types of turbines. Energy calculations-dimensioning. Biomass. Biological conversion and storage of energy. Technologies for the energy conversion of biomass. Thermal energy storage. Chemical storage. Other methods for energy storage. Physics of non-conventional energy sources. Energy saving-rational use of energy. Electrochromic materials and devices. Hydrogen as a fuel. Fuel cells. Hydrogen production. Financial analysis of energy systems. Directions for the development of energy sources in the future.
Recommended Reading	1) "New Energy Sources", P. Yianoulis 2) J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes". 3) J. Twidell and T. Weir, "Renewable Energy Resources". 4) J. F. Kreider and F. Kreith, "Solar Energy Handbook".

	5) D. Le Gourieres: “Wind Power Plants. Theory and Design”. 1982, Pergamon Press, ISBN: 0-08-029967-9. 6) R. Gash, J. Twele (Eds): “Wind Power Plants. Fundamentals, Design, Construction and Operation”, 2002, Solarpraxis A.G., ISBN: 1-902916-37-9. 7) Δ. Παπαντώνης: «Μικρά Υδροηλεκτρικά Έργα», 2001, Εκδόσεις Συμεών, ISBN: 960-7888-23-5. 8) C. L. Martin, D.Y. Goswami (Ed): “Solar Energy Pocket Reference”. 2005, ISES, ISBN: 978-1-84407-306-1. 9) D.Y. Goswami (Ed): “Wind Energy Pocket Reference”. 2007, ISES, ISBN: 978-1-84407-539-3.

EEC427	**Fluid Mechanics**
Course Contents	1. General concepts and definitions. 2. Hydrostatics. 3. General state of deformation of flowing fluids. 4. Continuity equation. 5. Ideal fluidsv. 6. Viscous fluids. 7. Momentum equation, Navier-Stokes equations. 8. Energy equation. 9. Laminar boundary layers. 10. Thermal boundary layers. 11. Turbulent flow – Turbulence models. 12. Special issues (Hydrodynamic stability, MHD, FHD, Multiphase flow, etc).
Recommended Reading	1) «Boundary-Layer Theory», H. Schlichting, K. Gersten, Springer, 2000. 2) «Fluid Mechanics», L.D. Landau and E.M. Lifshitz, Butterworth-Heinemann Ltd, 1987.

EEC421	**Physics of the Atmosphere I – Meteorology (+Laboratory)**
Course Contents	**Theory** 1. Earth’s atmosphere General notions, Magnitude of the atmosphere, Composition of lower atmosphere, Solar and Earth radiation, Temperature, Pressure, Simple atmospheric models, Water vapor. 2. Atmospheric Thermodynamics State equation, Thermodynamic Laws, Thermodynamic processes in the atmosphere, Static Stability, Atmospheric instability, Vertical temperature gradient and Potential Temperature as measures of atmospheric instability. 3. Cloud Physics Water vapor condensation, Rain formation theory, Cloud classification. 4. Atmospheric Dynamics Forces defining the air motion, Equations of motion, Air motion in the atmospheric boundary layer, Atmospheric General Circulation, Planetary winds, Troposhperic winds – Hadley cells, Tropospheric long (Rossby) waves. 5. Weather Systems

	Characteristics of air masses, Fronts – Front types, Low pressure centers, High pressure centers, Cyclogenesis. 6. Climate Dynamics Climate classification, Climate equilibria-sensitivity and feedbacks, Climate Change, Climate Models. **Laboratory** 1. Standard Atmosphere. 2. Vertical profile of the atmospheric parameters (radiosonde). 3. Thermodynamic diagrams. 4. Weather maps. 5. Atmospheric composite indices. 6. Atmospheric forces & winds.
Recommended Reading	**General Meteorology**, C.S. Sahsamanoglou, T. I. Makrogiannis, Ziti Editions, Thessaloniki, Greece, 1998. **Lessons of General Meteorology**, T.I. Makrogiannis, C.S. Sahsamanoglou, Charis Editions, Thessaloniki, Greece, 2004. **Courses of Meteorology and Climatology**, A. A. Flocas, Ziti Editions, Thessaloniki, Greece, 1994. **Atmospheric Science: An Introductory Survey**, J.M. Wallace, P.V. Hobbs, Academic Press, London, 2006. **Meteorology for Scientists and Engineers**, R. Stull, University of British Columbia, 2011.

EEE423	**Atmospheric Pollution**
Course Contents	1.Solar radiation and structure of the atmosphere Absorption, Scattering, Radiative transfer in the atmosphere, Vertical profiles of atmospheric constituents 2. Chemical compounds of air pollution Properties, Emission Sources, Primary and secondary pollutants, Photochemical smog 3. Aerosols Properties, Emission sources, Optical properties, Direct and indirect effect on climate change 4. Measurements of atmospheric pollution Analysis of samples, differential absorption, Remote sensing, Light detection and ranging 5. Dispersion of air pollutants Atmospheric dispersion, Turbulence, Elements of fluid mechanics, atmospheric dispersion models, Gauss plume model
Recommended Reading	1 “Atmospheric Pollution with elements of meteorology, M. Lazaridis, Eds Tziola, 2005 (A textbook in Greek language) 2 “Atmospheric Pollution”. J. Yentekakis, Eds Tziola, 2003 (A textbook in Greek language) 3 “Atmospheric Pollution”, M.Z. Jacobson, Cambridge University Press, 2002 4 “Atmospheric Chemistry and Physics: from air pollution to climate change”, J.H. Seinfield, S.N. Pandis, John Wiley & Sons, 2006

PHC431	Optoelectronics
Course Contents	1. Light Propagation in Optical Fibers Propagation modes, dispersion and optical pulse broadening, compensation for group velocity dispersion. 2. Propagation, Modulation and Laser Oscillation in Optical Waveguides Propagation modes, coupled mode theory, couplers, modulators, distributed feedback lasers, supermodes and laser arrays. 3. Theory of Amplification of Optical Radiation Density matrix operator, time-dependent perturbation theory, linear polarization, calculation of the gain coefficient for an atomic laser, Erbium doped fiber laser amplifiers. 4. Semiconductor Lasers Amplification in a semi conducting medium, double heterostructure lasers, direct current modulation. 5. Quantum Well and Quantum Dot Lasers Physics of quantum wells, two- and one-dimensional media, vertical cavity surface emitting lasers, quantum dot lasers.
Recommended Reading	"Lectures in Photonics (Optoelectronics", by A. T. Georges, and «Photonics», by A. Yariv and P. Yeh (Oxford, 2007).

PHC433	Applied Optics
Course Contents	Examination of Electromagnetic theory. Light and photons. Interaction of Electromagnetic Radiation and Matter. Optical properties of metals and dielectric materials. Refraction. Scattering. Fresnel Equations. Atmospheric Optics. Refraction of Light in Spherical Surface. Transfer Matrices and Jones Matrices. Polarization, polarizers, dichroism, birefringence, optical activity. Faraday, Kerr and Pockels effects. Mathematical description of polarization. Interference of optical waves. Interferometers: Mickelson, Mach ¬- Zehnder, Sagnac, Fabry-Perot, Twyman-Green. Applications. Fresnel and Fraunhofer diffraction
Recommended Reading	Instructive books: 1) "Applied Optics with subjects of Optoelectronics and Laser", D. Zevgoils. Tziola Publications, Thessalonica 2007 2) "Courses of Optics", G. Asimellis, Publications of Modern Knowledge, Athens 2006. Suggested Bibliography: 1) «Optics», E. Hecht (Addison Wesley Editίon) 2) «Introduction to Optics», Frank Pedrotti, Leno Pedrotti, (Pearson International Edition).

PHC435	Laser Physics

Course Contents	1) The Lasers as light sources and their properties 2) Light and matter: dispersion and absorption 3) The optical cavity 4) The basic light-matter interactions and the conditions for having lasing 5) The operation of laser 6) The Q-switching and the production of laser pulses 7) Mode-locking 8) The different types of lasers 9) The semiconductor lasers 10) An introduction to Non Linear Optics
Recommended Reading	1) «Φυσική των λέιζερ» Κουρής, Σ. (2015), ID Ευδόξου: 59303562, Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών. Διαθέσιμο στο: http://hdl.handle.net/11419/5366 2) "Laser Electronics", Joseph Verdeyen, 3rd ed. Prentice-Hall 3) "Laser Fundamentals", W. T. Silfvast, (2004), Cambridge University Press 4) "Principles of Lasers" O. Svelto, (2010), 5th ed., Springer US 5) "Laser Physics" P.W. Milonni, & J.H. Eberly, (2010). 2nd ed., Wiley

TAC445	**Nuclear Physics and Particle Physics**
Course Contents	Nuclear Physics 1) Basic properties of the nucleus and nuclear force. 2) α,β,and γ radioactive decays. 3) Laws of radioactive decays. 4) Introduction to radiation detectors. 5) Nuclear Models. 6) Nuclear Reactions. 7) Brief Introduction to basic experiments of Nuclear Physics: Mossbauer effect, Goldhaber experiment, etc. 8) Applications: a) Operation principles of a nuclear reactor, b) Elements of solar nuclear physics. Elementary Particle Physics 1) Introduction to the physics of elementary particles. 2) Leptons, quarks and gauge particles. 3) Mesons and baryons. 4) Kinematics. 5) Symmetries and conservation laws. 6) Introduction to gauge theories. 7) Parton model. 8) Resonances. 9) Feynman diagrams. 10) Standard Model of particle physics. 11) Higgs mechanism.
Recommended Reading	- Introduction to Particle Physics and Cosmology, J. Vergados, S. Lola and I. Triantafyllopoulos, Symmetria.

	- Notes on Nuclear Physics, S. Dedousis, M. Zamani, A. Sampsonidis, University of Thessaloniki.

TAC447	**Astrophysics I**
Course Contents	Fundamental Concepts of Astrophysics: luminosity, Brightness, Surface Temperature, Boltzman and Saha equations, theory of Spectral Lines. Spectral Classification of Stars, Double Stars, Stellar Masses, star clusters, observed mass luminosity relations,distance measurements Stellar Structure and Evolution: Hydrostatic equilibrium, energy generation, equation of radiation transport, optical depth, influence of convection, nuclear reactions in stellar interiors, PP chain, CNO cycle, the triple a- reaction, later stages of nuclear burning , s and r processes, equation of state of an ideal gas, opacity, homologous stellar models. Bioastronomy Methods of detecting extrasolar planetary systems. Recent discoveries, Drake equation.
Recommended Reading	Textbooks in greek language 1) «Introduction to Modern Astronomy». X. Varvoglis & I. Seiradakis, 1994, Gartaganis editions, Thessaloniki. 2) Astrophysics Vol I Shu H. Frank 2003 Crete University Press 3) «Fundamental Concepts of Astrophysics», C. Goudis., University of Patras press. 4) «Stars and Interstellar Matter» C. Goudis., University of Patras press 5) «Cosmic Pathways», C. Goudis., Editors Ekati ISBN960-408-045-8

TAC449	**Computational Physics**
Course Contents	1. Numerical analysis fundamentals (roots, interpolation with polynomials and splines, least squares, numerical differentiation and integration, linear and nonlinear systems of equations, ordinary differential equations). 2. Systems of ordinary differential equations. 3. Initial and boundary value problems for ordinary differential equations. 4. Eigenvalues and eigenvectors. 5. Optimization, modeling, simulation. 6. Partial differential equations. 7. Monte – Carlo methods. 8. Special issues.
Recommended Reading	1. G. E. Forsythe., M. A. Malcolm, C. B. Moler, Computer methods for mathematical computations (translated in Greek language), Crete University Press, 2006. 2. D. Georgiou, Numerical Analysis, Kleidarithmos, 2008. 3. K. Atkinson, Elementary Numerical Analysis, John Wiley & Sons, 1985. 4. I. Jacques, C. Judd, Numerical Analysis, Chapman and Hall, 1987. 5. S. Papaioannou, Ch. Vozikis, Numerical Analysis, E-book., www.kallipos.gr, 2015.

TAE451	**Astronomy Laboratory**
Course Contents	Lunar Phase- Basic Coordinates and Seasons- The horizontal coordinate system and the rotation of the sky- Motions of the Sun- Planetary orbits-Solar System Models-

	The Rotation of the Sun and the sunspots-Extrasolar planets-Habitable Zone-Uranografia (observations with naked eye/telescope).
Recommended Reading	a) E-P Christopoulou, “Manual for Astronomy Labs” e-class b) E-P Christopoulou & C. Goudis, «Introduction to Astronomy and Astrophysics», Lecture Notes, Patras University Press (e-class)

TAE469	**Special Topics of Quantum Physics**
Course Contents	1. Symmetries in quantum theory, introduction to group theory, unitary representations of groups. 2. Relativistic symmetries. The Poincare group and its unitary representations. Wave equations. 3. Many-particle systems, Fock space, elementary field quantization. 4. Scattering theory, the S matrix, the Born approximation, partial wave decomposition. 5. Decay of unstable systems, Fermi’s golden rule, random phase approximation and Wigner-Weisskof method.
Recommended Reading	1. C. Anastopoulos, Quantum Mechanics (Lecture notes, University of Patras, 2016)---in Greek. 2. S. Trachanas, Quantum Mechanics II (Crete University Press, 2008).—in Greek. 3. L. E. Ballentine, Quantum Mechanics: a Modern Development (World Scientific, 1998)

TAE503	**Selected Topics in Probability and Statistics**
Course Contents	Simulation of random variables. Stochastic processes. Information theory. Analysis of variance. Nonparametric hypothesis testing. Quality control. Time series analysis.
Recommended Reading	Instructor’s notes (Z. M. Psillakis)

TAE473	**Dynamical Systems & Complexity**
Course Contents	1. Autonomous Differential Equations of First-order • Critical points, stability, linear stability analysis, existence and uniqueness, bifurcations 2. Autonomous Systems on the plane • Linear Systems: classification, stable and unstable manifolds, phase diagrams • Non-Linear Systems: topological equivalence, critical points and linearization, phase diagrams • Limit cycles: existence and uniqueness, rule-out limit cycles • Bifurcations: saddle-node, transcritical, pitchfork, Hopf • Hamiltonian Systems, Gradient Systems, Reversible Systems 3. Poincare maps and non-autonomous systems on the plane 4. Three-Dimensional Autonomous Systems and Chaos

	• Linear and non-linear systems: critical points, stability, phase diagrams • Lorenz equations: properties, critical points, asymptotic stability, strange tractors, chaos 5. Discrete Dynamical Systems • Linear and nonlinear discrete systems: fixed points, stability, cobwebs, periodic solutions, trajectories, period doubling sequences • Triangular map • Logistic map and the Feigenbaum constant 6. Complexity • Complex iterations • Fractals • Complex networks
Recommended Reading	1. "Dynamical Systema and Applicationns", D. Sourlas, Press of University of Patras. 2009, (A text book in Greek language). 2. "Dynamical Systems and Chao" A and B Volumes, A. Boundis, Press Papasotiriou 1995. 3. "Non Linear Ordinary Differential Equations"», A. Boudis, Press Pneumatikos, 1997. 4. "The wonderfull World of Fractals", A. Boudis, Press Leader Books, 2004. 5. "Dynamical Systems with Applications using Maple" S. Lynch, Birkhauser 2000. 6. "Differential Equations and Dynamical Systems" , L. Perko, Springer, 2000. 7. "Dynamics and Bifurcations", J. Hale, H. Kocak, Springer-Verlag, 1991. 8. "Nonlinear Oscilations, Dynamical Systems and Bifurcations of Vector Fields" J. Guckenheimer, P. Holmes, Springer,1983. 9. "Chaos, An Introduction to Dynamical Systems", K. Alligoog, T. Sauer, J. Yorke, Springer, 1997. 10. "Differential Equations, Dynamical Systems and an Introduction to Chaos", M. Hirsch, S. Smale, R. Devaney, Elsevier Academic Press, 2004.

ELC471	**Theory of Signals and Circuits**
Course Contents	1 Basic signals 2 Elements of electric circuits 3 Στοιχεία κυκλωμάτων. 4 Techniques of circuit analysis 5 Response to dynamical excitations 6 Sinusoidal analysis 7 Fourier Analysis and Fourier transforms 8 Laplace transform techniques 9 Frequency response 10 Magnetically coupled circuits and transformers
Recommended Reading	1. Σπύρου Δ. Φωτόπουλου: «Συνοπτική ΘΕΩΡΙΑ ΚΥΚΛΩΜΑΤΩΝ», Εκδόσεις INSPIRATION, 2009. 2. G. Rizzoni: «Ανάλυση κυκλωμάτων και σημάτων», Τομ.1, Μετ. Χ. Χρηστίδης, Εκδ. Παπαζήση

ELC475	Analog Electronics
Course Contents	• MOS common-source amplifier, small signal operation and biasing. • MOS common-gate amplifier, small signal operation and biasing. • MOS common-drain amplifier, small signal operation and biasing. • Introduction to operational amplifiers, basic operation principle and typologies. • Application of operational amplifiers, inverting and non-inverting amplifier, elementary filter and oscillators, comparators, Schmitt triggers and pulse generators.
Recommended Reading	1. B. Razavi, "Fundamentals of Microelectronics», Klidarithmos Press 2018 (Greek Edition). 2. P. Gray, P. Hurst, S. Lewis, R. Meyer: «Analysis and Design of analog integrated circuits", Klidarithmos Press 2007 (Greek Edition). 3. C. Psychalinos: «Analog Electronics", Teaching notes, University of Patras, 2008. 4. S. Vlassis, «Basic Electronics with MOS transistors», Teaching notes, University of Patras, 2011.

ELC470	Digital Electronics
Course Contents	• Binary Logic • Binary Number System • Boolean Algebra • Logic Gates • Gate-Level Minimization • Combinational Logic • Adders, Comparators, Decoders, Multiplexers • Sequential Logic • Registers and Counters • Memory • Programmable Logic • Digital Integrated Circuits • Hardware Description Languages (HDLs)
Recommended Reading	1) M. Morris Mano & M. Ciletti, Digital Design (5th ed), Papasotiriou, 2013 (A textbook translated in Greek). 2) W. Kleitz, Digital Electronics (8th ed.), Tziola, 2012 (A textbook translated in Greek). 2) J. Wakerly, Digital Design (3rd ed), Kleidarithmos, 2004 (A textbook translated in Greek). 3) S. Brown, Z. Vranesic, Digital System Design with VHDL (3rd ed), Tziolas Publications, 2011 (A textbook translated in Greek).

ELE483	Introduction to Telecommunications
Course Contents	1. Introduction to Signals and Systems. 2. Fourier Series and Fourier Transform, Linear Systems and Filtering, Energy and Power Spectral Density, Noise and Random Processes. 3. Analog Communications

	4. Amplitude Modulation-Demodulation, Super-heterodyne Receivers, FDM, Noise in AM AM Radio, TV. 5. Angle Modulation, Frequency-Phase Modulation – Demodulation, PLL, Noise in FM, FM Radio, Stereo. 6. Pulse Modulation 7. Pulse Modulations, Analog to Digital Conversion, Sampling, Quantization Pulse-Code Modulation, Matched Filter, Line Coding, Pulse Shaping, TDM. 8. Information and Digital transmission 9. Information Measure, Channel Capacity, Probability of Error in Transmission, Geometrical Signal Representation, Digital Modulation Techniques (ASK,PSK,FSK,QAM, Spread spectrum).
Recommended Reading	1. G. Karagiannidis: «Communication Systems», Tziolas Publications, 2009 2. S. Haykin: «Communication Systems», Tziolas Publications,1994.

NME491	**Demonstration Experiments in Physics I**
Course Contents	Demonstration experiments in Mechanics & Heat. Especially: Conservation of mechanical energy. Principal axes of inertia. Rotation of a body about principal axes. Role of inertia in rotation. Degree of stability. Fundamental law of rotational motion. Angular momentum - conservation of angular momentum. Gyroscopes, Precession & Nutation. Oscillations. Free and forced oscillations – resonance. Addition of oscillations. Beats. Lissajous figures. Waves & standing waves. Wave phenomena. Elasticity & Hardness. Friction. Collisions. Non inertial reference frames (centrifugal & Coriolis forces). Hydrostatics. Aerostatics. Surface tension, capillary phenomena. Barometric formula. Magdeburg hemispheres. Boyle Mariotte law. Hydrodynamics - Aerodynamics (Continuity Law, & Bernoulli's law). Applications. Poiseuille's law. Vortices. Heat. Thermometers. Dimensional changes with temperature. Phase transitions. Thermal conductivity. Heat transfer. Absorption and emission of radiation.
Recommended Reading	"Conceptual Physics" P. G. Hewitt. Addison Wesley Longman. 2002. «University Physics, Vol.I» H.D. Young, Addison-Wesley Pub. Co. 1992. Fundamental University Physics. Alonso – Finn. Addison-Wesley Pub. Co. "Physics" Resnick, Halliday, Krane, (4th ed.) John Wiley & Sons, Inc. N.Y. (1992).

NME503	**School Counselling**
Course Contents	Lewin and group dynamics. Moreno and psychodrama. Rogers and encounter groups. How are child groups different from adult groups and the advantages of group work? What are psychoeducational groups and how are they different from other types of groups? Planning for a psychoeducational group for children. Group leadership skills for psychoeducational groups. Evaluating psychoeducational groups. Membership problems.

Recommended Reading	Vassilopoulos, S., Koutsopoulou, A., & Regli, D. (2011). Psychoeducational groups for children. Athens: Grigoris Publications. [in Greek] Vassilopoulos, S., Brouzos, A., & Baourda, V. (2016). Psychoeducational groups programs for children and adolescents. Athens: Gutenberg. [in Greek] Brown, N. W. (2004). Psychoeducational groups: Process and practice. NY: Brunner-Routledge. Corey, M. S. & Corey, G. (2006). Groups: process and practice. Belmont, CA: Thomson Brooks/Cole. Delucia-Waack, J. L. (2006). Leading psychoeducational groups for children and adolescents. London: Sage Publications. Geldard, K. and Geldard, D. (2001). Working with Children in Groups: A Handbook for Counsellors, Educators and Community Workers. Hampshire: Palgrave Macmillan. Yalom, I. (1995). The theory and practice of group psychotherapy (4th ed.). New York: Basic Books.

NME497	**Introduction to Geophysics**
Course Contents	1. Introduction to Geophysics Principles, Branches of geophysics. Geophysical survey design. 2. Seismic Methods Principles, introduction, elastic constants, seismic waves and their propagation. Seismic refraction, seismic reflection. 3. Gravity methods Principles, Earth's gravity field, Shape of the earth. Gravity field measurements. Gravity meters. Gravity measurements corrections. Gravity anomalies of simple bodies 4. Magnetic methods. Earth's magnetic field, Geomagnetic measurements and corrections. Paleomagnetism, Magnetometers. Magnetic anomalies of simple bodies 5. Geoelectrical methods Electric current propagating in earth, Resistance – Resistivity - Apparent resistivity. Geoelectrical arrays and measurements Geoelectrical data processing and analysis. Self Potential method IP method. 6. Electromagnetic methods. Principles, Natural source EM methods, controlled source EM methods. GPR 7. Well Logging Principles,methods and applications
Recommended Reading	1) «Applied Geophysics», Tselentis G-A, Paraskevopoulos.P., Ed. Liberal Books, Athens, 2013. 2) «Introduction to Geophysics», Papazachos B., Ed. Ziti, 2008.

8th Semester (Spring)

MSE402	Special Topics in Statistical Physics
Course Contents	1. Applications of statistical ensembles on special topics in solid state physics: Debye theory for the heat/thermal capacity of solids. Phonon gas. Black body radiation – Photon gas. 2. Applications of Fermi Dirac and Bose Einstein quantum statistics/distributions on ideal Fermi and Bose gases. Applications in Astrophysics: White dwarfs and neutron stars. Bose-Einstein condensation. Superfluidity. 3. Phase equilibrium – Phase diagrams and plase transitions. Ising model. Mean field theory. Critical phenomena. Landau theory. 4. Classical Statistical Mechanics. Theorem of energy equipartition. Applications in solid crystals and mono/polyatomic molecules. 5. Real classical gases. The role of interactions between atoms. Cluster expansion. Virial coefficients.
Recommended Reading	**Textbooks in Greek language** S. J. Blundell, K. M. Blundell, "Thermal Physics", Crete University Press, Heraclion, 2017. I. D. Vergados, I. N. Remediakis, H. Triantafyllopoulos, "Statistical Physics & Thermodynamics", 4th edition, Symeon Editions, 2017. F. Mandl "Statistical Physics", 2nd edition, A.G.Pneymatikos Editions, Athens, 2013. E. N. Economou "Statistical Physics and Thermodynamics", Crete University Press, Heraklion, 2002. **Textbooks in English** Dugdale, J. S., "Entropy and Low Temperature Physics", Hutchinson University Library, (1966). Kittel C., Kroemer H., "Thermal Physics", CBS Publishers & Distributors, (1980). Pryde J. A., "The Liquid State", Hutchinson University Library, (1966). Reif F., "Fundamentals of Statistical and Thermal Physics", McGraw-Hill, (1965). Rosser W. G. V., "An Introduction to Statistical Physics", Ellis Horwood, (1982). Statistical Physics I - Equilibrium Statistical Mechanics, M. Toda, R. Kubo and N. Saito, 2nd Edition, Springer, 1998. Statistical Mechanics, R. K. Pathria and P. D. Beale, 3rd Edition, Academic Press, 1996. Statistical Physics of Particles, M. Kardar, Cambdridge University Press, 2007.

MSE404	Physics of Polymers, Polymer Composites and Liquid Crystals
Course Contents	Basic concepts of polymer science. Classification of polymers. Degree of Polymerization, Molecular weight and molecular weight distribution. Polymerization mechanisms and macromolecular architecture. Molecular Structure, shape and conformations. Statistical mechanics of ideal polymer chains. Polymer solutions. Thermal properties-Phase transitions. Crystallinity. Mechanical properties Polymer composites. Liquid Crystals. Self-assembly and self-organization of amphiphilic molecules. Liquid crystalline state of matter and liquid crystal phases. Molecular organization and order parameters. Thermotropic and lyotropic liquid crystals. Electrical, optical, magnetic and mechanical properties of liquid crystals

	Characterization methods of liquid crystalline materials. Supermolecular liquid crystals and liquid crystalline polymers. Applications of liquid crystals.
Recommended Reading	- "Textbook of Polymer Science", Fred W. Billmeyer, Wiley - "The Theory of Polymer Dynamics (International Series of Monographs on Physics)", M. Doi, S. F. Edwards, Clarendon Press - "Physical properties and applications of polymer nanocomposites", S.C. Tjong and Y.-W. Mai (Eds.), Woodhead Publishing. - "Liquid Crystals: Fundamentals", Shri Singh, World Scientific, 2001.

MSE406	**Microelectronics Materials and Devices**
Course Contents	**Part A: Solid State Materials and Devices** 1)Conductors, Dielectrics and Semiconductors: A phenomenological introduction in the theory of energy bands for solids. Diagram E-x. Kronnig-Penney model. Diagram E-κ. 2)Conductors: Free electron model, thermionic emission, phenomena upon interfacial contact between metals. 3)Semiconductors: Intrinsic and extrinsic semiconductors. Growth of homogeneously doped semiconducting substrates (Czochralski και Molecular Beam Epitaxy (MBE) methods). Statistics of charge carriers in equilibrium. Carrier generation and recombination out of equilibrium. Drift and diffusion currents in semiconductors. Continuity equation. 4) Semiconductor film development and processing in the micro/nanoscale: Metallic film development. Dielectric film development. Lithography and etching. 5) Inhomogeneous doping of semiconductors: Diffusion from the gas phase and ion implantation. p-n structures. 6)The ideal Metal – Dielectric – Semiconductor (MIS) structure: Definition and basic principles. The structure under application of an external voltage. Capacitance of the MIS structure. 7) Realistic MOS structures: Dielectric defects and influence on the capacitance. 8) MOSFET transistor: A phenomenological description of its operation principles. Miniaturization of MOSFET. Parasitic phenomena in small channel MOSFETs. CMOS technology. **Part B: Organic Semiconductors and Organic Optoelectronic – Photonic Devices** 1) Organic Semiconductors: Conjugated (Semi)Conducting Polymers and Small Organic Molecules. Thermal and Optical Properties. Electronic Structure and Properties. Excited States (Excitons). Photoluminescence. Mechanisms of Conductivity and Charge Carrier Transport – Influence of Doping. Correlation of Chemical Structure and Optoelectronic Properties. 2) Organic Optoelectronic – Photonic Devices: Light Emitting Diodes (OLEDs), Solar Cells (Photovoltaics) (OPVs), Field Effect Transistors (OFETs), Lasers. Deposition Methods/Techniques for Development of Thin Films and Devices, Operation Principles of Devices, Degradation Mechanisms.
Recommended Reading	**Textbooks in Greek language** D. Skarlatos, "Materials with Applications in Microelectronics (Physics and Technology)", University Notes, Patras, 2011. L. Palilis, "Materials and Devices of Soft Condensed Matter", University Notes, Patras

	Textbooks in English S. M. Sze. "Semiconductor Devices : Physics and Technology", 2nd Ed., Wiley, (2002). Polymers for microelectronics and nanoelectronics Qinghuang Lin, R. A. Pearson, Jeffrey C. Hedrick Americal Chemical Society, 2004. Organic Electronics: Materials, Processing, Devices and Applications Franky So (ed.) Taylor and Francis, 2010. Organic Electronics - Materials, Manufacturing and Applications Hagen Klauk (ed.) Wiley-VCH, Weinheim, 2006.

EEC424	**Renewable Energy Sources Laboratory**
Course Contents	1. Study of a flat plate solar collector. Estimation of optical efficiency and thermal losses. 2. Study of a photovoltaic panel. Measurement of the I-V characteristic, measurement and estimation of the characteristic electrical parameters. 3. Study of the effects of light intensity and temperature on the performance of a photovoltaic element. Measurement of its spectral response with use of a monochromator. 4. Use of pyranometers and actinometers for the measurement of solar radiation. Spectrally selective filters. Electronic integrators of solar radiation. 5. FRESNEL lens concentrators of solar radiation. Focal point. Measurement of the concentration ratio. Applications. 6. Study of the effect of thickness of building materials on their thermal resistance. Estimation of the thermal conductivity coefficient and U-value of a wall. Use of a special simulator. 7. Measurement of wind velocity and direction. Production of the appropriate charts. 8. Measurement of photovoltaic panels under sunlight. Charging of batteries. Temperature effect on PV efficiency. 9. Independent study of special topics. The topics available are in the following fields: i) Wind Energy, ii) Photovoltaics, iii) Thermal collectors, iv) Greenhouses, v) Slar ponds, vi) Thermal losses, vii) Geothermal energy.
Recommended Reading	1) "Laboratory Exercises", Notes, G. Leftheriotis, A. Kazantzidis. 2) "Renewable Energy Sources", P. Yianoulis. 3) “Solar Energy Systems”, Notes, Y. Tripanagnostopoulos.

EEE428	**Physics of the Atmosphere II (+Laboratory)**
Course Contents	**Theory** 1. Solar and Terrestrial Radiation 2. Basic Meteological Measurements in the Atmosphere 3. Air Quality Measurements 4. Vertical profiles of Atmospheric Constituents 5. Atmospheric Remote Sensing **Laboratory** 1. Estimation of atmospheric humidity

	2. Vertical profiles of pressure and temperature 3. Direct, diffuse and global irradiance 4. Optical depth and transmittance of the atmosphere 5. Spectral distribution of solar irradiance 6. Calibration of pyranometer 7. Satellite remote sensing
Recommended Reading	1. Atmospheric Technology, D. Melas, A. Ατμοσφαιρική Τεχνολογία, Δ. Μελάς, A. Bais, D. Balis, Eds Kallipos (A textbook in Greek language). 2. Atmospheric Pollution and Meteorology, M. lazaridis, Eds Tziola (A textbook in Greek language). 3. Atmospheric Pollution, M.Z. Jacobson, Cambridge University Press.

EEE430	**Solar Energy Systems**
Course Contents	1. Solar radiation to the atmosphere and ground level. Basic principles of collection, conversion and storage of solar radiation. 2. Solar collectors and other systems for fluid heating at low temperatures. 3. Flat Plate Thermosiphonic solar systems for domestic water heating. Integrated Collector Storage solar water heaters. 4. Optical and thermal properties of concentrating solar energy systems. 5. Energy storage, space heating and cooling, solar power and electricity. 6. Stand alone and grid connected pholtovoltaics. Concentrating photovoltaics, Hybrid photovoltaic/thermal systems and other photovoltaic systems. 7. Operational effective and aesthetic integration of passive and active solar energy systems to the buildings. 8. Application of solar energy systems to the industry, agricultural sector, etc. 9. Solar energy systems combined with wind turbines, biomass and geothermic installations. 10. National and international policy and regulations regarding solar energy. 11. Environmental impact of solar energy systems.
Recommended Reading	1. Y. Tripanagnostopoulos, Notes “Solar Energy Systems” 2. P. Yianoulis "New Energy Sources" 3. K. Balaras, A. Argyriou, F. Karagiannis “Conventional and Renewable Energy Sources” 4. Y. Fragiadakis “Photovoltaic systems” 5. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes". 6. J. F. Kreider and F. Kreith, "Solar Energy Handbook". 7. U. Eicker “ Solar Technologies for buildings”

PHE436	**Introductory Quantum Optics**
Course Contents	1. Review of Quantum Mechanics Time dependent perturbation theory, two level atom - field interaction, harmonic oscillator, creation and destruction operators. 2. Density Matrix Operator Equation of motion, decay of atomic states, electronic polarization, two-photon interaction.

	3. Quantization of Electromagnetic Fields Coherent states, autocorrelation functions, and coherence properties of EM fields. 4. Interaction of Atoms with Quantized EM Fields Second quantization, Wigner-Weisskopf theory of spontaneous emission, quantum beats in fluorescence. 5. Resonance Fluorescence Coherent and incoherent scattering, the triplet spectrum under strong excitation, two-time intensity correlation, photon anti-bunching, squeezed states of the field.
Recommended Reading	"Lectures Notes: Introduction to Quantum Optics", by A. T. Georges. «Quantum Optics», M. O. Scully and M. S. Zubairy (Cambridge, 1997). «Quantum Optics: An Introduction», M. O. Fox (Oxford, 2006).

PHE438	**Lasers and Applications**
Course Contents	The laser as light source: properties of laser radiations, principles of laser operation. Laser sources for Spectroscopy. Scattering of light: Rayleigh, Mie, Raman, Brillouin. Instrumentation for Spectroscopy: diffraction and optical gratings, lenses, mirrors, filters, beam-splitters, polarizers, monochromators-spectrographs, Light Detectors (photomultipliers, photodiodes, diode arrays, CCD, ICCD, semiconductor based detectors for IR radiations, streak camera). Devices and Instrumentation for measuring low level electrical signals: Lock–in amplifiers, Boxcar integrators. Laser Spectroscopy: Laser Induced Fluorescence (LIF), Multi-photon Ionization Spectroscopy (MPI), Raman Spectroscopy, Infrared Spectroscopy (IR). Laser Induced Plasma Spectroscopy. Laser cooling. Bose–Einstein condensation. Introduction to Nonlinear Optics: the nonlinear optical susceptibility, wave equation description of nonlinear optical interactions, nonlinear absorption and refraction, second and third harmonic generation, nonlinear optical materials, the "all–optical" processes. Optical Trapping and applications in Biology and Medicine. Bio-photonics: basics of laser tissue interactions, Photodynamic Therapies. Bio-nano-photonics: applications of nanoparticles (quantum dots, metallic nanoparticles) in medical imaging and diagnostics. <u>Experiments</u> Experiment 1: The He-Ne laser Experiment 2: Coupling of a laser beam in an optical fibre. Experiment 3: Fourier optics; spatial filters. Experiment 4: The Nd:YAG laser. Experiment 5: Second Harmonic Generation (SHG).

Recommended Reading	1) “Optics and Photonics: An Introduction”, F. Graham Smith, T. A. King, D. Wilkins, 2nd Ed., John Wiley & Sons, 2007. 2) “Laser Spectroscopy: Basic concepts and Instrumentation”, W. Demtröder, 3rd Ed., Springer 2003. 3) “Introduction to Optics”, F. L. Pedrotti, L. S. Pedrotti, 2nd Ed., Prentice Hal International, 1997. 4) “Lasers: Principles and Applications”, J. Wilson, J.F.B. Hawkes, Prentice Hall. 5) “Physics of Optoelectronics”, Michael A. Parker, Taylor & Francis Group, 2005. 6) “Introduction to Biophotonics”, P. N. Prasad, John Wiley & Sons, 2003. 7) “Fundamentals of Photonics”, Saleh Teich, Wiley. 8) Review articles from scientific journals such as Nature, Science και Physics Today. 9) “Notes on Applications of Lasers in Physics, Chemistry και Materials Science”, S. Couris, Lecture Notes, Univ. of Patras.

TAC446	**Cosmology**
Course Contents	Cosmology studies the structure and evolution of the Universe in large scales. The course will focus on three basic pillars: 1. Review of the most important astronomical observations that developed the main Cosmological Concepts and lead to the theory of the expanding Universe. Following that, Newtonian models will be presented. Next, a brief introduction to the essential concepts from the General Theory of Relativity will be discussed to derive the evolutionary equations of describing the evolution of the Universe depending on its content. The main distance definitions used in Cosmology will be discussed. 2. The early evolution of the Universe will be presented including the decoupling of the forces, the nucleosynthesis, the Cosmic Microwave Background Radiation, until the Dark Ages of the Universe and the Re-ionisation Era. The main physical mechanisms describing these phenomena will be discussed. 3. The Standard Model of Cosmology will be presented along with the challenged. Possible resolutions to the open problems of Cosmology will be dicussed.
Recommended Reading	1. Frank H. Shu, THE PHYSICAL UNIVERSE. An introduction to Astronomy, Vol. II: Galaxies – The Solar System (translated in Greek language), Crete University Press, 2003. 2. V. Geroyannis, Cosmology, Lecture Notes, University of Patras. 3. E. R. Harrison, Cosmology, Cambridge University Press, 1981. 4. R. D’Inverno, Introducing Einstein’s Relativity, Oxford University Press, 1995. 5. J. N. Islam, An introduction to mathematical cosmology, Cambridge University Press, 1993. 6. K. Gourgouliatos, Cosmology Lecture Notes, University of Patras.

TAC448	**Modern Physics**
Course Contents	1.Quantization of the electromagnetic field, coherent and squeezed states. 2. Photodetection theory.

	3. Interaction of the EM field with atoms, Rabi oscillations, the Wigner-Weisskof atom, the optical master equation. 4. Many-fermion systems, the canonical anticommutation relations, fermionic Fock space, non-relativistic fields. 5. Theory and applications of quantum information. 6. Superfluidity, superconductivity.
Recommended Reading	1. C. Anastopoulos, Quantum Mechanics (Lecture notes, University of Patras, 2016)---in Greek. 2. I Karafyllidis, « Quantum Computers.», in Greek 3. P. L. Taylor and O. Heinonen, A Quantum Approach to Condensed Matter Physics (Cambridge University Press, 2002). 4. D. Walls and G. Milburn, Quantum Optics (Springer, 2008).

TAE454	**Astrophysics II**
Course Contents	Birth and evolution of stars of various masses, Variable stars, Rotating Stars. Magnetic Stars. Novae. Supernovae Stellar death : White Dwarfs. Neutron Stars. Pulsars. Black Holes, Interstellar Matter (HII Complexes- Molecular Clouds, Planetary Nebulae, Supernova Remnants). Cosmic Magnetic Fields, Cosmic Rays
Recommended Reading	Textbook in Greek language. «Stars and Interstellar Matter» C. Goudis., University of Patras press

TAE450	**Astrophysics' Laboratory**
Course Contents	1. Spectral Continuum. Determination of Temperature and Radius of Stars. 2. UBV System. Colour Indices. 3. Spectral Types of Stars. H-R Diagram. 4. Photometry of Pleiades. Distance and age of stellar clusters . (Project CLEA) 5. Solar Flux, solar Rotation. (Project CLEA) 6. Supernova remnants. Crab nebula 7. Dying stars and the birth of elements. X ray Spectroscopy of Cas A with XMM Newton . (Project CLEA) 8. Estimation of the expansion of the Universe, the age and the distance of nearby galaxies (Hubble constant) 9. Image processing of astronomical images with MAXIM DL. Properties' of a CCD camera. Tricolour imaging. 10. Observations using telescopes at the University Observatory 11. Observations using telescopes at the University Observatory 12. Observations using telescopes at the University Observatory
Recommended Reading	Each week students take one or more handouts which should read before next week's lab. These will be distributed during the lab meetings; but they can also get them from the class web site

TAE506	**Special Topics on Mechanics**

Course Contents	**A. Classical Field Theory** 1. Electromagnetic field equations. 2. Radiation of electromagnetic waves. 3. Particle motion in gravitational field. 4. Gravitational field equations. **B. Continuum Mechanics** 1. Introduction and basic concepts Elements of Tensor Calculus. Basic concepts and methods in Continuum Mechanics. 2. Kinematics Lagrange and Euler representation. Velocity distributions. Deformation tensor. Rate deformation tensor. 3. Dynamics Stress vector and stress tensor. Equations of motion for the continuum body. 4. Linear elastic body. 5. Ideal Fluid. 6. Newtonean fluid. **C. Elements of Analytical Mechanics** 1. Variation principles and Hamilton's principle. 2. Canonical transformations and the Hamilton-Jacobi equation. 3. Kinematics and dynamics of rigid body.
Recommended Reading	1. L. D. Landau and E. M. Lifshitz, The Classical Theory of Fields, Pergamon Press, 1971 2. «A Introductory Course in Continuum Mechanics», I.D.Xatsidemetriou, G. Bozis. 3. «A treatise on ANALYTICAL DYNAMICS», L.A. Pars. 4. «A Course in Continuum Mechanics», L. Sedov. 5. « Continuum Mechanics», P. Chadwick.

TAE452	**General Theory of Relativity**
Course Contents	• REVIEW OF SPECIAL RELATIVITY Axioms. Lorentz transformations. Four-vectors. Spacetime (Minkowski) diagrams. Review of most important results. • TENSOR ANALYSIS. Mathematical formalism. Applications in Special Relativity • PERFECT FLUIDS. Perfect fluids in Special Relativity. Number Flux vector and Stress-Energy tensor. • CURVED SPACETIME An overview of Differential Geometry. Covariant derivative. Parallel transport. Geodesics. Riemannian geometry. Bianchi identities: Ricci and Einstein tensors. • GEOMETRIC THEORY OF GRAVITY Equivalence Principle and laws of physics in curved spacetime. Einstein's field equations. • GRAVITATIONAL RADIATION Generation, propagation and detection of Gravitation waves.

	• RELATIVISTIC STARS Spherical stars. Pulsars, Neutron stars, Quasars and supermassive stars. • GRAVITATIONAL COLLAPSE AND BLACK HOLES Schwarzschild geometry. Gravitational collapse Horizons and singularity theorems. Black holes. • COSMOLOGY General relativistic cosmological models. Cosmological observations.
Recommended Reading	1. J.L. Martin, *Γενική Σχετικότητα, μια βασική εισαγωγή για φυσικούς*, 2005, ΠΕΚ. 2. Bernard F. Schutz, *A first course in General Relativity*, 1985, Cambridge University Press. 3. Charles W. Misner, Kip S. Thorne and Hohn Archibald Wheeler, *Gravitation*, 1973, W.H. Freeman and Company. 4. L.D. Landau and E.M. Lifsitz, *The classical theory of fields*, 1970, Pergamon press. 5. Δ. Χατζηδημητρίου και Γ.Δ. Μπόζη, *Εισαγωγή στην Μηχανική των Συνεχών Μέσων*, 1997, εκδόσεις Τζίολας. 6. Bernard F. Schutz, *Geometrical methods of Mathematical Physics*, 1980, Cambridge University Press.

ELC472	**Digital Signal Processing**
Course Contents	1 Introduction to Digital signals and systems 2 Signal representation – Discreet Fourier Transform 3 z-transform, Digital Filters 4 FIR Digital Filters 5 Oversampling and Noise shaping AD converters (ΣΔ) 6 Adaptive Filters 7 Spectral estimation – Parametric and non-parametric techniques 8 High order spectra - Bispectrum 9 Introduction to Neural networks 10 Non-linear digital filters A. Discreet Fourier transform properties B. The importance of phase in digital signal processing
Recommended Reading	1. Πανεπιστημιακές Σημειώσεις, "Ανάλυση και Επεξεργασία Ψηφιακών Σημάτων", Βασίλης Αναστασόπουλος, 1999, 2012, 2020. 2. Βιβλίο [94702518]: ΘΕΜΕΛΙΩΔΕΙΣ ΕΝΝΟΙΕΣ ΤΗΣ ΕΠΕΞΕΡΓΑΣΙΑΣ ΣΗΜΑΤΩΝ, McCLELLAN, SCHAFER, YODER Λεπτομέρειες 3. Βιβλίο [14869]: Ψηφιακή Ανάλυση Σήματος, Proakis J, Manolakis D. Λεπτομέρειες

ELC473	Introduction to Microcomputer Architecture
Course Contents	• Introduction (microcomputer architecture, busses). • Data Coding (fixed/floating point numbers, characters, symbols, instructions) • CPU (arithmetic/logic unit, control unit, register file). • Stack/accumulator/register-based architectures. • Assembly programming (instruction set, addressing modes, stack, subroutines). • Memory (technology, interfacing, hierarchy, cache). • Peripherals (I/O, interrupt/poling). • Microcontrollers (Arduino/Raspberry Pi).
Recommended Reading	1) P. Papazoglou, Microprocessors: Principles and Applications, 2nd edition, Tziolas Publications, 2022 (A textbook in Greek). 2) D. Nikolos, Computer Architecture, 2017 (A textbook in Greek).

ELC474	Analog Electronics Laboratory
Course Contents	1. Circuits Simulations with Capture SPICE. One- stage amplifier topologies. 2. Two- stage amplifier topologies. Differential Amplifier. 3. Operational Amplifier. 4. First and second- order filters. 5. Comparator circuits. 6. Multivibrators. 7. Harmonic Oscillator Circuits.
Recommended Reading	C. Psychalinos, S. Vlassis, G. Economou, «Simulation and Experimental verification of analog circuits», University of Patras Press, 2008.

ELE481	Digital Electronics Laboratory
Course Contents	• Logic Gates. • Combinational Logic (half adder, full adder, comparator, decoder, demux, multiplexer, parallel adder/subtractor). • Latches and Flip-flops. • Synchonous Sequential Circuits. • Synchronous and Ripple Up/Down Counters. • BCD Counters. • Shift and Parallel Registers. • Johnson Counters. • EPROMs and RAMs. • HDL (Verilog/VHDL) and FPLDs. • Clock Generation Circuits (Astable/Monostable Multivibrator). • Analog-to-Digital (A/D) and Digital-to-Analog (D/A) Converters. • Simple Logic Gates with MOS/BJT Transistors.
Recommended Reading	1) D. Bakalis, Digital Logic Laboratory (Labs), University of Patras, 2015 (A textbook in Greek). 2) W. Kleitz, Digital Electronics (8th ed), Tziolas Publications, 2011 (A textbook translated in Greek).

	3) S. Brown, Z. Vranesic, Digital System Design with VHDL (3rd ed), Tziolas Publications, 2011 (A textbook translated in Greek). 4) M. Morris Mano & M. Ciletti, Digital Design (5th ed), Papasotiriou, 2013 (A textbook translated in Greek). 5) J. Wakerly, Digital Design (3rd ed), Kleidarithmos, 2004 (A textbook translated in Greek).

ELE478	**Microelectronics**
Course Contents	• Introduction to MOS transistors integrated circuit layout. • Current mirrors. • Reference generators. • Differential amplifiers with MOS transistor, dc and small signal operation. • Cascaded MOS amplifier. • Circuit structure of MOS based operational amplifiers. • Frequency response of basic MOS amplifiers.
Recommended Reading	1. A. Sedra. K. Smith Kenneth, "Μικροηλεκτρονικά Κυκλώματα", Τόμος Α', 7η Έκδοση, Εκδότης: Παπασωτηρίου, 2017. 2. Γ. Χαριτάντη: «Ηλεκτρονικά», Εκδόσεις Αράκυνθος, Αθήνα 2013. ISBN: 978-960-94744-08-05. 3. A. Malvino, D. Bates, «Ηλεκτρονική», Εκδόσεις Τζιόλα, 2016. 4. B. Razavi, Βασικές αρχές Μικροηλεκτρονικής, Εκδόσεος Κλειδάριθμος 2018.

NME492	**Demonstration Experiments in Physics II**
Course Contents	Demonstration experiments in Electricity & Optics. Especially: Electrostatics, piezoelectric effect. Capacitors - Dielectrics. Applications. Electricity. Resistors in series & in parallel connection. Resistivity dependence on temperature. Potenciometers, rheostats, Ohmmeter. Fuses, short circuit. Results of electric current (Joule heating effect, Oersted's experiment, electrolysis, effect of electric currents on living organisms). Interaction of currents. Magnetic field (field lines). Lorentz force. Equivalence of an electric current carrying coil to a magnet. Induction experiments. Lenz's law. Self-induction experiments. Eddy currents. RLC circuits, resonance. Magnetization and demagnetization of a ferromagnetic material. Transition of Ni rod from the ferromagnetic to the paramagnetic state (Curie point). Paramagnetic Mn ions in an inhomogeneous magnetic field. Operating principles of measuring instruments, frequency meters, gausmeters, etc. Transformers. Applications (induction cookers, induction welding, etc). A.C. & D.C. Generators. Three-phase generator. Electric motors. Rotating magnetic field. High frequency currents (induction & self-induction phenomena). Resonance. Tesla Transformer. Microwaves. Electric discharges.

	Experiments on geometric optics. Analysis of light with prisms and diffraction gratings. Experiments on wave optics (interference, diffraction, polarization). Birefringence, phase delay plates, photoelasticity. Optically active substances.
Recommended Reading	"Conceptual Physics" P. G. Hewitt. Addison Wesley Longman. 2002. «University Physics, Vol.II» H.D. Young, Addison-Wesley Pub. Co. 1992. Fundamental University Physics. Alonso – Finn. Addison-Wesley Pub. Co. "Physics" Resnick, Halliday, Krane, (4th ed.) John Wiley & Sons, Inc. N.Y. (1992).

NME494	**Physics Education**
Course Contents	(1) The History of Physical Sciences in Educational Programs for Science Teaching. (2) The Philosophy of Physical Sciences in Educational Programs for Science Teaching. (3) What Students think about Concepts and Phenomena of Physical World. (4) Understanding Sciences. Theories of learning (Cognitive, Socio-cultural, Social Constructivism), Models of Physical Sciences Teaching. (5) Multicultural Didactics. (6) Teacher Education.
Recommended Reading	Gerald Holton & Stephen G. Brush, Introduction to Concepts and Theories in Physical Science, Princeton University Press. Κόκκοτας Π. Β., Διδακτική των Φυσικών Επιστημών (2 τόμοι), εκδ. Γρηγόρη. Κολιόπουλος Δ., Θέματα Διδακτικής Φυσικών Επιστημών. Η συγκρότηση της σχολικής γνώσης, εκδ. Μεταίχμιο. Κουζέλης Γ., Από τον Βιωματικό στον Επιστημονικό Κόσμο, εκδ. Κριτική. Matthews, Michael R., Science Teaching. The role of History and Philosophy of Science, Routledge. Ραβάνης Κ., Εισαγωγή στη Διδακτική των Φυσικών Επιστημών, Εκδόσεις Νέων Τεχνολογιών. Σκορδούλης Κ., Επιστημονική Γνώση, εκδ. Τόπος. Sutton, Clive, Words, Science and Learning, Open University Press. (συλλογικό), Ανοίγοντας την Επιστήμη στην Κοινωνία. Η διδασκαλία των φυσικών επιστημών στην επιστημονική, πολιτισμική και ηθική της διάσταση, εκδ. University Studio Press. (συλλογικό), Ιστορία Φιλοσοφία και Διδακτική των Επιστημών, εκδ. Νήσος. (συλλογικό), Διδακτικές Προσεγγίσεις στις Φυσικές Επιστήμες, Σύγχρονοι προβληματισμοί, εκδ. Τυπωθήτω. Χαλκιά Κ., Διδάσκοντας Φυσικές Επιστήμες, Θεωρητικά ζητήματα, προβληματισμοί, προτάσεις, εκδ. Πατάκη.

NME500	**Medical Physics**
Course Contents	• Bioelectricity (the nervous system and the neuron, electrical potential in neurons, electrical signals from muscles, electrical signals from heart, electrical signals from brain). • Radiation-matter interaction (excitation and ionization of atoms, mechanisms of radioactive decay and emission, interaction of charged particles and photons of high energy with matter).

	• Physics of Diagnostic Radiology (components of radiation imaging systems, projection and tomographic imaging systems, analog and digital image detectors, medical image quality). • Physics of Nuclear Medicine (criteria for choosing radioisotopes in the differential diagnosis, basic components of imaging systems, statistics in nuclear medicine). • Physics of Radiation Therapy (teletherapy and brachytherapy, radiation therapy planning, radiation therapy with charged particles). • Radiation Protection (basic principles of radiation protection, units and methods of dosimetry, radiation protection of patient and personnel, legislation and guidelines of radiation protection).
Recommended Reading	(Greek language) Συγγράμματα: • "Ιατρική Φυσική" Ευάγγελος Γεωργίου, Εκδόσεις Π.Χ. Πασχαλίδης. • «Η Φυσική στη Βιολογία και την Ιατρική», Paul Davidovits, Επιστημονικές Εκδόσεις Παρισιάνου Α.Ε. Αθήνα. • Συμπληρωματικό εκπαιδευτικό υλικό: Σημειώσεις-Παρουσιάσεις Διαλέξεων

NME504	**History and Philosophy of Physical Sciences**
Course Contents	1st Unity (1) From classical Empiricism to Logical Positivism. 'Vienna Circle' (1920-1930). (2) The transition to the 'historicistic turn' (1960's decade). T.Kuhn, P.Feyerabend, I.Lakatos. (3) Characteristics of scientific research and methods, it's aims. Distinction between sciences and pseudosciences. (4) The history of ideas on 'scientific method'. Induction. Falsificationism (K.Popper). (5) Philosophical views on scientific 'change' and scientific 'progress'. Rationalism. Relativism. (6) Scientific realism vs. anti-realism debate. In the laboratory. Theory and observation. (7) Some aspects of 'Continental Philosophy of Science'. G.Bachelard, G.Canguilhem. 2nd Unity (1) Ancient Greece. Physical philosophy of Aristotle. (2) First Medieval Universities. European physical sciences in the Middle Ages. (3) The history and significance of 'Scientific Revolution' in Western Europe. Sciences and Enlightenment. (4) Historiographical elements: for the history of history of science. Cultural and Social History of Sciences. (5) From 'History and Philosophy of Science' to 'Science and Technology Studies'. (6) The sociology of scientific knowledge. Contemporary debates over 'Social Studies of Science'. 'Gender and Science'.
Recommended Reading	Πέτρος Μετάφας, Σημειώσεις για τις Επιστήμες. Φιλοσοφία, Ιστορία και Κοινωνιολογία των Επιστημών, Εκδόσεις Πανεπιστημίου Πατρών. Mario Biagioli, Galileo, Courtier. The Practice of Science in the Culture of Absolutism, University of Chicago Press.

Michel Blay & Efthymios Nicolaïdis (eds.) L'Europe des sciences: Constitution d'un éspace scientifique, Paris: Seuil.
Herbert Butterfield, The Origins of Modern Science (1300-1800), Free Press.
A.C. Crombie, Augustine to Galileo (2 volumes), Heinemann Educational Books.
Duhem P., To Save the Phenomena: An Essay on the Idea of Physical Theory from Plato to Galileo, University of Chicago Press.
Grant E., Physical Science in the Middle Ages, Cambridge University Press.
Koyre A., From the Closed World to the Infinite Universe, The Johns Hopkins University Press.
Lindberg C.D., The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, Prehistory to A.D. 1450, University of Chicago Press.
Steven Shapin, The Scientific Revolution, University of Chicago Press.
Richard S. Westfall, The Construction of Modern Science: Mechanisms and Mechanics, Cambridge University Press.
James Ladyman, Understanding Philosophy of Science, Routledge.
Batens D., Menselijke kennis. Pleidooi voor een bruikbare rationaliteit, Garant.
Brown I.H., Perception, Theory, and Commitment: The New Philosophy of Science, University of Chicago Press.
Alan F.Chalmers, What is this thing called Science? University of Queensland Press, Hackett.
Feyerabend P., Against Method, Verso.
Ian Hacking, Representing and Intervening, Introductory Topics in the Philosophy of Natural Science, Cambridge University Press.
Hanson N.R., Patterns of Discovery, Cambridge University Press.
Kuhn T.S., The Structure of Scientific Revolutions, University of Chicago Press.
Lakatos I., The Methodology of Scientific Research Programmes, Cambridge University Press.
Tiles M., Bachelard: Science and Objectivity, Cambridge University Press.

Erasmus+

Erasmus+, also called Erasmus Plus, is the new EU funding program for education, training, youth and sport. The new Erasmus+ programme combines all the EU's past schemes including the Lifelong Learning Programme (Erasmus, Leonardo da Vinci, Comenius, Grundtvig), Youth in Action and five international cooperation programmes (Erasmus Mundus, Tempus, Alfa, Edulink and the programme for cooperation with industrialised countries).

The University of Patras participates in the Erasmus+ programme, and has conducted c. 200 Bilateral Agreements with higher education institutions all over Europe that facilitate the mobility of students, teaching and administrative staff. Undergraduate courses in English are available in Primary Education and in the Department of Educational Sciences and Early Childhood Education. In Master level, Departments of Civil Engineering and Chemical Engineering offer courses in English. In all other fields Erasmus students follow individual study programmes, with private tutoring. The faculty member in charge of a course prepares a study program for the exchange students enrolled in his/her course based on English resources (books, the internet etc). Students are assessed by a written exam (in English) or project(s) development and in some cases by both. There are also courses offered in German, French and Spanish. The Physics Department Erasmus+ website is accessible here.