DEPARTMENT OF PHYSICS
Content of Philosophy of Doctorate in Physics

COURSE CODE	COURSE NAME AND CONTENTS	T	A	C	ECTS
FIZ801	**Advanced Quantum Mechanics I**	**3**	**0**	**3**	**8**
Purpose and Content	To introduce fundamental principles and discussions of advanced quantum mechanics. Fundamental Concepts, Quantum Dynamics, Angular momentum theory				
FIZ802	**Advanced Quantum Mechanics II**	**3**	**0**	**3**	**8**
Purpose and Content	To introduce fundamental principles and discussions of advanced quantum mechanics. Symmetry in quantum mechanics and conservation laws, Translational symmetry in time and space, Conservation laws of energy and momentum, Rotation symmetry and conservation of angular momentum, Variational methods in quantum mechanics and calculation of ground state energy, Perturbation theory, Perturbation of non-degenerate states, Perturbation of degenerate states, Time-dependent perturbation theory, Applications of perturbation theory, Identical particles and exchange interaction, Pauli principle for identical particles				
FIZ803	**Advanced Statistical Mechanics I**	**3**	**0**	**3**	**8**
Purpose and Content	To describe collective properties of materials through the laws which define the motion of atoms. To introduce statistical methods as the bridges between microscopic and macroscopic world, To introduce Boltzman statistics with classical ensembles, To introduce Fermi and Bose statistics. Fundamental postulates of thermodynamics, Legendre transformations and alternative thermodynamics potentials, minimalism principle for thermodynamics potentials, kinetic theory of ideal gases, Liouville theorem, microcanonical ensemble, Entropy of mixing, Indistinguishability of particles, canonical ensemble and partition function, Helmholtz free energy and canonical partition function, equivalence of canonical and microcanonical ensembles, non-interacting particles,Virial and equipartition theorems , Dulong and Petit law, Curie paramagnetism, Grand potential ve grand canonical ensemble, Quantum ensembles, density matrix, harmonic oscillator, Fermi-Dirac and Bose-Einstein Symmetries in many-particle systems, Fermi-Dirac and Bose-Einstein partition functions for non-interacting particles.				

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FIZ804	**Advanced Statistical Mechanics II**	**3**	**0**	**3**	**8**
Purpose and Content	Introducing quantum statistics. Classification of phase transitions teaching statistical models. 1- Debye model for specific heat of solids, Black body radiation 2- Correction for classical theory of Fermi and Bose gases in sparse limit, properties of degenerate Fermi gas at T=0 3- Degenerate Fermi gas, expansion at low temperature and specific heat 4- Pauli paramagnetism of non-interacting electron gas 5- Landau diamagnetism for non-interacting electron gas 6- Bose-Einstein condensation in an ideal gas. 7- Specific Heat and Entropy for Bose-Einstein condensation 8- Superfluid He4, BCE in trapped atomic gases, classical gas with intrinsic degree of freedom 9- Classical non-ideal gas, the Mayer cluster expansion, Virial expansion of state equation, van der Waals theory of liquid-gas phase transition 10- Continuity of liquid-gas phase transition, Maxwell correction, Continuity of liquid-gas phase transition, Behaviour at close to critical point, critical powers, Clausius-Clapeyron equation and Gibss sum rule. 11- Ising model, magnetic ensembles, spontaneous symmetry breaking, phase transitions and thermodynamic limit 12- Mean field solution of Ising model and Landau theory of second degree phase transtions 13- Complete solution of one dimensional Ising model, Landau-Ginzburg theory and fluctuations around mean field solutions, upper critical dimension				

FIZ805	**Nuclear Structure Theory I**	**3**	**0**	**3**	**8**
Purpose and Content	To introduce the physics of nuclear structure. Stable Nuclei, Emprical evidence for the magic numbers, Review of electronic structure of atoms,Individual Orbits in the nucleus, properties of nuclear ground states, Discussion of emprical data for odd-A nuclei, Selected Problems in nuclear structure theory				

FIZ806	**Nuclear Structure Theory II**	**3**	**0**	**3**	**8**
Purpose and Content	To introduce physics of nuclear structure. Determination of parity and occupation numbers by the angular distribution of (d,p) and (d,n) reactions, Quadrupole moments and isotope shifts, Beta decay, Light nuclei, Nuclei of even-A, General facts about nuclear spectroscopy, Isomerism in nuclei of odd-A				

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FIZ807	**Group Theory and Applications To Physics I**	**3**	**0**	**3**	**8**
Purpose and Content	To teach Quantum Mechanics, Spectroscopy, Crystallography, Solid State Physics applications of group theory. Group Representation Theory, Symmetry Operators and Point Groups, Irreducible Representations, Basis Functions, Applications of Group Theory to Quantum Mechanics, Splitting of atomic orbitals under crystal field, Selection Rules and Direct Multiplications, Molecular Systems, Application of Group Theory to bonds and structures, Electronic orbitals in polyatom molecules, Application of group theory to electronic spectroscopy, Molecular vibrations, Infrared and Raman Activities, Techniques of Vibration Spectroscopy, Transitions between electronic states				
FIZ808	**Group Theory And Applications To Physics II**	**3**	**0**	**3**	**8**
Purpose and Content	To teach Quantum Mechanics, Spectroscopy, Crystallography, Solid State Physics applications of group theory. Applications of group theory to periodic structures, Symmetry groups in real space, Space Groups and representations in reciprocal space, Electron and phonon dispersion relations, Electronic energy levels in cubic crystals, Spin-orbital interactions and double groups in solids, Application of double groups with spins to energy bands, Time Reversal Symmetry, Magnetic Groups, Permutation Groups and Many electron states, Symmetry Properties of Tensors, Crystallographic symmetry and Space groups, Experimental measurements and selection rules, Compact Groups and Lie Groups.				
FIZ809	**Crystal Structure Determination by X-Ray Diffraction Method I**	**3**	**0**	**3**	**8**
Purpose and Content	1. To provide basic background about X-rays and diffraction. 2. To provide theoretical and practical skills in X-ray diffraction analysis. 3. To give an ability to make phase and structural analysis of real materials. X-Rays and Diffraction, Lattices and Crystal Structures, Notation, Bragg's Law, Structure Factor,Diffraction from Crystalline Materials, X-Ray Diffractometer, Diffraction Patern,Practical Diffractometry (Structure determination, Lattice parameter measurement, Identification of an unknown specimen)				
FIZ810	**Crystal Structure Determination by X-Ray Diffraction Method II**	**3**	**0**	**3**	**8**
Purpose and Content	The PhD student should obtain theoretical knowledge on the possibilities and limitations of X-ray diffraction for the purpose of microstructure characterization (phase analysis, texture analysis, stress analysis and line profile analysis) and apply this knowledge to particular problems in applied materials science and engineering. The course will provide lectures on the fundamentals of x-ray diffraction (kinematical scattering theory) and an introduction to common methods for microstructure analysis as quantification of crystallographic texture, evaluation of internal stresses and strains and line profile analysis.				

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FIZ811	Particle Physics I	3	0	3	8
Purpose and Content	To teach laws of modern physics, fundamental forces and interactions, and standard model of particle physics. Introduction to Physics of Fundamental Particles, Classifications and Standard Model, Dynamics of Fundamental Particles, Fundamental Forces in Nature, QED, QCD, Weak Interaction and Decays, Relativistic Kinematic, Four Vectors, Energy and Momentum, Collisions, Symmetries, Groups and Conservation Laws, Flavor Symmetry, Parity and CP violation, Introduction to Feynman calculations, Calculations of Half-lives and Cross-Sections, QED : Dirac Equation, QED : Feynman Rules, Casimir Method and Trace theorem, Weak Interaction, Charged and Neutral Weak Interactions.				

FIZ812	Particle Physics II	3	0	3	8
Purpose and Content	To teach laws of modern physics, fundamental forces and interactions, and standard model of particle physics. Introduction to Physics of Fundamental Particles, Classifications and Standard Model, Quarks and Leptons, Particle Interactions in Standard Model, Yukawa Theory, Electromagnetic, Weak and Strong Forces, Electromagnetic theory and Gauge transformation, Electromagnetic theory and Gauge transformation, Relativistic Quantum Mechanics, Klein-Gordon Equation, Dirac Equation and Solution of Free Particle Problem, Introduction to Quantum Field Theory, Free Scalar Fields, Interacting Scalar Fields, Complex Scalar Fields				

FIZ813	Radiation Physics For Nuclear Medicine	3	0	3	8
Purpose and Content	1-To give information about radiation. 2-To give information about classical superconductor 3-To give information about radiation diagnosis and treatment areas. 4-To give information about accessories and accessories of X-ray tubes and X-ray devices. Introduction to radioactivity, Radiation and its properties, Use of radioactive rays in medical field, Optics, Shadow and digital imaging methods, Radiology laboratories and rules to be followed in practice, Accessories and accessories of X-ray tubes and X-ray devices, Diagnostic and Therapeutic Radiological Devices, Radiation Biological Effects and Radiation Protection				

FIZ814	Advanced Neutron and Reactor Physics	3	0	3	8
Purpose and Content	Production in nuclear regions of neutrons, which is the most important radiation source, learning system theories and nuclear power plants in power explosion Teaching working principles Fundamentals of neutron physics, Slowing down neutrons, Thermal neutrons properties, Nucleus Fission, Physical properties of nuclear reactors properties, criticality in homogeneous reactors, group reactor calculations, Heterogeneous Reactors, Infinite multiplication coefficient, minimum critical size, Reactor control, structure of Nuclear Reactors				

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FIZ815	Applied Superconductivity	3	0	3	8
Purpose and Content	1-To give comparative information about superconductivity with conventional conductivity. 2-To give information about classical superconductor 3-To give information about theories of superconductivity. 4-To give information about high temperature superconductivity 5-To give information about superconducting tunneling 6-To give information about engineering applications of superconductivity Conventional conductivity, Introduction to superconductivity, Classical superconductors, Ginzburg-Landau Theory, London Theory and BCS Theory, High temperature superconductivity, Critical States, Tunneling, Transport Phenomena.				

FIZ816	Biocompatible Material Production and Characterization	3	0	3	8
Purpose and Content	Biomaterials are modern materials and they have transformed the world in which we live. This course explains in simple terms the basic ideas of the biomaterials and outlines the importance. The applications, improving the range and safety of biomaterials available for several purposes, their specific targets will be also discussed during the course. 1 - To learn the main concepts of biomaterials and related concepts 2 - To understand the physical, chemical and biological properties of biomaterials 3 - To understand the natural and synthetic production and synthesis mechanisms of polymers and biopolymers 4 - To learn how biomaterials are produced 5 - To be able to understand the relationship between immunity and the properties of the biomaterials 6 - To be able to understand the relationship between structures of various biomaterials (implants, prosthetics etc.) and their applications				

FIZ817	Advanced Solid State Electronics	3	0	3	8
Purpose and Content	To introduce metal-semiconductor diodes, P-N junction diodes, transistors, semiconductor electronics, continuity equations, thermionic emission. Metal-Semiconductor Diodes, P-N junction Diodes, Transistors , Semiconductor Electronics, Continuity Equations, Thermionic Emission, Richardson Equations				

FIZ818	Optoelectronics	3	0	3	8
Purpose and Content	1-To introduce optoelectronic components 2- To introduce working principles of basic optoelectronic components. Photodetectors, Photonic Transducers and Applications, Solar Cells and Applications, Lasers, Photodiodes Characteristics and Types, Fiber Optic Cables, Non-communicative Applications of Fibers, Led, Photodetectors, Fiberoptic Devices, Fiber Optic Bands and Schematic Energy Band Diagram, Analysis of Visible Light Spectra communication systems, Optical Fiber Sensors and Light Guide Fibers.				

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FIZ819	Spectroscopic Methods	3	0	3	8
Purpose and Content	To teach some spectroscopic methods including, but not limited to, luminescence, atomic force microscopy and scanning tunneling microscopy. Fluorescence and principles of fluorescence, Measurement Systems for fluorescence and phosphorescence spectroscopy, Analysis on Florescence and Phosphorescence Spectre, Applications of fluorescence and phosphorescence spectroscopy, Principles of Atomic Force Microscopy, Measurement Systems for Atomic Force Microscopy, Images from Atomic Force Microscopes, Analysis of Atomic Force Microscopy images, Applications of Atomic Force Microscopy, Principles of Scanning Tunnelling Microscopy, Measurement Systems for Scanning Tunnelling Microscopy, Scanning Tunnelling Microscopy images, Analysis of Scanning Tunnelling Microscopy images, Applications of Scanning Tunnelling Microscopy				

FIZ820	Surface Analysis Methods	3	0	3	8
Purpose and Content	To teach most common surface analysis methods which are used both in industrial applications and research. Introduction to surface analysis Vacuum technology in surface science Auger electron spectroscopy- introduction and principles. Secondary Ion mass spectroscopy-surface mass spectroscopy X-ray absorption and scattering techniques Scanning electron microscopy (SEM) in surface science X-ray photoelectron spectroscopy principles and application areas. Introduction to scanning tunneling microscope (STM) Principles of Atomic force microscope (AFM). Applications of Atomic force microcope Applications of infrared spectroscopy in surface analysis Raman spectroscopy and its applications.				

FIZ821	Large-Area Electronics	3	0	3	8
Purpose and Content	Introduction to the physical concepts involved in the description of optical and electronic transport properties of thin-film semiconductor materials found in many large-area applications (solar cells, displays, imagers, etc) and introduction to the physics of the related devices. This course will start with the general description of thin-film materials which are common in macro-electronic applications. These materials include metal oxides, disordered semiconductors and organic materials. The effect of disorder at the atomic scale on electronic states and electronic transport properties will be discussed, as well as the optical characteristics of such materials in relation to device applications. Then the device physics of various devices based on disordered semiconductors will be presented: first solar cells will be discussed and especially the relation between the material properties (absorption behavior and charge transport) on the cell efficiency. Finally other examples of large-area devices such as photo-detectors, particle sensors and Thin-Film Transistors (for flat panel displays and flat panel imagers) will be presented; the physics of these devices and some fabrication aspects will also been discussed.				

FIZ822	Material Optical Properties	3	0	3	8
Purpose and Content	To introduce optical properties of metals, insulators and semiconductors. Introduction, Propagation of light in media, Band absorption, excitons, luminescence, quantum confined structures, metals and doped semiconductors, phonons, non-linear optics.				

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FIZ823	**Optoelectronic Properties Of Amorphous Semiconductors**	**3**	**0**	**3**	**8**
Purpose and Content	To teach the theory behind physics of amorphous semiconductors and experimental techniques of producing them in bulk and thin film forms and measuring and analyzing most relevant properties. Theory of electronic conductivity and photo-conductivity for amorphous semiconductors, absorption and transmission spectra, analysis of noise spectra, sample preparations, thickness determination, film structure, temperature and field dependence of conductivity, photo-conductivity.				
FIZ824	**Physics Of Semiconductor Devices**	**3**	**0**	**3**	**8**
Purpose and Content	To introduce structural properties of semiconductors and relevant mathematical models. Electronic Band Structure, Vibrational Properties of Semiconductors, Electron-Phonon interaction, Electronic Properties of Defects.				
FIZ825	**Advanced Surface Physics**				
Purpose and Content	To introduce advanced level surface physics Surface Analysis I : Diffraction Methods Surface Analysis II : Electron Spectroscopy methods Surface Analysis III : Ion scattering Spectroscopy Surface Analysis IV : Microscopy Atomic scale structures on clean surfaces Structure defects in surfaces Electrical properties of surfaces				
FIZ826	**Advanced Measurement Techniques in Plasma**	**3**	**0**	**3**	**8**
Purpose and Content	The aim of the course is to teach the students at the doctorate level how to diagnose the plasma which has common usage areas. It will be taught how to use experimental probe systems and how to interpret the measurement results. Various measurement techniques are used when making diagnostics in plasma. The parameters of the plasma can be measured with the help of experimental and theoretical techniques.				
FIZ827	**Selected Topics In Mathematical Physics**	**3**	**0**	**3**	**8**
Purpose and Content	To introduce Complex Analysis, Special Functions, Fourier Series, Fourier Transformations, Calculus of Variations, Non-linear differential equations, Lie Algebra, and relevant mathematics. Complex Analysis, Special Functions, Fourier Series, Fourier Transformations, Calculus of Variations, Non-linear differential equations, Lie algebra.				

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FIZ896	**PhD Qualification**	**0**	**1**	**0**	**26**
Purpose and Content	Student involves in an independent study to prepare for qualification exam. Student answers both verbal and written questions in the exam. The student should convince the qualification exam committee that he/she has enough comprehension of the field and can thoroughly engage in a research based study.				
FIZ897	**PhD Seminar**	**0**	**2**	**0**	**6**
Purpose and Content	To give the ability of the oral presentation and discussion. To decide on the objectives of the thesis work and the strategy. Presentation of the thesis work				
FİZ8098D	**Course Field of Specialization**	**4**	**0**	**0**	**4**
Purpose and Content	The aim of this course is to provide students who are at the course stage with the ability to follow, evaluate and discuss the literature on the subject they will study. In addition, it is the development of students' knowledge and skills in terms of science ethics and scientific research methodology. Gathering information on current professional issues Literature research Science ethics Scientific research methodology				
FİZ8098T	**Thesis Field of Specialization**	**4**	**0**	**0**	**4**
Purpose and Content	The aim of this course is to provide students who are at the thesis stage with the ability to follow, evaluate and discuss the literature on the subject they will study. In addition, it is the development of students' knowledge and skills in terms of science ethics and scientific research methodology. Gathering information on current professional issues Literature research Science ethics Scientific research methodology				
LUEE801	**Scientific Research Techniques and Scientific Ethics**	**3**	**0**	**3**	**8**
Purpose and Content	To be able to know how a process in a scientific research proceeds and how a scientific report must be prepared. Fundamental concepts and information about the science, the structure of scientific research, scientific methods and different ideas on these methods, data acquisition methods (quantitative and qualitative), registration, analysis, interpretation and reporting of datas.				

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