Dept. of Physics

Physics is a fundamental science aimed at discovering the basic principles governing our universe, and applying these to the everyday life. Most of today's scientific knowledge is based on the laws of physics, and therefore Physics is considered to be one of the most fundamental fields in the science and engineering and has broad impacts in the real world. The education and research goal of the Department of Nano and Electronic Physics is to explore the quantum phenomena in the nanometer scale, to apply the principles of Physics to the electronic systems, and to cultivate the manpower needed in the 21st century industry. The research and education within the department will be performed by carrying out the cutting-edge experiments and developing new methods to overcome the limitations of the conventional methodologies in nanometer scale. The department also focuses on the theoretical and numerical studies on the physical phenomena in the nanometer region.

The department of Physics consists of 5 faculty members who are actively pursuing researches on many forefront fields in physics and providing high-quality education. The main research topics include physics of magnetic material, geometrical optics, plasma physics, computational condensed matter physics, semiconductor physics, surface physics, and nanoelectromechanical systems. The department offers the educational program which encourages the students to study the multidisciplinary aspects of nanoscience through the various courses offered by the department. Also for students, many research opportunities will be available through on-going research programs in the department.

☐ Courses

❑ Core Courses

· Classical Mechanics (3)

Classical Mechanics is a field of physics which describes the motion of the macroscopic bodies including celestial objects like star and everyday machineries. In this course, Lagrangian and Hamilton mechanics based on Hamiltonian theory in the classical mechanics will be studied in depth. The scope of the subject will include not only the typical aspects of classical mechanics area but also small oscillation, collision of two particles and relativistic theory.

· Electrodynamics (3)

Electrodynamics deals with the physical phenomena related to electric and magnetic field and related dynamics of the fields and the dynamics of the charged particles. The scope of the subject includes time independent and dependent electric fields in vacuum and in dielectrics, magnetic fields associated with constant and variable currents, magnetic materials, Maxwell's equations, electromagnetic wave propagation

in medium, generation of electromagnetic wave, relativistic 4vector treatment of electromagnetic entities.

· **Quantum Mechanics (3)**

Quantum Mechanics is a fundamental subject which is backbone of the modern science. The course will introduce quantum mechanical concepts like operators, expectation value, wave function, etc. The course will also discuss angular momentum operators, harmonic oscillator problem, atomic hydrogen problem, perturbation theory, scattering theory, identical particles, radiation, second quantization, etc.

❑ **Physics Major Courses**

· **Modern Optics (3)**

This class discusses the concepts and the experimental applications of various optical techniques, utilized in modern physics based on optical theory.

· **Solid State Physics (3)**

Solid State Physics deals with the many aspects of the solid state materials, including semiconductors, magnetic material. Physical properties of solid state material will be discussed with both classical and quantum mechanical theories. The scope of the course will cover atomic, molecular and crystal structure, energy levels of electrons, and binding energies in molecules and solids, etc.

· **Advanced Solid State Physics (3)**

Advanced Solid State Physics is an advanced course for the student who has background on the graduate level solid state physics. The course will mainly focus on the quantum mechanical phenomena in the solid state material. The scope of the course will include band theory, superconductors, magnetism of matter, heat capacity of materials and optical properties of solids, etc.

· **Statistical Mechanics (3)**

Statistical Mechanics is a fundamental subject in the physics which deals with collective many-body phenomena in nature. The course will introduce the concepts of micro-canonical ensemble, canonical ensemble, grand-canonical ensemble, free energy, entropy, chemical potential, partition function, etc. Also, the course will introduce the equilibrium thermodynamics and elementary statistical mechanics. The knowledge of Statistical Mechanics is essential to the understanding of the modern solid state physics of semiconductor and magnetic material.

· **Advanced Statistical Mechanics (3)**

Advance Statistical Mechanics is for the student who are familiar with the basic

Statistical Mechanics. In the course, the advanced subjects of statistical mechanics like advanced thermodynamics, superfluids, Ising model, phase transition and Landau theory will be studied. Introductory nonequilibrium theory is also another topic to be discussed in the course.

· **Mathematical Physics (3)**

Firm knowledge of mathematics is very important in the study of the physics since many theoretical works on physics are expressed in mathematical equations, graphs, and mathematical models. This course is to provide the basic background and skills in mathematical physics which is needed for the further study and research in physics. The scope of the course will include Ordinary Differential Equation, Complex Variable, Calculus of Variation, Numerical Method, etc.

· **Computational Physics (3)**

The course presents the computational techniques and software development skills. Also, the students will learn network and software development tools including parallel batch processing systems, code management systems, debuggers and optimizers, auto documentation generators, and web utilities. Computational Physics is closely related to the success of the modern computational material physics.

· **Semiconductor Physics (3)**

Semiconductor is very essential to the success of the modern solid state electronic devices including integrated circuits, transistors, diodes, LEDs, etc. The physical properties of the semiconductors are subjects of study in Semiconductor Physics course. Since semiconductor is also a solid state material with well defined crystal structure, basic knowledge of solid state physics is required. The scope of the course will include lattice vibration, band structure and conductivity of semiconductor, etc.

· **Advanced Semiconductor Physics (3)**

Advanced Semiconductor Physics course is for the students who have graduate level knowledge on the semiconductor physics. The topics covered in the course are interface of semiconductor, optical absorption, semiconductor laser, amorphous semiconductor and doping effect. Forefront research topics and issues of the semiconductor physics will be also discussed in the course.

· **Magnetism (3)**

This course begins with the basic concept of magnetism. Topics of this course covers diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, Curie-Weiss law, Zener's super exchange model, Anderson's double exchange model and application to oxide materials. Basic of magnetic spectroscopy with neutron and

X-ray is also presented. Prerequisite for this course is undergraduate course of solid state physics.

· **Quantum Optics (3)**

This course begins with basic tools of quantum optics such as Atom-field interaction.

· **Topic in Solid State Physics (3)**

This is a special course on solid state physics. Rather than discussing the general theories of solid state physics, this course focuses on topics in solid state physics, which are not covered in regular courses on solid state physics. This course also discusses the advanced topics on modern solid state physics theories and experiments with emphasis on mesoscopic and microscopic systems.

· **Topic in Semiconductor (3)**

This is a special course on the physics of semiconductor and semiconducting materials. Rather than introducing the general theories of semiconductor, this course focuses on topics in semiconductor, which are not covered in regular courses on semiconductor. This course also discusses the advanced topics on modern physics of semiconductor and semiconducting materials with emphasis on applications in the field of nanotechnology.

· **Seminar in Solid State Physics (3)**

This course consists of a series of weekly presentations of current research topics in solid state physics. This course is designed to expose students to the topics and excitement of the research frontier. Each lecture will be given by a different researcher who will describe his/her field and his/her own work. Also each student will be given a chance to present a research paper related to solid state physics.

· **Applied Optics (3)**

This course is intended to serve as a graduate level introductory course on optics. This course focuses on introducing general theories of optics such as geometric and physical optics, aberrations, optical instrumentation, interference, and polarization in optics. In addition, brief description of current researches in optics and their applications in modern technologies will be presented.

· **Advanced Applied Optics (3)**

This course is intended to serve as a graduate level advanced course on optics. Based on general theories of optics such as geometric and physical optics, aberrations, optical instrumentation, interference, and polarization in optics, this course will discuss the advanced topics in optics research. Also, this course will present applications of optics in the fields of nanotechnology and biotechnology.

· **Quantum Solid State Physics (3)**

This is an advanced course on solid state physics. This course is intended for students, who are planning to research in the field of both theoretical and experimental solid state physics. Especially this course focuses on the quantum theories of solid and reviews some of experiments in light of those. The topics include phonons, lattice specific heat, neutron scattering in solids, Landau diamagnetism, de Hass Alphen effect, and energy band theory.

· **Topic in Optics (3)**

This is a special course on optics. Rather than introducing the general theories of optics, this course focuses on topics in optics, which are not covered in regular courses on optics. This course also discusses the advanced research topics on current theories and experiments in the field of optics, with emphasis on their applications in modern technologies.

· **Research in Plasma (3)**

This course presents the current topics in physics of plasma. This course introduces current theories in the field of plasma and offers chances to review some of experiments. This course is intended for a small group of students involved in plasma research projects to discuss the current topics in plasma physics, which are actively pursed in the field of plasma research and their applications.

· **Seminar in Optics (3)**

A series of weekly presentations of current research topics in optics. This course is designed to expose students to the topics and excitement of the research frontier. Each lecture will be given by a different research who will describe his/her field and his/her own work and each lecture will be processed by seminar and discussion on current special topics.

· **Seminar in Nano Solid Spectroscopy (3)**

This course will introduce emerging nano materials and structures as well as measurement and spectroscopy techniques in sub-micron region.

· **Quantum computing (3)**

We learn quantum technologies combined with the principles of quantum mechanics in the quantum computer invented on the basis of quantum physics. We understand fundamental concepts such as quantum bits(qubits), quantum universal gates, quantum algorithms, and underlying technologies for quantum computers currently being implemented.

· **Quantum Device and Instrumentation (3)**

Quantum physics-based device and measurement techniques can significantly improve sensitivity and resolution in information gathering. In this course, students learn single photon source and single photon detector technologies for various quantum sensors and quantum imaging, which are emerging as the necessary element technologies in quantum technology development.

· **Independent Study (3)**

Students can carry out the independent research projects of interest under the supervision of faculty members.

☐ Faculty Members

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