Physics

Objective: The main goal of the study of physics is to cultivate creativity, adaptability, and responsibility in scientifically talented individuals through the study of the laws of nature and the physical properties of matter. This goal is achieved both through the study of elementary principles and by learning about the accomplishments at the cutting edge of science. Students also learn about cultural aspects of physics and how it has contributed to the improvement of society. Our department provides a balanced curriculum, superior faculty, creative teaching methods, and appropriate student counseling.

Major:

(1) Total credits:
- Multiple majors and single major students: minimum of 48 credits
- Teacher training program: minimum of 51 credits

(2) Required courses: PHY2001, 2003-2005, 2009, 2101, 2102, 3001-3004, 3101, 3102 (total 35 cr.)

(3) Students also need a minimum of 13 credits from among these courses: PHY2002, 2006-2008, 4001-4013, 4015-4017, 4019, 4101, 4202, G001, G003. Students in the teacher-training program need a minimum of 16 credits including EDUS981, S982, S983(9 credits).

(4) Major prerequisites:
In order to declare physics as their major, students must take a minimum of 16 credits from the following prerequisites. (Note: These do not count as major courses.)

PHY1001, 1002, 1101, 1102	8 cr.
Select one from	
(CHM1001, 1002, 1051, 1052), or	
(BIO1101, 1102, 1105, 1106)	8 cr.
	16 cr.

(5) Senior students planning to do graduate work at Sogang University can take the elementary graduate courses PHYG001, PHYG003 with the consent of their advisor.

(6) Specialized research PHY4201, physics patents and technological transfer PHY4203, and graduation project PHY4204 are selective courses and they are not required in major credits but required in graduation credits.

(7) PHY4201 and PHY4204 cannot be taken at the same time in the same semester.

(8) PHY4203 cannot be overlapped with other department's patents and technological transfer(chemistry CHM4203 and biology BIO3204) course.

* In case that the students with different major from class of 2006 major in multiple majors with physics, Differential and Integral Calculus I and Differential and Integral Calculus II need to be completed additionally.

Course Completion Roadmap

Acad. Year	1st Semester		2nd Semester	
1	ETS2001-2004	3	COR1001	2
	(choose one)		COR1003	3
	STS2005	3	CHS2001-2004, 2009	3
	PHY1001	1	(choose one)	
	PHY1101	3	STS2006	3
	Select 1 from:	4	PHY1002	1
	CHM1001,1051 or		PHY1102	3
	BIO1101,1105		Select 1 from:	4
	Total	**19**	CHM1002,1052 or	
			BIO1102,1106	
			Total	**19**
2	HFS2001-2003	3	SHS2001-2007	3
	(choose one)		(choose one)	
	PHY2001	3		
	PHY2003	3	PHY2004	
	PHY2005	3	PHY2009	3
	PHY2101	2	PHY2102	3
	Electives	5	Electives	2
	Total	**19**	**Total**	8
				19
Year 3	PHY3001	3	PHY3002	3
	PHY3003	3	PHY3004	3
	PHY3101	2	PHY102	2
	Electives	11	Electives	11
	Total	**19**	**Total**	**19**
Year 4	Electives	19	Electives	19

Notes.: Electives : Major requirements, Core requirements, Free requirements.

PHY1001 General Physics I 3 cr.
(lect.: 3hr)
This course looks into basic concepts of mechanics, including displacement, velocity, and acceleration, which are described in terms of vector calculus. Linear and angular momentum, energy, and their conservation laws are studied, as well as inverse-square laws and point particle mechanics.

PHY1002 General Physics II 3 cr.
(lect.: 3hr)
A study of the basic concepts of electromagnetism, including electrostatics, electric currents, electric fields of moving charges, magnetic fields, and optics.

PHY1101 General Physics I Laboratory 1 cr.
(lab.: 2hr)
Experiments in: probability/error analysis, gravitational acceleration, momentum and energy conservation, equilibrium of forces, heat capacity, material property, and waves.

PHY1102 General Physics Laboratory II 1 cr.
(lab.: 2hr)
Basic experiments on optics in the following areas: geometric optics, reflection and refraction of light, total reflection and dispersion, color of light, polarization, slits, mirrors, and aberration.

PHY2001 Mechanics I 3 cr.
(lect.: 3hr)
A survey of matrices, vector calculus, Newton's laws of motion, reference frames, conservation laws, gravitational potential energy, Newtonian limits, simple harmonic oscillators, damped and forced oscillation, the Laplace transform, nonlinear oscillation, calculus of variations, Euler equations, and Hamilton's principle.

PHY2002 Mechanics II 3 cr.
(lect.: 3hr)
A study of special relativity and collision theory, as well as Lagrangian and Hamiltonian mechanics, their associated conservation laws, and their generalizations to wave phenomena.

PHY2003 Electromagnetism I 3 cr.
(lect.: 3hr)
A survey of Coulomb's law, Gauss's law, conservativeness of electrostatic force, electric potential energy, Laplace's equation and its solution, electric properties of conductors, electric properties of dielectrics, the relationship between currents and magnetism, magnetic field of solenoid, magnetic dipoles, and magnetic properties of matter (This course can also be taken as EEE2101 Electromagnetic Field Theory I, but can only be accepted for credit once.).

PHY2004 Electromagnetism II 3 cr.
(lect.: 3hr)
A study of Maxwell's equations, wave equations, properties of electromagnetic waves, refraction of light on surfaces, computation of absorption and transmission coefficients, interference of light, analysis of the Fabry-Perot interferometer, generation of electromagnetic waves, Green's function, derivation of the Leonard-Jones potential, and the Lorentz transformation of electro-magnetic fields (This course can also be taken as EEE2102 Electromagnetic Field Theory II, but can only be accepted for credit once.).

PHY2005 Mathematical Physics I 3 cr.
(lect.: 3hr)
This course focuses on infinite series, convergence and divergence of series, power series, complex numbers, Euler's formula, matrices, partial derivative, the Leibniz formula, multiple integrals, the Jacobian, vector calculus, divergence/ Stokes's theorem, the Fourier series, complex forms of the Fourier series, and ordinary differential equations.

PHY2006 Mathematical Physics II 3 cr.
(lect.: 3hr)
A study of Euler equations, the calculus of variations, eigenvalues and eigenvectors, tensor analysis, dyadics, gamma and beta functions, elliptic integrals, Legendre equation/polynomials, Bessel functions, the Laguerre function, Laplace's equation, Poisson's equation, contour integrals, the residue theorem, conformal transformation, Laplace transform, Fourier transform, the Dirac delta function, Green's function, and probability theory.

PHY2007 Physical Electronics I 2 cr.
(lect.: 2hr)
An analysis of DC and AC circuits using Kirchhoff's first and second laws, band theory of semiconductors, impurities and generation of holes, junction characteristics between p- and n-type semiconductors, characteristics of diode and transistors, and transistor amplification circuit and its applications.

PHY2008 Physical Electronics II 3 cr.
(lect.: 2hr and lab.: 2hr)
A study, including experimentation, of the characteristics and applications of operational amplifiers, characteristics of NOT, OR, AND logic devices, design of logic circuits, and the principles of analog/digital and digital/analog conversion.

PHY2009 Modern Physics 3 cr.
(lect.: 3hr)
A study of special relativity, Doppler energy, mass and binding energy, charge, light, quantization of energy, atoms, the nucleus, the duality of particles and waves,

the Schrodinger equation, eigenvalues and eigenfunctions, angular momentum, the hydrogen atom, the Zeeman effect, and energy levels of molecules and their spectra.

PHY2101 Physical Laboratory I 2 cr.
(lab.: 4hr.)

Students develop an understanding of Ohm's law through measurements of current, voltage, and resistance. Also, students examine electrical damped oscillation and resonance, and observe the motion of electrons inside a cathode-ray tube using an oscilloscope.

PHY2102 Physical Laboratory II 2 cr.
(lab.: 4hr)

Students set up AC circuits composed of resistance, capacitors, and coils, and measure their voltage and currents in order to learn about Fourier analysis of waves, multiple joint resonance, beats, and dispersion effects. Also includes fabrication of resonators and current amplifiers based on the measurement of transistor characteristics.

PHY3001 Quantum Physics I 3 cr.
(lect.: 3hr)

A study of black body radiation, the photoelectric effect, the Bohr model, harmonic oscillators, Compton scattering, the Fourier transform, wave packets, the Schrödinger equation, expectation values, the uncertainty principle, the superposition principle, motion of wave packets, step potential, well potential, orthogonality, WKB approximation, operators, and eigenfunctions.

PHY3002 Quantum Physics II 3 cr.
(lect..: 3hr., prereq.: PHY3001)

Schrödinger equation with spherical symmetry, harmonic functions, angular momentum, hydrogen atom, plane waves, partial waves, the Green function, the Born approximation, matrix mechanics, Hilbert space, spin, the Zeeman effect, selection rule, time-independent perturbation, time-dependent perturbation, identical particles, and Helium atoms.

PHY3003 Thermodynamics 3 cr.
(lect.: 3hr)

A survey of temperature, specific heat, thermal expansion and conduction, ideal gas, van der Waals gas, equation of states, the first and the second laws of thermodynamics, the Carnot cycle, thermodynamic functions, the Maxwell relation and phase transition, velocity distribution, the equipartition principle, Bose-Einstein, Fermi-Dirac, Maxwell-Boltzman distributions, partition functions, and statistical definition of entropy and its computation.

PHY3004 Statistical Physics 3 cr.
(lect: 3hr., prereq.: PHY3003)

A study of thermal equilibrium, thermodynamic functions, probability theory, partition function, microscopic and macroscopic theory, canonical distribution and average values, classical and quantum statistics of point particles, kinetic theory of ideal gases, and the application of quantum statistics.

PHY3101 Physics Laboratory III 2 cr.
(lab.: 4hr, prereq.: PHY2101, 2102)

This lab focuses on measuring electric charges and finding charge-to-mass ratios, the photoelectric effect and measuring the Planck constant, and measuring the electric charge from the motion of charged oil drops. Students also study the Hall effect, the Faraday effect, the speed of sound in air and through solids, electric conductivity of metal and semiconductors, and the permittivity of dielectric materials.

PHY3102 Physics Laboratory IV 2 cr.
(lab.: 4hr.)

Students study vacuum evaporation and fabricate electronic circuits such as amplifiers using linear IC, measure the optical constants of solids, X-ray diffraction of single crystals, and examine spectrum measurements.

PHY4001 Solid State Physics I 3 cr.
(lect.: 3hr)

A study of the stability of solids, liquids, gases, and non-crystalline phases,

point group of single crystal, the Bravais lattice, reciprocal lattices, determination of crystal structure by X-ray, electron, and neutron scattering; ionic and covalent bonds, lattice waves, phonons, Brillouin and Raman scattering, periodic boundary conditions, density of states, Debye and Einstein models, the specific heat of solids, thermal expansion, thermal conductivity, energy band theory, the Hall effect, and cyclotron resonance.

PHY4002 Solid State Physics II 3 cr.
(lect.: 3hr., prereq.: PHY4001)
A survey of energy band and semiconductor band gaps, Fermi energy, concentration of electrons and holes, donors and acceptors, mobility, the Hall effect, the Gunn effect, p-n junctions, diode semiconductor lasers, dipoles in dielectrics, polarizability of ions and electrons, piezoelectric effect, ferroelectric effect, Langevin diamagnetism, ferromagnetism, magnetic domain, nuclear magnetic resonance, spin waves, superconductors, the Meissner effect, critical magnetic field, the London theory, BCS theory, and the Josephson effect.

PHY4003 Modern Optics I 3 cr.
(lect.: 3hr)
A study of the propagation of light, light as an electromagnetic wave, the Poynting vector, the Jones matrix, inter- ference, amplitudes, Fabry-Perot interferometer, transmission of light through multilayered thin films, diffraction, and Fraunhofer and Fresnel diffraction.

PHY4004 Modern Optics II 3 cr.
(lect.: 3hr)
Students study the propagation of light in solids, isotropic dielectrics, Faraday rotation, blackbody radiation, quantum nature of light, momentum and energy of photons, photonic pressure, induced emission and spontaneous transition, photo resonators, lasers, dye lasers, gas lasers, ring lasers, and nonlinear optics.

PHY4005 Particle Physics I 3 cr.
(lect.: 3hr)
A study of the Lagrangian, scalars, Noether's theorem, gauge invariance, non-abelian gauge theory, the Dirac equation, the Dirac Lagrangian, quarks and leptons, the standard model Lagrangian, continuous and discrete symmetries, the quark QCD Lagrangian, spontaneous symmetry breaking, the Abelian Higgs mechanism, the Higgs mechanism in the standard model, the mass of fermions, and vacuum energy.

PHY4006 Particle Physics II 3 cr.
(lect. 3hr; prereq.: PHY4005)
A survey of the scattering cross-section, decay amplitude, lifetime of elementary particles, scattering branching ratio, muon decay, accelerators, detectors, mesons, baryons, quarks, structure function, the parton model, coupling constants, the Higgs boson, CP violation, the grand unified theory, proton decay, supersymmetry, neutrinos, and Lie groups.

PHY4007 Computational Physics I 3 cr.
(lect.: 2hr and lab.: 2hr)
A study of the basic principle of numerical analysis, Runge-Kutta methods, realization of algorithms for PC and mainframes, numerical approaches to physics problems, and programming techniques.

PHY4008 Computational Physics II 3 cr.
(lect.: 2hr and lab.: 2hr)
A study of digital circuits, advanced programming languages, logical operation languages, and the artificial intelligence language LISP. Also covers the application of a programming language to an interface and the real-time computer control of external experimental devices.

PHY4009 Semiconductor Physics 3 cr.
(lect.: 3hr)
A study of energy-band theory, statistics of charge carriers, generation and recombination processes, carrier transport, and their applications to electronic and optoelectronic devices.

PHY4010 Astrophysics I **3 cr.**
(lect.: 3hr)
A survey of the basics of astronomy, the motion of celestial bodies in the celestial sphere, celestial mechanics, and the quantum theory of light.

PHY4011 Astrophysics II **3 cr.**
(lect.: 3hr)
A continuation of PHY4010, this class further studies the astronomy of star systems, stars, galaxies, and the cosmos.

PHY4012 Nanophysics **3 cr.**
(lect.: 3hr)
A study of the operation of nanostructured devices, analysis methods, optical characteristics, and current research trends.

PHY4013 Biophysics **3 cr.**
(lect.: 3hr)
This course is a study of the basics of biology, a review of thermal and statistical physics, reaction theory, fluorescence spectroscopy, mass spectrometers, electrolytes, and single molecule fluorescence spectroscopy such as APM, PRET, and PCS.

PHY4015 Medical Physics **3 cr.**
(lect.: 3hr)
A survey of Newton's laws of motion, waves, thermal phenomena, bioelectric phenomena, geometric optics, vision, and nuclear physics with a focus on radioactivity.

PHY4016 Display Physics **3 cr.**
(lect.: 3hr)
This course explores cathod-ray tubes, plasma displays, electrolum in escences/ VFD/LED/LCD, operation principles of organic transistors, OLED, and human technology.

PHY4017 Atomic Physics **3 cr.**
(lect.: 3hr)
A study of atomic mass, the periodic table, the Boltzman distribution law, charges, isotopes, wave and particle duality, black body radiation, the photoelectric effect, Rutherford scattering, the Bohr model, Compton scattering, the uncertainty principle, the Schrödinger equation, the structure of hydrogen and helium atoms, spectroscopy, the structure of molecules, semiconductors, classical statistics, quantum statistics, and band theory.

PHY4019 Spectroscopy **3 cr.**
(lect.: 2hr and lab.: 2hr)
Students explore the structure of the hydrogen atom, spin, the Pauli principle, shell structure, the Zeeman and Stark effect, black-body radiation, absorption spectroscopy, UV-IR detectors, collision, radiative broadening, selection rules, and the molecular spectroscopy of molecular rotation and vibration.

PHY4101 Advanced Physics Experiment **2 cr.**
(lab.: 4hr)
Advanced experimental studies in various fields of physics.

PHY4201 Research Project **3 cr.**
Independent study, research, and thesis writing under the supervision of an instructor (in the fourth year).

PHY4202 Current Topics in Physics **3 cr.**
(lect.: 3hr)
Introduction to current research topics.

PHY4203 Physics Patent and Technology Transfer 1 Credit
This course covers the process required to make useful research result of physics intellectual property rights(IPR) and related contents. To do so, this course helps students learn the importance of IPR, process to create the rights and the contents of technology transfer through the cases in the present system. (The courses of biology BIO4203 and chemistry CHM4203 cannot be overlapped in taking)

PHY4204 Project for Graduation 3 Credits
This is the course for the students in the graduating class and based on the education course for physics major, students conduct the research project and present its result after designing under the guidance of academic advisors.

PHYG001 Classical Physics I 3 cr.
(lect.: 3hr)
A study of the Lagrange equation, eigenvalues, integral equations, the Hamilton equation of motion, canonical transformation, the Hamilton-Jacobi theory, and the boundary value problem of electrostatics.

PHYG003 Statistical Mechanics 3 cr.
(lect.: 3hr)
A study of ensemble theory, micro and grand canonical ensembles, quantum statistics, the Debye theory of specific heat, non-ideal gases, ferromagnetism, phase transition, and critical phenomena.

<Teacher training program>

EDUS981 Education Theory on Science Course 3 Credit
This course takes a look at various theories and views for the goal, contents, method and evaluation of physics course and analyzes concretely the physics course in the middle and high schools.

EDUS982 Logics and Essay on Science Course 3 Credits
This course helps students improve the thoughts and the ability to teach essay with the contents and principles of physics or science based on the overall understanding of the structure and nature of physics course.

EDUS983 Study and Teaching Method of Science Course Textbook
This course helps students improve the ability to practice the teaching of physics course through understanding the systematic analysis on physics course and textbook in the middle and high schools and the theory and practice of physics teaching method.