Physics

[C] = Compulsory [S] = Selective

Semester 1

[C] Mathematical Analysis (A) I

Credits: 5 Class Hours: 112

The basic content of this course contains: Limits and Continuity, Single Variable Differential Calculus, Single Variable Integral Calculus, Multivariable Differential Calculus, Multivariable Integral Calculus, Theory of Series, Improper Integral and Integral Cosine Depending on a Parameter.

This course not only enable students to gradually acquire the abstract general conclusion, relevant concept, basic theory and method, but also cultivate students' systematic, rigorous abstract logical thinking and verification ability, scientific and standardized expression ability. In order to make them master the ideology and method of utilizing mathematical tools to analyze problems, transform problem and solve problem.

[C] Introduction to Physics (A) I

Credits: 5 Class Hours: 96

An introductory Physics course usually covers Mechanics, Thermal Physics, Electricity and Magnetism, Optics, and Modern Physics. Typically it takes two years to go through these subjects. We, on the other hand, will have only one year to cover all this material. A great challenge before us is to master the material in a short period of time, and do it well. Another challenge is that this class consists of students with intention of pursuing rather different majors - mathematics, physics, and life sciences. The preparations and backgrounds are also very different. To address this challenge, we will focus on the most fundamental aspects of physics, emphasizing concepts and general approaches.

[C] Introduction to Computer Science

Credits: 3 Class Hours: 48

This course has two parts: theory and technology. The first part introduces the content and influence of mathematical foundation applied in computer science. The second part introduces important foundation and technology of computer science with ample evidence. This course emphasizes the most important basic knowledge and technology in the field of computer science to make students have a broader understanding. This course also contains a practical operation.

[C] Introduction to Biology I

Credits: 4 Class Hours: 64

This course is an introduction of the Basic Principles of Modern Biology. It will introduce biochemistry, Molecular and Cell Biology, and Genetics and Development Biology. The purpose of this course is not only clarifies the important basic principles, meanwhile, discusses the discovery process and experimental methods, as well as introduces the methods of Applied Statistics, Mathematics and Computer Science to research complex biological system. The course is also suitable for those students majoring in Mathematics and Physics who have interest in basic biology knowledge of molecular and cellular.

[C] Chemical Principles

Credits: 4 Class Hours: 64

Chemical Principles is the foundation course for Zhiyuan Students. The course is about the basic principles of physical chemistry widely applied in the field of Chemistry, and the course is prerequisite of all subsequent chemistry courses (Inorganic Chemistry, Organic Chemistry, Physical Chemistry, and Analytical Chemistry and Chemical Engineering Elective Courses). It includes Atomic Molecular Electronic Structure, Molecular Structure, Molecular Interaction, the Basic Properties of Gas Liquid Solid (Crystal), the Three Laws of Thermodynamics, Thermodynamic Equilibrium and Reaction Kinetics.

[C] Introduction to Physics Laboratory

Credits: 2 Class Hours: 32

This is the first lab course for physics major at SJTU. The lab covers some basic experiments in mechanics, E&M, and optics & wave. The main purpose of this course is not to gain theoretical understanding in these topics, but rather to provide students hand-on experience working with basic lab equipment, and guide them to think how to design scientific experiments. Students will also learn basic data analysis techniques in this course.

[C] Introduction to Physics Research I

Credits: 2 Class Hours: 32

This is a freshman physics course which covers selected modern physics research topics. I will use a recent paper on direct dark matter search as the basis of all lecture discussion. The discussion topics touch upon the astronomy, particle physics, solid state physics, and particle experimental methods. The main goal is to inspire the students with cutting edge problems, and be prepared to start a research project early in their college years (without learning too much advanced physics course). I will use class discussion and homework assignment to invoke independent thinking and group discussions.

Semester 2

[C] Linear Algebra

Credits: 4 Class Hours: 64

This course is for physics major, including the basic content of linear algebra. Students will acquire the basic theory, ideas and methods of linear algebra and the polynomial. In addition, it helps improve students' ability of calculation and abstract thinking.

[C] Mathematical Analysis (A) II

Credits: 5 Class Hours: 112

The basic content of this course contains: Number Entries, Series of Functions, Multivariable Differential Calculus, Multivariable Function Integral Calculus, Integral Depending on a Parameter, Fourier Series.

This course not only enable students to gradually acquire the abstract general conclusion, relevant concept, basic theory and method, but also cultivate students' systematic, rigorous abstract logical thinking and verification ability, scientific and standardized expression ability. In order to make them master the ideology and method of utilizing mathematical tools to analyze problems, transform problem and solve problem.

[C] Introduction to Physics (A) II

Credits: 5 Class Hours: 96

The course is designed for two semesters. Introduction to Physics I covers the core content of classical mechanics, hydrodynamics and thermal physics. Introduction to Physics II covers the core content of electromagnetism, physical optics and modern physics. The course also introduces a considerable number of expansion of the content. In the teaching process, it cover the classical, highlight the characteristics and key points, etc. Each chapter includes the basic content, reading materials, exercises and small paper, etc. In the teaching process, it try to express the content clearly in appropriate difficulty, and attractively, with particular attention to the application of physical principles and physical ideas in practice.
Through the course of study, the students can gradually grasp the ideas and methods of solving problems by physics. They can not only acquire the knowledge, but also their ability to establish physical model, and the capacity of calculation and estimation of quantitative analysis and qualitative analysis, and the ability to obtain knowledge independently, the ability of linking theory to practice can be synchronously improved and developed. Students can open their thinking, inspire their spirit of exploration and innovation, enhance their adaptability, enhance their quality of science and technology. Through the course of the study, to enable students to master the scientific learning method and form good learning habits, form the dialectical-materialism-theory-formation world outlook and the methodology.

[C] Supplementary Physics

Credits: 2 Class Hours: 32

[C] Physics Experiment I

Credits: 2 Class Hours: 32

This is the second lab course for physics major at SJTU. The lab covers some basic experiments in mechanics, E&M, and optics & wave. The main purpose of this course is not to gain theoretical understanding in these topics, but rather to provide students hand-on experience working with basic lab equipment, and guide them to think how to design scientific experiments. Students will also learn basic data analysis techniques in this course.

[C] Introduction to Physics Research II

Credits: 2 Class Hours: 32

Semester 2.5 (Summer Semester)

[S] Application of Simulation Software

Credits: 2 Class Hours: 32

With the rapid development of the computer, there are a large number of applications in the Physics using computer to aid calculation and data processing. It becomes one of the indispensable quality of people who carry out physics research to master the key computing software. This course focuses on the basic use of two commonly used computing software, Mathematica and Matlab, basic skills and. Course will be through examples, so that learners master how to find analytic and numerical solution of differential equations, code basic numerical simulation program, analysis data, draw graphics and animation. The course will lay the foundation for further grasping and making full use of this computing software.

[S] High Dimensional Statistical Inference

Credits: 2 Class Hours: 32

Semester 3

[C] Mathematical Methods in Physics I

Credits: 4 Class Hours: 64

Modeling the world in terms of ordinary and partial differential equations, solving these equations and interpreting the solutions are fundamentally important for physicists. The course “Methods of Mathematical Physics” for second-year undergraduate students is designed to make students familiar with the basic methods to solve ordinary differential equations and partial differential equations with typical boundary value problems. Topics include: the general theory of ODEs and common methods for solving these equations, series methods to solve linear ODEs with constant and non-constant coefficients; special functions: Gamma function, beta function, hypergeometric functions, Bessel’s functions and Legendre polynomials; Fourier series; solutions of PDE’s in rectangular, cylindrical, and spherical coordinates by means of eigenfunction-expansion method, Fourier-transform method, Green’s function method, conformal transformation method, etc.

[C] Mathematical Methods in Physics II

Credits: 4 Class Hours: 64

Mathematical Physics (2) is a core course required for undergraduate students in the Physics Class of Zhiyuan College at Shanghai Jiao Tong University. The course covers several topics, including complex functions and applications, integral transforms, calculus of variations, conformal mapping and its applications, probability theory and statistical methods. The primary objective is to develop those parts of the mathematical methods that are essential to students majored in physics. After taking this mathematical physics course, students will have a solid foundation of mathematics and problem-solving skills, which form a solid foundation for the up-coming physics courses.

[C] Analytical Mechanics

Credits: 4 Class Hours: 64

This course is the fundamental one in theoretical physics. It will build on concepts that you have been exposed to in General Physics, but with more mathematical sophistication. It will also serve as a bridge to prepare you with the problem solving skills that you will need for senior level classes. This course will focus on teaching the Lagrangian and Hamiltonian treatment of mechanics. While these new treatments give the same results as Newtonian mechanics, they provide better ways to both arrive at these solutions and to see how conservation laws connect to symmetries. They also provide a connection to the foundations of Quantum Mechanics and Statistical Mechanics.

[C] Physics Experiment II

Credits: 3 Class Hours: 48

[C] Physics Research Practice I

Credits: 1 Class Hours: 16

Physics Research Practice I, II, III and IV are compulsory courses for undergraduates, which covering four semesters from the third semester to the sixth semester. Student can get 4 credits in total with one credit for each semester. This course aims to encourage innovation and train students' research ability in physics field.

In this course, students can join the research groups by their preference as long as they get approval from teachers in the Department of Physics and Astronomy or Institute of Natural Sciences. Before the end of the semester, students are required to hand in research practice reports and comments from teachers in research groups.

Students are suggested to join two to three research groups to study and practice to broaden their horizon, gain more information about the cutting-edge theory and practice of Physics, further cultivate and confirm their research interests. Students can choose a group to continue scientific practical training after accumulation of research results and practice experience.

During the course, students can also do scientific research by individual or groups. Report presentation will be arranged during the semesters. The score of Physics Research Practice is categorized into the levels of A，B，C，D and F.

Semester 4

[C] Quantum Mechanics I

Credits: 4　　Class Hours: 64

This course introduces the basic concept of quantum mechanics, and students will acquire the ability to explain the basic phenomenon inside the atom and molecules through quantum mechanics.

[C] Electrodynamics

Credits: 4　　Class Hours: 64

Electrodynamics, together with classical and quantum mechanics, statistical physics, forms the core of present day theoretical training for undergraduate and graduate physicists. A thorough grounding in these subjects is a requirement for more advanced or specialized studies. The undergraduate program in electrodynamics begins in eletrostatics and we focus on the discussion of the boundary value problems and generalize the description from initially the electric field E and the magnetic field B to macroscopic quantities, D and H. Furthermore we discuss the macroscopic electromagnetic phenomena, especially the dispersion and the propagation of the plane wave in different media. In addition, we discuss the elementary theory of multipole radiation from a localized source. Considering that the special theory of relativity had its origins in classical electrodynamics, in the end of the course we introduce the special theory of relativity. It is interesting that classical electrodynamics still impresses and delights as a beautiful example of the covariance of physical laws under Lorentz transformations.

[C] Physics Experiment III

Credits: 3　　Class Hours: 48

Contemporary Physics Experiment is another fundamental experiment course of technique after General Physics Experiment. The course covers a wide range of physics knowledge，which is quite comprehensive and technical.

Contemporary Physics Experiments can enrich and inspire student’s ideas about physics, cultivate their ability to observe and analyze physical phenomena, instruct them to learn about the role of generating, forming and developing of experimental physics in physics concepts, comprehend common methods, technology, apparatus and knowledge of contemporary Physics, further cultivate their accurate experimental habit and rigorous science quality to help build a solid foundation for mastering, applying and development new technologies of Physics Experiments.

[C] Physics Research Practice II

Credits: 1 Class Hours: 16

Physics Research Practice I, II, III and IV are compulsory courses for undergraduates, which covering four semesters from the third semester to the sixth semester. Student can get 4 credits in total with one credit for each semester. This course aims to encourage innovation and train students' research ability in physics field.

In this course, students can join the research groups by their preference as long as they get approval from teachers in the Department of Physics and Astronomy or Institute of Natural Sciences. Before the end of the semester, students are required to hand in research practice reports and comments from teachers in research groups.

Students are suggested to join two to three research groups to study and practice to broaden their horizon, gain more information about the cutting-edge theory and practice of Physics, further cultivate and confirm their research interests. Students can choose a group to continue scientific practical training after accumulation of research results and practice experience.

During the course, students can also do scientific research by individual or groups. Report presentation will be arranged during the semesters. The score of Physics Research Practice is categorized into the levels of A，B，C，D and F.

[S] Selected Topics in Scientific Computing

Credits: 3 Class Hours: 48

This course is designed for sophomore undergraduate Physics students to prepare with selected but fundamental topics in scientific computing. Topics of the course include numerical linear algebra, solution of nonlinear equation(s), polynomial interpolation, function approximation, function differentiation, evaluation of integrals as well as numerical ordinary differential equations. This course contains intensive homework problems and projects from computational physics and physical applications. Numerical experiments and computer implementation play a key role for the students to get a systematic training through this course. The students should be experienced with at least one computer programming language such as C, C++ or MatLab.

Semester 4.5 (Summer Semester)

[S] An Overview of the Physics and Applications of Modern Nanoscience and Technology

Credits: 1 Class Hours: 16

Semester 5

[C] Quantum Mechanics II

Credits: 4 Class Hours: 64

This is the second part of Quantum Mechanics, for the students who have successfully completed the first part. They should have the previous knowledge about the examples for solving the Schroedinger Equation. In the second part, the approximation methods will be the major topic, which includes the following chapters: Time-independent perturbation theory, the variational principle, the WKB approximation, time-dependent perturbation theory, the adiabatic approximation, and scattering. The class uses the textbook by David J. Griffiths, Introduction to Quantum Mechanics. Prentice-Hall, 2005.

[C] Thermodynamics and Statistical Physics

Credits: 4 Class Hours: 64

[S] Ordinary Differential Equations and Dynamic System

Credits: 3 Class Hours: 48

The course is one of the basic major courses for undergraduate students of mathematical department. The theory and methods in this course can be applied to the other disciplines such as mechanical, engineering, economics and so on. This course will focus on the basic concepts and fundamental theory of ordinary differential equations, qualitative analysis and solving methods, mathematical modeling and their calculation. And it will train think manner such as qualitative and quantitative manner, geometry and analysis ways, etc. As a consequence, the audiences for the course can be expected to correctly understand the concepts and basic theory of ordinary differential equations, preliminary understand some knowledge of dynamical system, master the method for solving ordinary differential equations, and deal with some practical problem by these knowledge.

[C] Physics Research Practice III

Credits: 1 Class Hours: 16

Physics Research Practice I, II, III and IV are compulsory courses for undergraduates, which covering four semesters from the third semester to the sixth semester. Student can get 4 credits in total with one credit for each semester. This course aims to encourage innovation and train students' research ability in physics field.

In this course, students can join the research groups by their preference as long as they get approval from teachers in the Department of Physics and Astronomy or Institute of Natural Sciences. Before the end of the semester, students are required to hand in research practice reports and comments from teachers in research groups.

Students are suggested to join two to three research groups to study and practice to broaden their horizon, gain more information about the cutting-edge theory and practice of Physics,

further cultivate and confirm their research interests. Students can choose a group to continue scientific practical training after accumulation of research results and practice experience.

During the course, students can also do scientific research by individual or groups. Report presentation will be arranged during the semesters. The score of Physics Research Practice is categorized into the levels of A，B，C，D and F.

[S] Laser Plasma Physics

Credits: 2 Class Hours: 32

Through this course, the students can grasp the basics of laser plasma physics, know the developing history and trends of this field, and lay foundation for graduate study in this area, while grasping general methods and basic skills to do scientific researches.

Main content includes: Basics and cutting-edge studies in Ultra-short ultra-intense laser pulse, laser-plasma interaction and its application in acceleration of charged particles and radiation source, basic principles and research development in laser fusion.

[C] Thermodynamics and Statistical Physics

Credits: 4 Class Hours: 64

Statistical Mechanics is a probabilistic approach to equilibrium properties of large numbers of degrees of freedom. In this course, basic principles are examined.

Topics included: Thermodynamics, probability theory, classical statistical mechanics, interacting systems, quantum statistical mechanics, identical particles, and phase transitions.

Semester 6

[S] Condensed Matter Physics

Credits: 4 Class Hours: 64

[C] Professional Experiment

Credits:3 Class Hours: 48

[S] Quantum Optics

Credits: 4 Class Hours: 64

[S] Continuum Mechanics

Credits: 3 Class Hours: 48

Continuum physics describes the macroscopic physical world around us. The enormous progress of quantum physics in the 20th century has almost eliminated macroscopic phenomena from the core physics curriculum. Nonetheless, research in engineering, geophysics, and biology demands increased mastery of its methodology. The course aims to readdress the balance by offering a modern, unified introduction to the basic concepts and phenomenology of continuous macroscopic systems. It presupposes knowledge of Newtonian mechanics and differential equations with the equations of continuum mechanics derived from Newtonian particle mechanics. The basic concept is the concept of stress, valid for all continuous materials. The course proceeds along the two tracks, the two extremes in the world of continua: elastic solids and viscous (Newtonian) fluids. Emphasis is placed equally on intuition and formalism with the many examples from geophysics, astrophysics and other fields.

[C] Physics Research Practice IV

Credits: 1 Class Hours: 16

Physics Research Practice I, II, III and IV are compulsory courses for undergraduates, which covering four semesters from the third semester to the sixth semester. Student can get 4 credits in total with one credit for each semester. This course aims to encourage innovation and train students' research ability in physics field.

In this course, students can join the research groups by their preference as long as they get approval from teachers in the Department of Physics and Astronomy or Institute of Natural Sciences. Before the end of the semester, students are required to hand in research practice reports and comments from teachers in research groups.

Students are suggested to join two to three research groups to study and practice to broaden their horizon, gain more information about the cutting-edge theory and practice of Physics, further cultivate and confirm their research interests. Students can choose a group to continue scientific practical training after accumulation of research results and practice experience.

During the course, students can also do scientific research by individual or groups. Report presentation will be arranged during the semesters. The score of Physics Research Practice is categorized into the levels of A，B，C，D and F.

Semester 6.5 (Summer Semester)

[S] Biological Physics

Credits: 4 Class Hours: 64

The course aims to demonstrate the richness and complexity of the living cell by way of introducing basic phenomena of biological processes in cells. In demonstrating underlying unifying physical principles, the course will emphasize physical pictures and order-of-magnitude arguments for understanding properties of the living cell.

[S] Plasma Physics

Credits: 4 Class Hours: 64

Semester 7

[S] General Relativity

Credits: 3 Class Hours: 48

[S] Particle Physics and Field Theory

Credits: 4 Class Hours: 64

[S] Advanced Optics

Credits: 4 Class Hours: 64

[S] Seminars on Solid State Physics

Credits: 4 Class Hours: 64

[S] Semiconductor Physics

Credits: 3 Class Hours: 48

Semiconductor physics is a course that basic theory and practical application are closely related. This course will teach systematically the basic theory of semiconductor physics. The main content of the course includes the electronic states in semiconductor, impurity and defect levels, statistical distribution of carriers, conductivity of semiconductors, non-equilibrium carriers, p-n junction, and semiconductor photoelectric and magnetic effects. The goal is to make the students grasp the basic concepts, theories and methods of semiconductor physics, as well as the enhancement of the ability of solving practical problems.

[S] Theory of Laser

Credits: 3 Class Hours: 48

Semester 8

[C] Undergraduate Project (Thesis)

Credits: 6 Class Hours: 96