Mathematics

[C] = Compulsory [S] = Selective

Semester 1

[C] Mathematical Analysis I

Credits: 5 Class Hours: 112

Mathematical Analysis is the basic course of undergraduate students for the mathematical disciplines, usually including the Mathematical Analysis I, Mathematical Analysis II and Mathematical Analysis III. Mathematical Analysis I is the first stage of mathematical analysis, mainly introduces the theory of the limit, the real continuous theorem, the differential and integral calculus for function, Through the study of this course, we hope to cultivate students' scientific rigorous thinking habits and serious and meticulous work style, to lay a solid foundation for the follow-up courses in mathematics department.

[C] Linear Algebra

Credits: 5 Class Hours: 80

Linear Algebra is the most fundamental course of Mathematics as well as all the Science and Engineering undergraduate education. The basic content is Liner Space and Liner Transformation (Matrix), which applied extensively. In teaching basic theory, basic method, we also emphasize cultivation for students' Math literacy and Mathematical ability. We do hope students can obtain the beauty of mathematical theory and the fun from mathematical logical thinking, also, can acknowledge the course application in other disciplines and connection with follow-up courses. This course contains Polynomial, Determinant, Matrix, system of Linear Equation, Linear Space, Linear Transformation, Similar Standard and its application, Real Quadratic From, Real Inner Product Space, common decomposition of Matrix.

[C] Introduction to Physics 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.

Semester 2

[C] Mathematical Analysis II

Credits: 5 Class Hours: 112

Mathematical Analysis is the basic course of undergraduate students for the mathematical disciplines, usually including the Mathematical Analysis I, Mathematical Analysis II and Mathematical Analysis III. Mathematical Analysis II is the second stage of mathematical analysis, mainly introduces the convergence methods of improper integral, the theory of infinite series and the differential calculus for multiple variable functions. Through the study of this course, we hope to cultivate students' scientific rigorous thinking habits and serious and meticulous work style, to lay a solid foundation for the follow-up courses in mathematics department.

[C] Advanced Linear Algebra

Credits: 3 Class Hours: 48

Higher Algebra is a continuation of Linear Algebra. The main contents include: bilinear forms，real symmetric (and Hermite) matrices, inner product spaces, symplectic spaces, and affine and projective spaces and so on.

[C] Introduction to Physics 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] Numerical Analysis and Scientific Computing

Credits: 3 Class Hours: 48

This Course is to learn how to use computer to solve some mathematical problems. For example, how to find a curve that can fit best some discrete data, how to find the solution to an equation or a linear algebra system, how to calculate the integral and derivatives of some continuous functions and how to solve an ordinary differential equation by computer. All these problems are useful in engineering.

[C] Physics Laboratory I

Credits: 1.5 Class Hours: 26

The course is set up to make students hold the ideas, the fundamental principles and the basic methods of the physical experiments, and to teach students how to use the basic experimental instruments and apparatus and how to deal with the data. What’s more, the course is set up also to make students have the attitude of working hard and coming down to bedrock and have the hard-bitten style, and lastly to make students basically hold the ability to research.

[S] High Dimensional Statistical Inference

Credits: 2 Class Hours: 32

Semester 3

[C] Mathematical Analysis III

Credits: 4 Class Hours: 80

The Mathematical Analysis is a course for multiple variable calculus. The aim of the course is to let the students be familiar with the calculations in multidimensional spaces and their significance. The following topics will be covered:
(1) The representation and approximation of surfaces
(2) Multiple integrals
(3) Line integrals
(4) Surface integrals
(5) Mathematics for the fields
(6) The integrals with parameters

[C] Topic Course I

Credits: 1 Class Hours: 32

[C] 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] Complex Analysis

Credits: 4 Class Hours: 64

This course is an introduction to the theory of complex valued functions of a complex variable. Fundamental ideas and rigorous proofs will be emphasized. Students are expected to understand the classical theory of complex analysis from the analytic, algebraic and geometric point of view. The prerequisite of a course in mathematical analysis is essential. Some background in algebra and geometry is preferred.

[C] Physics Laboratory II

Credits: 1.5 Class Hours: 26

Through the learning of this course, students should review and reinforce the understandings about operations of instrument, realization of experiments and analysis of data. They should know about the underlying motivation of designing physical experiments, and be able to briefly design reasonable schemes based on the aim of experiment and instruments, also

determine the parameters. They should acquire fundamental methodologies to analyze errors and evaluate results.
Through experiments, students should acquire the ability to observe, analyze and judge. They shall be cultivated to possess manners of scientific research, and acquire elementary research ability.

Semester 4

[C] Topic Course II

Credits: 1 Class Hours: 32

[C] Fourier Analysis and Real Analysis

Credits: 4 Class Hours: 64

The course consisted of the two parts: the analysis and application of Fourier and Real Analysis and Measurement Theory. The course is an introduction to the theory of Fourier series and transform (with some applications) as well as to the theory of Lebesque integration. Fundamental ideas and rigorous proof will be presented. Topics of the course to be covered include Fourier series, their convergence and applications, Poisson kernel, Cesaro and Abel Summability, Plancherel formula, Poisson summation formula, measures, measurable sets and functions, Lebesgue integral and Fubini theorem.

[C] Probability

Credits: 4 Class Hours: 64

Probability is a branch of Mathematics about quantitative research on random phenomenon (events) statistical regularity. The goal for acquiring Probability is: acknowledge, recognize statistical property of random phenomena, comprehend how to construct random mode and calculate and analyze random events probability and its related properties. Probability includes Classical Probability Model, Random Variable and its Distribution Function, Mathematical Expectation and Variance and Limit Theorem.

[C] Abstract Algebra

Credits: 4 Class Hours: 64

Abstract Algebra (also called Modern Algebra) is an important basis of modern mathematics, and is widely used, such as in computer science, information and communication, physics, and chemistry. The course Abstract Algebra is one of the main required courses for undergraduates in mathematics. It studies the fundamental algebraic structures of groups, rings, and fields (for the limited time, as a course for undergraduates, it will not deal with the representation theory of groups and rings. In fact, Representation Theory of Groups is another course for undergraduates; and Module Theory will be a basic course of graduates). The main contents include the basic structural theory of groups, permutation groups, groups' actions on sets and applications of these actions, Sylow Theorems, the structure of finitely generated abelian groups, properties of solvable groups; the basic structures of rings, the Chinese Remainder with applications, the properties of uniquely factorized domains, and polynomial rings; the extensions of fields, finite fields with applications; and the basic Galois theory with applications. The aim of the course is to make students to acquire the

fundamental theories and tools; to train and strengthen their interest and ability of abstract thinking, such that a solid foundation in algebra will be built for their further studies. We emphasize that it is important to understand Abstract Algebras via concrete examples and backgrounds; and also we stress the applications of ideals and tools in this course.

[S] Summer Seminar in Mathematics

Credits: 2 Class Hours: 32

The course is primarily designed for lower division undergraduates to help them experience the joy of doing mathematics, communicating mathematics and appreciating mathematics. It consists of seminar talks on various topics related to mathematics and by a faculty team organized by the instructor. We emphasize the great diversity of mathematics as well as the rich connections between some seemingly independent areas of mathematics. Usually, the speaker will only assume basic linear algebra and calculus from the audience and will try to demonstrate the spirit of mathematics by getting from first principle in a few steps some beautiful results or fundamental ideas. The course aims to stimulate communications between students and the mathematics faculty.

Semester 5

[C] Topic Course III

Credits: 1 Class Hours: 32

[C] Partial Differential Equations

Credits: 4 Class Hours: 64

[C] Differential Geometry

Credits: 4 Class Hours: 64

Elementary Differential Geometry is a subject of studying curves and surfaces in 3-dim Euclidean space by using the differential and integral methods. This course has three parts. The first part is on curves theory in 3-dim Euclidean space; the second part is on general surfaces theory in 3-dim Euclidean space; the third part is on intrinsic geometry of surfaces in 3-dim Euclidean space.

[S] Stochastic Process

Credits: 4 Class Hours: 64

Stochastic Processes are ways of quantifying the dynamic relations of sequences of random events. It is a branch of mathematics. The main content of this course includes: General theory of stochastic processes; Poisson process and renewal theorems; Martingales; Discrete-time Markov Chains; Continuous-time Markov Chains; Brownian motion; Introduction to stochastic analysis; Stationary processes and ARMA models.

[S] Mathematical Programming

Credits: 3 Class Hours: 48

[S] Graph Theory and Network

Credits: 3 Class Hours: 48

The course will consists of the three parts.

(i) Introduction to general graph theory,

(ii) Algebraic graph theory,

(iii) Network theory from the graph theoretical viewpoint.

Semester 6

[C] Topic Course IV

Credits: 1 Class Hours: 32

The course is a compulsory undergraduate Mathematic course of widening students horizon and cultivating research consciousness. On account of compulsory course of Ordinary Differential Dynamic System, through deliberating classical Mathematical model or theoretical subject, for example, Logistic Equation and Chaos Theory, N-body Problem and KAM Theory, Hilbert 16 Problem and Qualitative Theory. From finding problem, looking for solutions to the recalling and exploring of establishing or developing theory and method, from the combination of teaching and research to stimulate students' learning interest and thinking forwardly, conducting sub-consciousness of scientific research, laying the foundation for dissertation.

[S] Mathematical Statistics

Credits: 3 Class Hours: 48

[S] Functional Analysis

Credits: 3 Class Hours: 48

Introduction to metric spaces (Basic topological notions, such as open sets, compact sets; Arzela-Ascoli lemma; contraction mapping theorem; Baire category theorem etc.)

[S] Numerical Methods for Ordinary and Partial Differential Equations

Credits: 3 Class Hours: 48

1, Numerical method for ordinary differential equations, Euler method and its convergence proof, truncation error, consistency and stability, multistep method, Runge-Kutta method, symplectic method

2, Finite difference method for elliptic problems, consistency and convergence, higher order finite difference method, treatment of curved boundary.

3, Finite element method for elliptic problems, variational formulation, Lax-Milgram theorem, error estimate for conforming finite element

4, Finite difference method for time dependent problems, Lax equivalence theorem, consistency, stability, convergence, truncation error, CFL condition, Fourier stability analysis, von Neumann condition, maximum principle, amplitude and phase errors, group velocity, modified equation analysis, Fourier and eigenvalue stability of systems

5, Possible selected topics: Fast Fourier transform, multiscale finite element methods for elliptic problems with multiscale coefficients, level set methods for multiphase flows, boundary integral methods, fast summation algorithms, pseudo-spectral and spectral methods.

[S] Topology

Credits: 3 Class Hours: 48

[S] Asymptotic Analysis

Credits: 3 Class Hours: 48

The topics include: asymptotic expansions, method of steepest descent, method of stationary phase, asymptotic evaluation of Fourier and Laplace transforms, WKB method, turning points, singular perturbations, method of multiple scales, boundary layers, plus the applications of asymptotic analysis in the modeling and numerical computations as time permits.

[S] Representation of Groups and Algebras

Credits: 3 Class Hours: 48

[S] Dynamics System

Credits: 3 Class Hours: 48

Semester 7

[C] Topic Course V

Credits: 1 Class Hours: 32

[S] Computational Physics

Credits: 3 Class Hours: 48

[S] Algebraic Number Theory

Credits: 2 Class Hours: 32

[S] Differential Manifold

Credits: 3 Class Hours: 48

[S] Coding and Decoding

Credits: 2 Class Hours: 32

[S] Mathematical Finance

Credits: 3 Class Hours: 48

[S] Time Series Analysis

Credits: 3 Class Hours: 48

[S] Nonlinear Mathematical Methods in Physics

Credits: 2 Class Hours: 32

[S] Selected Topics in Scientific Computing

Credits: 2 Class Hours: 32

Semester 8

[S] Lie Groups and Lie Algebras

Credits: 3 Class Hours: 48

[S] Combinatorial Mathematics

Credits: 3 Class Hours: 48

[S] Computational Fluid Mechanics

Credits: 2 Class Hours: 32

[S] Riemannian Geometry

Credits: 3 Class Hours: 48

[S] Statistical Data Analysis

Credits: 3 Class Hours: 48

[S] Ordinary Differential Equations（A）

Credits: 2 Class Hours: 32

[S] Continued Course in Partial Differential Equations (A)

Credits: 2 Class Hours: 32

[S] Algebraic Topology

Credits: 3 Class Hours: 48

[S] Algebraic Geometry

Credits: 2 Class Hours: 32

[C] Undergraduate Project (Thesis)

Credits: 6 Class Hours: 96