Computer Science

[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] 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] An Introduction to Computer Science

Credits: 4 Class Hours: 64

This course will introduce the mathematical foundations of computer science, including set theory, induction and recursion, combinatorics, graph theory and logic etc.. While delivering the knowledge to students, the course will also help students to develop their rigorous mathematic thinking and inferencing abilities, and train their abilities of solving problem by computer. Through this course, students will lay a solid mathematical foundation for their subsequent studying and research.

[C] Programing

Credits: 5 Class Hours: 80

This course uses C++as the teaching language, introduces structured programming and thoughts and ideas towards object-oriented programming, and the specific realization within C++.

Semester 2

[C] Mathematical Analysis (A) II

Credits: 5 Class Hours: 112

The basic content of this course is Number Entries and Series of Function Terms, Multivariable Differential Calculus, Multivariable Function Integral Calculus, Integration with One-parameter and Fourier Series.

This course not only require 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: 80

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 intension 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] Data Structure

Credits: 3 Class Hours: 48

When students have acquired structured programming design and object-oriented programming, further introduce the basic content of data structure and the basic content of Algorithm Design / Analysis. This course covers the ideology, method, implementation and application of data structure, cultivates students' ability to master and design an effective algorithm and data structure, and utilize computer to solve problems. The main content is using the logical relation of data as a clue to introduce relevant data element storage, processing method and the implementation on C++ of Linearity, Tree Relationship, Aggregation Relationship and Graphic Relationship.

[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.

[C] Programming Practice

Credits: 3 Class Hours: 48

This course is an expanded curriculum of programming and data structure. Firstly, strengthen students' practice ability, at least complete 100 programming. Secondly, expand the knowledge of data structure and algorithm. Among them, one-third lectures for expand knowledge, one third practice hours for all the selected and elective exercise, one third class hours for group task. The course aims to improve students' computer science knowledge foundation and professional skills for further study.

Semester 3

[C] Introduction to Physics (A) II

Credits: 5 Class Hours: 80

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] Algorithmic Design & Analysis

Credits: 3 Class Hours: 48

Contents of this class are: Classical algorithms and algorithmic design paradigms (e.g. divide and conquer, greedy algorithms, dynamic programming); maximum flow and minimum cut; Linear programming (duality, simplex, applications). We will also discuss some important data structures and how to use them in algorithms. Depending on the time frame, we will teach more advanced topics like randomized, approximation, exponential, and streaming algorithms.
We will devote ample time to: (i) the path from a basic idea to the final algorithm; (ii) proofs of correctness; (iii) running time analysis.
Goals: Deep understanding of the mathematical structure underlying the algorithms we treat in class and the ability to apply learned methods and paradigms to new problems.

[S] Introduction to Scientific Computation

Credits: 3 Class Hours: 48

The rise of scientific computing is one of the most important scientific progress in the 20^{th} century. The core is mainly for using the computer to efficiently solve the problems from scientific study and engineering design. Thus, experiment, theory, computer has been recognized as the basic three main research methods in science and engineering. The main task of the course is through algorithm design, theoretical analysis and "trinity" teaching method of using computer in algorithm to enable students to master the basic method and principle of scientific computing algorithm design, the effective analysis of astringency, stability and complexity of algorithm, further improve students' ability to solve practical problems with computer. This course mainly introduces interpolation and approximation, numerical integration and numerical differentiation, the numerical solution of non-linear equation and system of linear equation, briefly introduces eigenvalue of matrix and feature vector calculation, numerical method of initial value problem of ordinary differential equation. This course emphasizes practice construction that students need to do a certain amount of homework.

[S] Algebraic Structures

Credits: 3 Class Hours: 48

"Algebraic Structure" is a basic course in the area of abstract algebra. In this course, we study fundamental algebraic structures, namely groups, rings, fields etc, and maps between these structures. The theory and techniques introduced in this course are not only used in many areas of mathematics, but also applied in the areas of physics, engineering and computer science. Specifically, it serves as an essential mathematical foundation course for cryptography and coding theory.

[S] Automata Theory

Credits: 2 Class Hours: 32

This course covers finite automata, nondeterminism, regular expressions, context free languages, Turing machines and computability. The material is essentially that of "Finite Automata and Computability" by Hopcroft and Ullman. Students should have a good back ground is mathematics and able to give proofs of material.

[C] Physics Laboratory II

Credits: 1.5 Class Hours: 24

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] Probability

Credits: 3 Class Hours: 48
The main contents of Probability Theory course covers Definition of Probability, Conditional Probability, Independent, Random Variables and Distributions, Discrete Distributions, Continuous Distributions, Multivariate Distributions, Marginal Distributions, Conditional Distributions, Functions of Random Variables and Distributions, Expectation, Variance, Covariance and Correlation, Central limit theorem.

[C] Computer System I

Credits: 4 Class Hours: 64

Improve students' research ability of computer system on overall structure, system analysis and performance evaluation. Enable students to acquire basic concept, theory, design and analyzed method of computer system structure, as well as comprehend the development history and current situation of computer system structure.

The main content includes basic concept, development and research situation, performance valuation index of computer system structure, also storage hierarchy, instruction level parallelism, thread level parallelism, data level parallelism and request level parallelism. The content not only introduces classical structure and design ideology, but also combines the latest development direction of computer system structure to introduce multi-core processor, general-purpose graphics processor, data center and other core technology.

[S] Discrete Mathematics

Credits: 2 Class Hours: 32

Discrete mathematics is the part of mathematics devoted to the study of discrete objects.
Goal: Teach students a particular set of mathematical facts. Teach students how to apply the mathematical facts. Teach students how to think logically and mathematically
Contents: Set theory, Probability theory, Combinatorics, Logic, Recurrence relation, Graph, Automata and language, Computability theory.

[S] Graph Theory and Combinatorics

Credits: 3 Class Hours: 48

This course serves as a broad exploration in the field of combinatorics, with a focus on the topics in or related to the theory of graphs and hyper-graphs. The course starts with the basic enumerative combinatorics, including combinatorial proofs in counting, the inclusion-exclusion principle and Mobius inversion, recursion and generating functions. Then we will discuss many interesting topics and techniques, including Ramsey theorems, extremal graph theory, conbinatorial designs, combinatorial geometry, graph matching, connectivity, planarity, and colouring, random graphs, Szemeredi's regularity lemma, the probabilistic method, and the algebraic method. We will adore the legendary Erdos and his co-authors, and attack open problems. The course will be self-contained. The students are assumed to have the basic ability in problem solving.

[C] Compiler Design and Implementation

Credits: 3 Class Hours: 48

This course requires students to compete a full complier, which can translate a mainstream high-level programming language, such as C or JAVA. The target language selects the most compact MIPS instruction set. The front part of the work is that students can use morphology and grammar generator, such as Lex and Yacc, but the later part of the work needs tutor's guidance to complete with mature framework. Through this course, students are able to comprehend working process of complier, application context of algorithm and data structure, and how the structure modes apply in large soft drop project. The final score is mainly decided by the validity and efficiency of students' programming.

[S] Cryptography

Credits: 2 Class Hours: 32

[S] Approximation Algorithm

Credits: 2 Class Hours: 32

For many important optimization problems, there are no known polynomial-time algorithms that can compute the exact optimum. In particular, using the concept of NP-completeness, one can show that a great number of problems are equally hard to solve, in the sense that the existence of a polynomial-time algorithm for any one of them would imply polynomial-time algorithms for all the rest. Approximation algorithms have since been developed in response to such apparent hardness of these problems by relaxing the algorithm designer's goal to pursue the exact optimum. Instead, we aim to efficiently compute a solution that can closely approximate the optimal solution in terms of its value. Such trade-off between optimality and tractability is the paradigm of approximation algorithms. This summer course will cover the fundamental concepts in approximation algorithms. The topics we will discuss include 1) Greedy algorithms and local search; 2) Rounding data and dynamic programming; 3) Deterministic and randomized rounding

of linear programming; 4) Randomized rounding of semidefinite programming, and 5) The primal-dual schema.

[S] Probability and Computing

Credits: 2 Class Hours: 32

Semester 5

[C] Computer System II

Credits: 4 Class Hours: 64

The course "Computer System II (CS-II)" is a follow-up of CS-I. The I is about Computer Architecture and a FPGA-based pipelined micro-controller is required to implemented; And II is of Operating System, in which concepts, structures, policies and variety of mechanism and algorithms are introduced. The last but not the least, a design and implementation of prototype OS is required to drive your micro-controller which was built in CS-I. Utilization of limit Memory, Real-time response, or some trivial functional kits are recommended for alternatives.

[S] Mathematics for the Information Age

Credits: 2 Class Hours: 32

This course covers the mathematics to carry out research in most areas of computer science. Topics include high dimensional space, singular value decomposition, random graphs, random walks on graphs, machine learning, algorithms for massive data, clustering, compressed sensing, and wavelets. The course requires a rigorous mathematical background.

[S] Computing Complexity

Credits: 3 Class Hours: 48

This is a foundational course for computer science major. It is a core course for those postgraduate students majoring in theoretical computer science, cryptography and information security. The course provides an introduction to the students the basic concepts, methodologies and models in computational complexity.

[S] Technology and Application of Deep Learning

Credits: 2 Class Hours: 32

This course will give a full picture of recently developed deep learning techniques. Basic concepts, main structures, core algorithms and key applications will be introduced in detail. Content includes: basic concepts and algorithms of machine learning and neural networks, popular network structures and activation functions of deep learning, algorithm details of deep learning and key application cases.

[C] Professional Seminar I

Credits: 2 Class Hours: 32

This course is a comprehensive discussion on database systems. It covers both the system oriented topics and application layers in a database system. In application layers, the course introduces ER model, relational query language such as relational algebra and SQL, functional dependencies and normalization, as well as the usage of database transactions. At the system kernel layer, the course includes topics such as storage and file systems in a DBMS, indexing, query execution and optimization, concurrency control and the support and realization of transactions. The course includes projects at both application and system layers.

[C] Lab Practice

Credits: 3 Class Hours: 48

This is a practical course. According to interest and intention, students will be assigned to different mentors' lab. Mentors are responsible for carrying out students' research scheme, specify work content, goal and assessment and instruct research project completion. With the guidance of mentor, students need to complete the task. During the experience in lab, students are required to master the methods of finding out scientific direction, search for project materials, and the method and ability of finding out and solving questions.

Semester 6

[C] Database System

Credits: 3 Class Hours: 48

This course is a comprehensive discussion on database systems. It covers the system oriented topics in a database system. At the system kernel layer, the course includes topics such as storage and file systems in a DBMS, indexing, query execution and optimization, concurrency control and the support and realization of transactions. The course includes projects at both application and system layers. It will also talk about other data management systems and data analytics techniques.

[S] Machine Learning

Credits: 3 Class Hours: 48

The course includes three parts. The first part is about statistical foundations of machine learning. The second part studies statistical computation and inference methods such as EM algorithms and MCMC sampling. The focus is about the basic principle and methodology of these computational methods. The third part presents machine learning models such as mixture models, latent data models, generalized linear models, etc. The highlight of this part is about statistical data analysis methods.

[S] Computer Network

Credits: 3 Class Hours: 48

This course focuses on the exciting, dynamic topic of computer networks and features the Internet and a top down approach. The goal of this course is to get the students some insight into the rationale of why networks are structured the way they are today, to understand the key issues in computer network design and to master the principles for solving the issues. It covers fundamentals, concepts, architecture, principles and important protocols for computer networks.
In the application layer, typical applications and their protocols will be discussed, including Web and HTTP, File Transfer and FTP, Email and SMTP, Naming Service and DNS, and Peer-to-Peer. In the transport layer, UDP and TCP will be introduced. In addition, the principles of reliable data transfer and congestion control will be covered. In the network layer, we will learn the basics of a router, IP protocol, routing algorithms, and Internet routing protocols. In the link layer, we will learn error detection and correction, media access control, Link-layer addressing, Ethernet, Switches, PPP, Virtualization. We don't explicitly learn stuffs in the physical layer. However, we will also cover other important topics including wireless and mobile network, multimedia network, and network security.
In this course, the students are expected to under the key concepts and learn the principles that underline today's computer network. And, they will develop network applications and learn network programming with sockets. In addition, the course will introduce the students with hot research frontiers in computer networks, such as wireless sensor network, Internet of things, etc.

[C] Professional Seminar II

Credits: 2 Class Hours: 32

Students are required to select a research project from a list of topics, carry out the project, write a short report and give a 20 minute presentation. Students are taught how to get start in research and how to engage the audience when giving a talk. In 2016 the research projects were on deep leaning.

[S]Natural Language Processing

Credits: 2 Class Hours: 32

Natural Language Processing is an elective course for students majoring in Computer Science and Technology. It intends to familiarize the students with major content and key technology of Natural Language Processing, and introduces its research results, thus prepare for researching and developing natural language processing. Through instructing students to read, generalize and comment conference papers of Computational Linguistics, and introduce, discuss and raise questions upon those papers, which will enhance their understanding of the relationship between the curricular concepts and the popular methods and technology. In the end, the students are required to complete a project related to Natural Language Processing, thus they are able to utilize their knowledge and ability to search for materials and generalize the cutting-edge theories and technologies of certain fields worldwide.

[S] Programming Language and Logic

Credits: 2 Class Hours: 32

Advanced Programming Skills Procedural programming techniques: A theory of program correctness inspires a programming methodology for developing program and proof hand-in-hand. Numerous examples of algorithm development and algorithm presentation illustrate the efficacy of

the methodology. Functional programming techniques: Programming topics include recursive and higher-order procedures, models of programming language evaluation and compilation, type systems, and polymorphism.

Semester 7

[C] Scientific Research and Practice

Credits: 10 Class Hours: 160

This course is a practical course. Each student will go to a world-class university or an internationally renowned research institute for a semester to participate in the research and development of the most cutting-edge research projects in the field of computer science under the mentorship of their own mentor. The course intends to get the students in couch with the very frontier of computer science research, to deepen their understanding of the knowledge and concepts and to apply what they learned into practice, thus cultivating their ability to do independent scientific research. Students will also get the chance to publish their papers in this course.

Semester 8

[C] Teaching Practice

Credits: 2 Class Hours: 32

Students have to complete at least one teaching practice course in their four-year undergraduate school experience. This course asks the students to cooperate with the lecturer to complete teaching tasks, cultivates the students to help and mentor the mentees with their courses and broadens their knowledge. The course aims at cultivating the ability to learn actively, to communicate smoothly, to express oneself bravely, and to discover and solve the problems.

[C] Undergraduate Project (Thesis)

Credits: 10 Class Hours: 160

Under the guidance of tutors, the students will combine their theories and technologies to complete a project/ thesis on their own. To complete the graduation project, the students will do a thorough and systematic research on a certain topic, thus consolidating, expanding and deepening what they have learned, and cultivating the ability to cope with the problems by integrating their knowledge. This course will assess the students from the aspects of the depth of their knowledge, their ability to combining theories and practice to cope with actual problems, their experiments skills, foreign language skills, computer skills, oral and written expressions.