交叉信息研究院

20470024 普通物理（1）（英） 4 学分 64 学时

General Physics(1)(in English)

Calculus-based first physics course for physics majors and students with a serious interest in physics. Students are required to actively participate during the lectures, asking questions, and having questions asked. This class will provide you with an enhanced opportunity to acquire a good understanding of fundamental mechanics and thermodynamics and to learn how to apply this understanding to physics and beyond.

20470034 普通物理（2）(英) 4 学分 64 学时

General Physics(2)(in English)

This course is a follow-up course of General Physics I and for undergraduate students with serious interests in physics and interdisciplinary sciences. The main focus of this course is to cover the most important topics in classical electrodynamics including electrostatics, magnetostatics, Maxwell's equations for electromagnetic fields, and special relativity. This course will emphasize both basic concepts and solving practical problems. After completing this course, students are expected to gain a good understanding of basic classical electrodynamics.

30470013 计算机入门 3 学分 48 学时

Introduction to Computer Science

Designed to appeal to a diverse audience, this course examines some of the fundamental ideas of the science of computing. Lectures and hands-on assignments cover a wide variety of topics such as hardware organization, the Internet, computer programming, limits of computing, and graphics. No prerequisite.

30470023 计算机应用数学 3 学分 48 学时

Mathematics for Computer Science

This course aims to introduce the fundamental mathematical techniques useful for computer science undergraduate majors, illustrated with a rich spectrum of applications. Modern computer science education requires the students to be equipped with broad knowledge in mathematics, so that they could cope with current and future technological challenges handily and innovatively. In this course, mathematical techniques from algebra, geometry, probability theory, stochastic modeling, and information theory will be covered. These techniques will be applied to algorithmic and design problems in various topics, including internet, cryptography, distributed systems, wireless sensor network, optimization, etc. Finally, this course introduces the students to deep scientific issues in the foundation of computing such as undecidability, complexity, and quantum computers.

30470084 操作系统 4 学分 64 学时

Operating System

In this course, student will learn the design principles of operating systems, and techniques to build a complex software systems. Topics covered in this course include operating systems structure, multi-programming (processes, inter-process communication, and synchronization), memory management (virtual memory, segmentation, and paging), scheduling, file systems, system security, basic computer networking (switching, protocols), and basic concept on database management systems (transaction). In addition to classroom instruction, the students are required to complete a substantial programming project.

30470093 计算生物学　　3 学分　　48 学时

Computational Biology

To introduce various computational problems for analyzing biological data (e.g. DNA, RNA, protein sequences, and biological networks) and the algorithms for solving these problems. Topics covered include: biological sequence analysis, gene identification, regulatory motif discovery, genome assembly, genome duplication and rearrangements, evolutionary theory, clustering algorithms, and scale-free networks.

30470104 机器学习　　4 学分　　64 学时

Machine learning

Machine learning studies how computers can learn from experiences. Combining ideas from theoretical computer science and statistics, researchers have developed many learning methods and their applications to computer vision, bioinformatics, natural language processing etc. are highly successful. Machine learning theory addresses the fundamental problems in learning. It studies the power and theoretical limits of learning. The aim is to provide deep understand of learning and the guidance for the development of practical algorithms.

30470113 高等计算机图形学　　3 学分　　48 学时

Advanced Computer Graphics

本课程是为清华大学计算机系本科生开设的选修课，旨在介绍计算机图形学的基本概念、理论、方法和系统，主要内容包括：颜色模型、光照模型、明暗处理、纹理、光线跟踪算法、曲线曲面造型和几何处理等。

30470124 算法设计　　4 学分　　64 学时

Algorithm Design

This course gives an introduction to the basics of algorithm, common algorithm design techniques, and the analysis of running time (complexity). The main contents include: tools of algorithm analysis, divide and conquer algorithms, dynamic programming, greedy algorithms etc. algorithm design techniques, and NP complete, randomized algorithms, approximation algorithms and other advanced topics.

30470134 计算理论　　4 学分　　64 学时

Theory of Computation

This course gives an introduction to the basics of computation theory, including: Finite Automata, Regular language, Pushdown Automata, Context-Free Grammars, Turing machine, undecidablity, and computational intractable topics (NP complete, PSPACE, BPP etc).

30470154 博弈论　　4 学分　　64 学时

Game Theory

It is preferable that students have studied basic linear algebra, and have basic calculus skills. Although this is not required because we will develop the mathematical skills as we introduce the material.

This course will serve as an introduction to game theory. We will begin from the very basics of game theory. We will work on important concepts like Nash equilibria, and end with a taste of more advanced subjects like evolutionary game theory and games on graphs.

30470204 近代物理（1）(英)　　4 学分　　64 学时

Modern Physics (1)(in English)

This course will cover the basic formalism and modern applications of optics and atomic physics. In the optics part, we will introduce geometric optics, wave optics, and their applications in the current research frontier such as quantum information science. For the atomic physics part, we will present many interesting experiments performed in early 20th century and explain how these results lead to the modern understanding of atomic structure. Modern applications of optics and atomic physics, such as laser and laser cooling of atoms, will also be discussed.

30470214 近代物理（2）（英） 4 学分 64 学时

Modern Physics(英)(in English)

This course provides undergraduate students with background in science and engineering the foundation to understand many key aspects of quantum and statistical physics, which are essential for learning advanced topics such as condensed-matter physics, quantum field theory, and quantum information science. Conceptual understanding of the physical ideas and detailed mathematical derivations will be equally emphasized. Active class participation of students is expected.

30470223 计算机网络基础 3 学分 48 学时

Introduction to Computer Networks

This course aims at giving a comprehensive introduction to the fundamentals of computer networks and network performance analysis. The course contains two parts. The first part covers various networking topics including network principles, Ethernet, WiFi, routing, inter-networking, transport, WiMax and LTE, QoS, and physical layer knowledge. The second part presents mathematical techniques for modeling, analyzing and designing computer systems, including convex optimization, queueing theory, game theory and stochastic analysis. This course is intended for junior or senior undergraduate students in computer science or electrical engineering.

30470232 信息物理 2 学分 32 学时

The Physics of Information

The 21st Century has seen a string of profound discoveries that interface physics, information theory and computer science. This course will introduce undergraduate students this exciting frontier by connecting the various physics and computational ideas they learn in first year. After completion of the course, students will appreciate how information theoretical principles led to new understanding in physics, and how new physics facilitated new models of computation. Topics include physical consequences of the Church Turing thesis, unravelling Maxwell's Demon through information thermodynamics, and the information theoretic consequences of quantum mechanics.

30470242 数据科学导论 2 学分 32 学时

Introduction to Data Science

The course intends to motivate students by fundamental (selected) aspects
of Data Science. In this course, we discuss selected aspects of the concept of data, related
techniques and aspects, and future achievements in the area of Data Science.

40470024 密码学基础 4 学分 64 学时

Fundamentals of Cryptography

The purpose of this unit is to introduce the basic concepts of modern cryptography. We start this tour by a very brief introduction to classic cryptography, and main issues related to the distribution of digital content such as confidentiality, integrity and non-repudiation. After a short introduction to the preliminaries, we will show several

equivalent cryptographic primitives and their reductions to each other. Privacy issues and solutions are discussed in the context of modern private-key and public-key cryptography. Next, we will review tools allowing authentication of digital content using hash function and digital signatures. The presented constructions are building blocks for designing secure systems and protocols for real-world applications. Attacks and security analysis of the cryptographic schemes and protocols will also be discussed.

40470034 分布式计算（基础与系统） 4 学分 80 学时

Distributed Computing(Fundamentals and Systems)

Through this course, students will learn fundamental algorithms and principles in distributed computing systems, such as logical clocks, consensus problem, failure detection, Byzantine agreement, distributed locking, and gossip protocols. They will also learn how to design and analyze distributed systems using these fundamental algorithms and principles through the study of a number of advance distributed systems.

40470075 综合论文训练 15 学分 240 学时

Diploma Project (Thesis)

本课程采用导师与学生一对一指导的形式，通过对当今计算机学科的最前沿问题或基础理论问题的研究，使学生学会如何着手开展科研工作，培养提出、分析与解决问题的能力，加强学生从事论文（研究）工作的书面和口头表达能力，以及协调组织能力。通过本环节的训练，学生应对计算机学科的科研工作有较全面的了解，并具有开展理论研究或研发工作的能力。论文题目在导师的指导下通过前期文献调研后确定。本课程要求学生在期末提交研究论文并进行口头报告和答辩，由多名教师组成的答辩委员会根据论文工作的质量和答辩的情况给出成绩。本课程要求学生至少将一篇有关的外文文献译成中文。

40470085 专题训练实践 5 学分

Research Immersion Training

本课程设在大三年级夏季学期，是为大四年级的《计算机科学研究实践》和《综合论文训练》做准备。在该课程中，设置了算法理论、量子网络、复杂性研究、密码及安全、博弈论等专题，并根据学生的兴趣安排进入各专题训练小组进行专题研讨和实践，使学生在实际动手能力、创新思维、团队合作精神等方面得到锻炼和提高。

40470094 量子信息 4 学分 64 学时

Quantum Information

Quantum Information is a course offered to upper level undergraduate students (junior or senior students in the Yao Class, physics, EE, and computer science departments) and graduate students. The course will cover many topics at the forefront of the new field of quantum information science, including, for instance, quantum entanglement theory, quantum cryptography, quantum communication theory, quantum computing models, quantum algorithms and complexity theory, quantum error correction and fault-tolerant computation, physical implementation of quantum computation, communication and networks.

40470169 计算机科学研究实践 9 学分 144 学时

Research Practice

该课程为实践性课程。学生将赴国内外各著名研究院所进行为期一学期的研究实践，每位学生单独跟随各自的导师，参与到具体的、目前理论计算机领域最前沿的研究项目中去，进行研究型开发研讨等实践活动。该课程的目的是让学生真正接触到理论计算机科学研究的最前线，对自己所学理论知识有更深入、更实际的认识和应用。学生也有机会在该实践课程中在自己的研究实践领域发表论文。在该课程中，学生将会被

要求进行正式的研究实践报告答辩，包括开题、期中和期末答辩。

40470184 大数据算法与模型　　4 学分　　64 学时

Algorithms and Models for Big Data

Analysis, computation, and privacy issues over environments involving a huge amount of data. Formal approaches: (i) datastream computation, (ii) property testing of large objects, (iii) big data statistics and machine learning techniques (Bootstrapping, Bagging and their variants), and if time permits (iv) introduction to differential privacy (anonymizing databases). For these settings we study models and algorithms.

40470194 言语科学技术及创新应用　　4 学分　　64 学时

Speech Science, Technology and Innovative Applications

Speech communication refers to the process of transferring information from one person to another by speaking in a specific language. It is a highly inter-disciplinary subject, which is related to physiology, linguistics, phonetics, signal processing, and computer science. Many interesting and impactful computer applications have been developed to enable and improve human-computer and human-human speech communications. In this course, students will learn the scientific fundamentals underlying human speech communication, the basic techniques of computer speech and language processing, state-of-the-art spoken language technologies and their applications. Advanced research topics and future directions will also be discussed.

40470202 网络科学　　2 学分　　32 学时

Network Science

Network science is a new and emerging scientific discipline that examines the interconnections among diverse physical or engineered networks, information networks, biological networks, cognitive and semantic networks, and social networks.In this course, we examine the many facets of internet from the algorithmic perspective, including for instance the mathematical modeling of large-scale networks, information retrieval algorithms for massive data sets, algorithmic game theory and electronic commerce. Specific topics include small world phenomena, power law distributions, rank aggregation, web crawling, hubs and authorities, clustering large data sets, streaming algorithms, network routing, Nash equilibrium, market clearing, mechanism design, auction theory, social networks, etc.