TBSI course introduction-brief

(Update December 2019)

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Mandatory course

Track 1

1. **Course Name:** Introduction of physics chemistry disciplines 物理化学学科介绍

    Credits: 1, 16 teaching hour

    Specific course information: Combine with their own research achievements, Track one (physics chemistry) will host about eight PIs to present individual frontier research areas. In the meantime, open and dynamic discussion with students will be carried out. It will be divided into five themes: nano energy materials (new energy development、thermal management and battery for energy storage), low dimension materials and devices(two dimension materials、functional devices and growth optimization), optoelectronic materials and devices (solar cells, LEDs and photodetectors), water environment (nano-environment engineering、environment bio engineering and waterwaster management) and photon electronics(silicon photonics、photonic fiber based sensors and photonic crystals)。Throughout vivid examples and close interaction among professors and students, graduate students will mask science advances and increase their research interests.

2. **Course Name**: Nano-energy Materials 纳米能源材料

    Credits: 2; 32 teaching hour

    Specific course information: Three professors from the Lab. of Nano Energy Materials, will give lectures focusing on nano-materials, carbon materials, energy application and thermal management, other applications. Lecturers will discuss with students about the concepts and frontier research trends in the related research areas.

3. **Course Name**: Dynamics of Environmental Systems: Principles of Mass Transformation and Energy Flow 环境系统与过程原理

    Credits: 2; 32 teaching hour

    Specific course information: The course will introduce common knowledge of mass transformation and energy flow in environmental systems, especially for the latest development in the fields of separation and purification, chemical treatment processes and biological treatment processes. Its inter-relations with natural environment, massive energy production and dissipation. In addition, the control and management

of environmental processes will be presented through the viewpoints of sustainability and low carbon concept.

4. **Course Name**: Sustainable Development:　Ethics, Physics and Technology　可持续发展：伦理，机理和应用技术

   Credits: 1; 16 teaching hour

   Specific course information: Although sustainability and sustainable development have become common themes in public discourse there is little consensus on how to translate these concepts into decisions and actions in the realms of policy, technology, economics, environment. This course will examine the focal issue underlying sustainable development, change and its limits, from different perspectives: ethics, dynamics, physics, technology. Selected applications in various disciplines and economic sectors will be discussed. The course will introduce several mathematical and physical concepts in a rigorous way but with emphasis on understanding these concepts rather than on technical details. Basic college physics and calculus classes would be beneficial for the student.

5. **Course Name**: Chaos and Complexity　–　System Dynamics Approach 混沌和复杂性--系统动力学方法

   Credits: 1; 16 teaching hour

   Specific course information:　Exploration of diverse concepts in fractal geometry, nonlinear phenomena and their dynamics leading to chaos and complexity. We will try to look at a variety of natural objects and processes, and their mathematical counterparts to see if we can characterize such features as ruggedness, structure, contingency, "butterfly effect". The focus will be on the development of intuition and on applications rather than rigorous mathematical derivations. I hope that you will acquire a new Weltanschauung and start thinking about scaling laws, sensitivity to initial conditions, small changes and large effects.

6. **Course Name**: Computational materials and materials genome initiative 计算材料学与材料基因组工程

   Credits: 3; 48 teaching hour

   Specific course information: This course will cover fundamentals of computational materials, theory of bandstructures, the conventional applications of computational methods, including Molecular Dynamics, Monte Carlo. Meanwhile, topics from

research frontiers will be selected as projects. The newly development of computational materials—materials genome initiative and its various applications including lithium batteries, catalysts design, thermoelectricity, and topological insulators will be introduced.

7. **Course Name**: Materials Physics 材料物理

   Credits: 3; 48 teaching hour

   Specific course information: This course will cover basic materials physics, including defects, alloy phase diagram, thermodynamic properties, vibration and thermal transport, energy band theory, electronic properties of defects and transport behaviors, dielectric and magnetic properties. We will also incorporate closely-related research on low-dimensional materials in our group study.

8. **Course Name**: Materials Chemistry 材料化学

   Credits: 3; 48 teaching hour

   Specific course information: This course will start from elements, and will talk about how elements can form molecules and solids via different kinds of chemical bonding. The crystal structures, electronic properties, and solid chemistry of these molecules and solid state materials will be discussed. Later, the course will introduce most commonly used methods to prepare nanometerials, and use carbon nanotubes and graphene as examples to deepen students' understanding about nanomaterials synthesis. There will also be a lab visit or practice and student seminar sessions at the end of the course

9. **Course Name**: Principle of Environmental Behavior 环境行为学原理

   Credits: 2; 32 teaching hour

   Specific course information: Environmental behavior of pollutants at molecular level;Methodological tools: energy metabolism, life cycle assessment, environmental risk assessment, CO_2 emission analysis; Environmental behavior of bio-unit at individual level: algae, bacteria, plant, animal, humankind body; Environmental behavior of natural eco-system: forest, farming land, wetland, river and lake; Environmental behavior of social eco-system: prelim society, agricultural society, industrial society, postmodern society, city society and village society; Typical case studis: CO_2 emission

10. **Course Name**: Advanced Materials Characterization: Principles and New Developments 先进材料表征：原理和最新进展

    Credits: 3; 48 teaching hour

    Specific course information: This course will cover materials characterization techniques including both imaging methods and spectroscopy methods. The emphasis will be basic principles of these techniques, examples of applications in scientific research, as well as new developments of the techniques. In addition, the course will offer seminar and hands on experiment practice for students.

11. **Course Name**: Materials and Devices of Energy Storage and Conversion 能源储存与转化：材料和器件

    Credits: 1; 16 teaching hour

    Specific course information: This course will cover four topics on energy storage and conversion: (1) fundamental chemistry, (2) advanced power sources, (3) new energy storage techniques, and (4) development of electric vehicles. Materials and devices applied in energy storage and conversion are the focus of this course. We will employ open discussion through this course.

12. **Course Name**: MEMS and Its Application　MEMS 及其应用

    Credits: 3; 48 teaching hour

    Specific course information: The class hours will be assigned to lectures, invited talks, seminars and flipped teaching activities. The topics of the lectures and the talks will include the development and the features of MEMS, current research hotspots in the field of MEMS, typical MEMS products and their applications. R&D training will be provided through case studies. Students will present and discuss their ideas in the seminars. In the flipped teaching activities, students will learn by themselves through making use of the abundant resource in Tsinghua, Berkeley and internet.

13. **Course Name**: Materials Science and Engineering 材料科学与工程

    Credits: 3, 48 teaching hour

Specific course information: Materials are foundations of human civilization. Materials science involves the investigation on structure-property relationship, and the design and fabrication of a materials with a predetermined set of properties. The ability to understand and manipulate materials and their properties is crucial skill in both of industrial process and scientific research. This course will provide essential knowledge of materials science.

14. **Course Name**: Micro Sensors 微传感器

Credits: 2; 32 teaching hour

Specific course information: The class hours will be assigned to lectures, seminars, flipped classrooms and lab experiments. The purpose of this course is to enable the students to fully understand the working principle and realization method of Micro sensors, so as to acquire the basic knowledge and ability to the research, developing and application of Micro sensors. In the beginning, the relative theories of Micro sensors will be introduced in the form of lecture, including the mechanical properties of the micro structures and the principles of signal detection. Then taking several typical micro sensors as examples and through case studies, seminar discussions, flipped classrooms and lab experiments, the complete process of the design, fabrication, packaging and performance testing of Micro sensors can be practiced by the students.

15. **Course Name:** Introduction of Photonics　光电子概论

Credits: 3; 48 teaching hour

Specific course information: Photonics is the physical science of light (photon) generation, detection, and manipulation through emission, transmission, modulation, signal processing, switching, amplification, and detection/sensing, etc. This course mainly covers basic optics, interactions between light and materials, laser fundamentals, waveguide theory, semiconductor devices, optical modulation & detection, as well as nonlinear optics. Photonics advances together with other information technologies, making it one of the fundamentals of today's modern information technology.

16. **Course Name**: Nanomaterials and Nanotechnology 纳米材料与技术

Credits: 3; 48 teaching hour

Specific course information: This course aims to: 1. Describe the basics of nanomaterials 2. Describe the various techniques for fabrication and characterization of nanomaterials and appraise the advantages and limitation of these techniques. 3. Describe the various assembling techniques for nanomaterial-based bulk structure and appraise the advantages and limitation of these techniques. 4. Describe the structure-property relationship of nanomaterials-based bulk structure and their applications

17. **Course Name**: Optical Fiber Communications 光纤通信

    Credits: 3, 48 teaching hour

    Specific course information: Optical fiber technology has brought great technological revolution to the field of communications. With its unique advantages, optical fiber has become one of the main directions of modern communications, and has been widely used. This course focuses on the basis of optical fiber communication, optical fiber cable, optical passive / active devices, photodetector and laser light receiving / transmitting technologies, and several kinds of optical amplifiers; and includes several optical fiber transmission systems, such as electrical frequency division multiplexing system, electrical time-division multiplexing system, optical time-division / wavelength-division multiplexing and optical code division multiplexing systems, as well as recent coherent lightwave communication systems and optical soliton communication system. It will also introduces several problems to be considered in design of optical fiber transmission system, such as the fiber dispersion on the performance of the system and the dispersion compensation method of compensation limit management. The goal of this course is to enable students to understand the latest developments and applications in optical fiber communications.

18. **Course Name**: Nanoscale Fabrication and Optoelectronic Devices 纳米加工和光电子器件导论

    Credits: 2; 32 teaching hour

    Specific course information: Two hours of lecture and one hour of discussion per week. This course discusses various top-down and bottom-up approaches to synthesizing and processing nanostructured materials. The topics include fundamentals of self assembly, nano-imprint lithography, electron beam lithography, nanowire and nanotube synthesis, quantum dot synthesis (strain patterned and

colloidal), postsynthesis modification (oxidation, doping, diffusion, surface interactions, and etching techniques). In addition, techniques to bridging length scales such as heterogeneous integration will be discussed. We will discuss new electronic, optical, thermal, mechanical, and chemical properties brought forth by the very small sizes.

19. **Course Name**: Semiconductor Physics and Devices 半导体物理与器件

Credits: 3; 48 teaching hour

Specific course information: Since the 1st transistor was invented in 1947, human beings are experiencing an era based on microelectronics, in the meantime, semiconductor physics and devices are the basis of microelectronics. This course contains two parts: semiconductor physics and devices. Semiconductor physics includes the fundamental semiconductor materials, carrier models and transportation, and band gap theory; semiconductor devices contains PN junction, bipolar transistor, MOS capacitors and FET.

20. **Course Name**: Sustainable Nanotechnology: Environmental Applications and Implications 可持续纳米技术：环境应用及其影响

Credits: 3; 48 teaching hour

Specific course information: Topics include the synthesis and characterization of nanomaterials, environmental application of nanotechnology, nanoparticle dispersion and colloidal chemistry, environmental fate and transport of nanomaterials, the nano-bio interface and mechanistic nanotoxicology, predictive toxicological profiling, the nanomaterial ecosystems interface, in vivo and inhalation toxicity, societal implications of nanotechnology, and nanotechnology regulation.

21. **Course Name**: Introduction to Statistical Mechanics and Molecular Simulation 统计力学与分子模拟简介

Credits: 3; 48 teaching hour

Specific course information: Statistical mechanics is one of the most important cornerstones of materials physics. It is critical to understand statistical mechanics before we understand most phenomenon in materials science, as it is the most

important theory that bridges microscopic structures and macroscopic properties. As a direct application of stat mech, molecular simulation is also widely used in modern materials science researches. This course will introduce these two subjects, the main topics include: ensemble theory, ideal gas models, polyatomic molecule and crystal vibrations, Ising model and phase transition, stochastic dynamics, liquid structure, Monte Carlo and molecular dynamics etc.

22. **Course Name**: Partial Differential Equations for Practical Applications in Engineering 数理方程在工程科学中的实践应用

    Credits: 3; 48 teaching hour

    Specific course information: Based on the analysis of the application of advanced mathematics calculus in practice, this course starts with the importance of the application of advanced mathematics calculus in practice, and then makes an effective analysis of the application of advanced mathematics calculus in practical engineering application such as in materials science, optical electronics and communication. For example, The partial differential equation will be introduced to simulate the carrier transport in PN junction with external electrical field, to analyze the statistical data and exciton life time in semiconductors. Therefore, complicated problems will be simplified with appropriate mathematical equation, resulting more efficient productivity for researchers with basic transport, wave equation, heat equation and harmonic equation.

23. **Course Name**: Opto-electronic Materials & Devices 光电子材料与器件

    Credits: 2; 32 teaching hour

    Specific course information: While silicon ICs have become ubiquitous in many smart appliances, optoelectronic devices such as solar cells, LED lighting, LED displays, and 3D sensors that use VCSELs and other lasers are becoming increasingly visible, besides being the backbone of fiber-optic communications. This course will teach students already familiar with semiconductor devices about developing opto-electronic devices such as leds, lasers and photodiodes made from compound semiconductor materials. This course will also discuss topics at the frontier of photonic materials research, including metamaterials, plasmonics and related characterization tools.

24. **Course Name**: Environmental Monitoring and Analysis 环境污染物监测与分析

Credits: 3; 48 teaching hour

Specific course information: This course will cover water quality parameters (with a focus on toxic pollutants), pollutants properties, measurement techniques, and control technologies. We will also review strategies to monitor complex environments for established and emerging contaminants, with comprehensive theories and principles to use particular technologies and/or methods to monitor water, soil/sediments, and flora/fauna for anthropogenic contamination.

25. **Course Name**: Nanoscale energy transfer 微纳尺度能量输运

Credits: 3; 48 teaching hour

Specific course information: This course discusses energy carriers (phonons, electrons, etc.) transport process in nanomaterials.

26. **Course Name**: Introduction to Quantum Chemistry: Theory and Application 量子化学简介：理论与应用

Credits: 3; 48 teaching hour

Specific course information: Quantum Chemistry has become a quite common tool in the study of chemical mechanisms and molecular properties. Considering its wide application (and how frequently it is used in modern literatures), we need an introduction course to teach students its core ideas and fundamental principles. The objective of the new course is to let student understand the basic ideas behind quantum chemistry and what problems they can solve using quantum chemistry tools. Meanwhile, the students are also supposed to learn how to use modern HPC systems to run a computation job in general

27. **Course Name**: Thermal Physics and Engineering 热物理学与工程

Credits: 3; 48 teaching hour

Specific course information: This course will focus on thermal physics (phonons, electrons and their physics), thermal measurement techniques and research progress in thermal sciences.

28. **Course Name**: Organic Electronics: Materials and Emerging Technologies 有机电子：材料与新兴技术

Credits: 3; 48 teaching hour

Specific course information: This course will introduce the development of cutting-edge technologies in organic electronics and the emerging applications. Chapter 1 introduces the basics of organic semiconductor materials, including the principles of structural design, microstructure engineering, electronic structure, and the band theory. Chapter 2 describes the fabrication and performance of organic elemental devices. Starting from the thin film deposition methods, this chapter focuses on the structure and working principle of organic field effect transistors (OFETs), organic light emitting diodes (OLEDs), and organic photovoltaics (OPVs), etc. On the basis of the fundamentals introduced above, Chapter 3 and 4 further introduce novel materials and the cutting-edge design of organic electronic and optoelectronic devices. The topics include interfaces, electrodes, single-molecule devices, low-dimensional devices, organic imaging and sensing systems, etc. Chapter 5 talks about organic bioelectronics. The emerging biocompatible organic materials, and the application in biomolecular sensing, biological diagnosis and treatment will be addressed. Chapter 6 introduces flexible and stretchable organic electronics. The concept and development of "electronic skin" will be thoroughly overviewed. The prototype of wearable circuits, textiles, and other flexible (opto)electronics will be demonstrated. The potential of organic electronics in driving the Internet of Things (IoT), and the technical challenges for future development are expected to trigger an open discussion in the class.

The grading of the course is based on four parts: Participation (10%), 6 Assignments (30%, 5% each), Discussion During Class (10%), and Seminar Presentation (50% = 25% students + 10% TA + 15% Instructor).

29. **Course Name**: Materials and Devices for Energy Storage and Conversion 能源储存与转化：材料与器件

Credits: 3; 48 teaching hour

Specific course information: This course is designed for first-year graduate students who have interests on technology and research about materials and devices for energy storage and conversion. In the classroom lecture sessions, lectures on basics and state-of-the-art of materials and devices for energy storage and conversion will be delivered. This course will cover four areas on energy storage and conversion: (1) fundamental chemistry and electrochemistry in typical energy storage and conversion

systems, (2) advanced power sources, (3) advanced energy storage and conversion techniques, and (4) development of characterization techniques. Materials and devices applied in energy storage and conversion are the focus of this course. Open discussion will be encouraged during this course. This is a 3-credit course with 48 teaching hours (3 hours per week). Upon completion of this course, students should be able to comprehend and summarize the primary categories of energy storage and conversion devices, integrate knowledge about energy storage and conversion from chemistry and physics, critically evaluate research progress in academic and popular media, and effectively present information about research project and proposal, etc.

The grading of the course is based on four parts: Participation (10%), 6 Assignments (30%, 5% each), Discussion During Class (10%), and Seminar Presentation (50% = 25% students + 10% TA + 15% Instructor).

30. **Course Name**: Techniques in Computational Materials Science 材料学计算技术入门

    Credits: 3; 48 teaching hour

    Specific course information: In this course we will introduce a variety of techniques commonly used in computational materials science, including: basics of linux and vim, software compilation and installation, parallel computing, HPC structure, job scheduler system etc. Also, we will introduce some common DFT and MD programs in materials science. Through this training, the students are expected to master an efficient tool chain to do the work ranging from environment configuration, system construction, running calculation, to data processing. We hope the students could perform a variety of computations in a modern HPC independently after this course.

31. **Course Name**: Lectures on frontier research about low-dimensional materials 低维材料前沿研究讲座

    Credits: 3; 48 teaching hour

    Specific course information: The objectives of teaching this course are: (1) to teach students the basic physic principles governing various materials properties, and (2) to train students to discuss research results and present their innovative ideas. The latter will be accomplished through the introduction of active research topics. I will select some prototype systems (for examples, graphene, two-dimensional transition metal dichalcogenides) and problems fitted with current research in TBSI as projects for investigative study, to make the connection between teaching and research, to

cultivate their research interest and to develop their understanding on how we do research.

32. **Course Name**: Principles and Applications of Electrochemistry 电化学原理及应用

    Credits: 3; 48 teaching hour

    Specific course information: On successful completion of this course, students will:

    (1) understand the basic principles of electrochemistry;

    (2) understand thermodynamics and kinetics of electrochemistry;

    (3) be familiar with different electrochemical measurement techniques for electrochemistry and explain which type of information that can be obtained with these techniques;

    (4) know different electrode materials, electrolytes, separators, and energy storage systems;

    (5) understand basic structure and the working principles of different energy storage devices.

Track 2

33. **Course Name**: Energy-Environment and Data-Information 100 level course 能源环境与数据信息概论

    Credits: 1, 16 teaching hour

    Specific course information: This course consists of seminars regarding Energy-Environment and Data-Information. The topics include: Smart grid and renewable energy, Intelligent transportation and logistic systems, Low carbon economy and financial risk analysis, Internet of things and social cyber physical systems, Big data and future Internet, Smart image, etc.

34. **Course Name**: Fundamentals of applied information theory 应用信息论基础

    Credits: 2; 32 teaching hour

    Specific course information: This course is based on three Shannon theorems in information theory and introduces the statistical method, information processing and theoretical issues involved in the information measurement. The course will help students to master the basic concept of information theory, and understand the theory and method of information processing, transmission, storage and compression. It is helpful for the in-depth understanding of some essential issues in information and communication engineering and improvement of the innovative thinking and analysis in practical problems.

35. **Course Name**: Introduction of smart grid 智能电网导论

    Credits: 2; 32 teaching hour

    Specific course information: Smart grid is an emerging and developing concept. The course Introduction of Smart Grid is for the graduate students of Low-carbon Economics and New Energy Technology Center at Tsinghua-Berkeley joint institute in Shenzhen. In this course, with well-designed seminars and discussions, the students will understand the motivation, definition, features, key technologies and typical cases of smart grid. It will cover the important elements in smart grid, including the source side (such as renewable energy sources and distributed generations), the grid side (such as advanced transmission grid, active distribution grid, micro grid), the demand side (such as electric vehicles, demand response, smart buildings), and

information & communication technologies (such as energy management and cyber physical systems). With this course, the students are expected to get an overview about smart grid, and have fundamental knowledge for future further research.

36. **Course Name**: Supply Chain Design and Management 供应链设计与管理

    Credits: 4; 64 teaching hour

    Specific course information: This course covers a wide range of topics in supply chain management, including facility locations models, uncertainty in facility locations, deterministic inventory models, stochastic inventory model, multi-echelon inventory models and uncertainty in inventory optimization. The objective of this course is to help students to gain some perspectives on supply chain management, its classical models and emerging developments. The students are expected to gain the understanding of the methods to model and analyze supply chain models. More importantly, these tools they learned can also be applied to other fields, such as health care, energy, finance and service management.

37. **Course Name**: Hot Topics in Computational Photography 计算摄像学专题

    Credits: 3; 48 teaching hour

    Specific course information: Computational Photography is an emerging new field created by the convergence of computer graphics, computer vision and photography. Its role is to overcome the limitations of the traditional camera by using computational techniques to produce a richer, more vivid, perhaps more perceptually meaningful representation of our visual world. The aim of this advanced course is to study ways in which samples from the real world (images and video) can be used to generate compelling computer graphics imagery. We will learn how to acquire, represent, and render scenes from digitized photographs. Several popular image-based algorithms will be presented, with an emphasis on using these techniques to build practical systems. This hands-on emphasis will be reflected in the programming assignments, in which students will have the opportunity to acquire their own images of indoor and outdoor scenes and develop the image analysis and synthesis tools needed to render and view the scenes on the computer.

38. **Course Name**: Introduction to Probability theory 概率论

    Credits: 3; 48 teaching hour

Specific course information: This is a course on the fundamentals of probability geared towards first- or second-year graduate students who are interested in a rigorous development of the subject. The course covers most of the topics in probability theory (sample space, random variables, expectations, transforms, Bernoulli and Poisson processes, limit theorems) in more depth. There are also a number of additional topics, such as language, terminology, and key results from measure theory; interchange of limits and expectations; multivariate Gaussian distributions; deeper understanding of conditional distributions and expectations.

39. **Course Name**: Optimization methods for power systems 电力系统优化方法论

    Credits: 1; 16 teaching hour

    Specific course information: The course will cover several topics on optimization theory and its application in power systems, including: - Nonlinear optimization - Numerical algorithms - Power optimization problems such as state estimation, unit commitment, optimal power flow, and transmission planning - Efficient optimization and numerical algorithms for mixed-integer nonlinear problems - Control and optimization for renewable energy

40. **Course Name**: Markov Chains: Theory and Applications 马尔科夫链：理论与应用

    Credits: 1; 16 teaching hour

    Specific course information: The course will cover basic concepts and results in the theory of stochastic processes, with applications, - Review of conditional probability and expectations - Markov chains and examples - Chapman-Kolmogorov equations and classification of states - Irreducibility, recurrence and periodicity of Markov chains - Stationary distributions and limiting distribution - Applications in Google search algorithms.

41. **Course Name**: Discrete-Event Simulation 离散事件系统仿偵

    Credits: 3; 48 teaching hour

    Specific course information: The primary objective is to introduce discrete-event simulation modeling and analysis techniques at a level that will enable students to correctly use simulation experimental methodologies in practice and research. Students will 1. learn the strengths and weaknesses of different approaches, giving

them a foundation for selecting methodologies and software appropriate for different types of engineering problems, 2. become familiar with the fundamental similarities among simulation packages (mainly Sigma and Arena), 3. learn how to model random processes and experiment with simulated systems, and 4. develop interactive simulation-based decision-support systems.

42. **Course Name**: Inference and Information 信息推论

    Credits: 3; 48 teaching hour

    Specific course information: This is a course on the intersection of information theory and machine learning geared towards first or second-year graduate students who are interested in the fundamental aspects and the state-of-art developments of these subjects. The course is geared towards students who are interested in understanding machine learning, data mining, and information theory at a fairly sophisticated level, and to carry out research involving the applications of the mathematical frameworks to machine learning problems. One of the objectives of the course is to understand the fundamental perspectives and develop solid connections between mathematical theory and learning systems.

43. **Course Name**: Learning from Data   数据学习

    Credits: 3; 48 teaching hour

    Specific course information: This is a course on the intersection of mathematical theory and machine learning geared towards first or second-year graduate students who are interested in the fundamental aspects and the state-of-art developments of these subjects. The course is geared towards students who are interested in understanding machine learning, data mining, and information theory at a fairly sophisticated level, and to carry out research involving the applications of the mathematical frameworks to machine learning problems. One of the objectives of the course is to understand the fundamental perspectives and develop solid connections between mathematical theory and learning systems.

44. **Course Name**: Distributed Control and Optimization of Power Systems 电力系统分布式控制与优化

    Credits: 3; 48 teaching hour

Specific course information: This course focus on the control and optimization of renewable energy generation. The trend of developing lower-carbon generation technology and higher efficiency devices in energy systems has resulted in more distributed generation resources and more diverse distributed energy storage systems. A short introduction into power systems with high renewable energy generation penetration and smart grid will be provided. Microgrid is a promising concept to meet the challenges of integrating various distributed generations and energy storage systems into power systems. Applications of advanced distributed control and optimization techniques to microgrid are presented.

45. **Course Name**: Mathematical Statistics and Application in R 数理统计与 R 语言应用

    Credits: 3; 48 teaching hour

    Specific course information: This course is a 3-unit graduate-level course in the theory of mathematical statistics. The primary objective of this course is to provide students with a basic foundation in statistics and prepare them for future specialized statistical courses. It will introduce students with statistical theory at a level that will enable students to correctly use statistical mythologies both in practice and research. Another component of this course is the introduction to R. Students will learn not only applications of mathematical statistics but also solving problems using R. Topics covered in this class include statistics and sampling distributions, overview of limit theorems; point estimation—methods and criteria, sufficiency, interval estimation, hypothesis tests, and goodness-of-fit tests.

46. **Course Name**: Introduction to Queuing Theory and its Applications   排队论及其应用

    Credits: 3; 48 teaching hour

    Specific course information: Queueing theory is one very important subject in operations management. The objective of this course is to help students learn about the basic mathematical models and analysis techniques in queueing theory, as well as its various applications in practice. From this course, students will have an understanding about what kinds of problems can be modeled as a queueing model, how to derive various performance measures, such as customer waiting time and queue length, and how to optimize a queueing model, in terms of minimizing the cost or waiting time.

47. **Course Name**: Seminar in Data Science and Information Technology 数据科学与信息技术讨论课

Credits: 2; 32 teaching hour

Specific course information: This is a seminar course on the intersection of information theory and machine learning geared towards first or second-year graduate students who are interested in the fundamental aspects and the state-of-art developments of these subjects. In this course, classical literatures in different topics in information theory and machine learning will be selected and discussed every week. In addition, each student will be asked to select a topic and present their reflection about the selected literatures. The presentation will be conducted in the manner of interactive discussions, so students can share their opinions with each other. Finally, some celebrated scholars around the world will be invited as guest speakers to present the up-to-date research results in information theory and machine learning. Finally, some celebrated scholars around the world will be invited as guest speakers to present the up-to-date research results in information theory and machine learning.

48. **Course Name**: Fundamentals of Digital Image and Video Processing 数字图像与视频处理

Credits: 3; 48 teaching hour

Specific course information: Signal, image and video processing continues to enable the multimedia technology revolution we are experiencing today. The course is an interdisciplinary course presenting the theory and practice of Signal, Image and Video Processing. We will learn the science behind how digital images and video are made, altered, stored, and used. Meanwhile, we will look at the vast world of digital imaging, from how computers and digital cameras form images to how digital special effects are used in various areas. The course starts with the fundamentals of how the human visual system works, followed by the engineering, mathematics, and computer science that makes digital images work. We will show the basic algorithms used for adjusting images, explore JPEG and MPEG standards for encoding and compressing video images, and go on to learn about image segmentation, noise removal and filtering. Finally, we will end with state-of-the-art image and video processing techniques used in various areas. In all cases, example images and videos pertaining to specific application domains will be utilized.

49. **Course Name**: Operations Research 运筹学

Credits: 3; 48 teaching hour

Specific course information: This course introduces commonly used methods of deterministic and stochastic operations research. Topics that can be taught include linear programming, simplex algorithms, duality, network flow, integer programming, dynamic programming, convex optimization, Markov chains, Markov process, queuing theory, and decision analysis. However, based on the need of each class, some of the topics may be skipped or new topics could be added.

50. **Course Name**: Estimation and Control of Dynamical Systems 动力系统的评价与控制

Credits: 3; 48 teaching hour

Specific course information: This graduate level course studies dynamical systems in time domain with inputs and outputs. We will learn how to design the estimator and controller for a system to ensure desirable properties (e.g., stability, performance, robustness) of the dynamical system. In particular, we will focus on systems that can be modeled by linear Ordinary Differential Equations (ODEs) and that satisfy time-invariance conditions. The course will introduce the fundamental mathematics of linear spaces, linear operator theory, and then proceeds with the analysis of the response of linear time-variant systems.

51. **Course Name**: Advanced Managerial Economics 高级管理经济学

Credits: 2; 32 teaching hour

Specific course information: Managerial economics is a branch of economics, managerial economics for business decision-making provides a systematic and logical analysis method, the management decision not only affects the day-to-day decisions, also affect the economic force of the long-term planning and decision-making, microeconomics in the practice of management, is the bridge of communication theory of economics and business management decision-making for enterprise decision-making and management to provide analysis tools and methods, the theory is mainly around demand, proposed several production, cost, market and other factors. How to analyze and compare the alternatives of the management economics, and find out the most likely solutions to the enterprise target. In this decision process, the

function of management economics is to provide the related analysis tools and analysis method.

52. **Course Name**: Foundations for Big Data Analytics 大数据分析基础

Credits: 2; 32 teaching hour

Specific course information: Commerce and research are being transformed by data-driven discovery and prediction. Skills required for data analytics at massive levels – scalable data management on and off the cloud, parallel algorithms, statistical modeling, and proficiency with a complex ecosystem of tools and platforms – span a variety of disciplines and are not easy to obtain through conventional curricula. The course will be focused on basis of statistics, data analytics, big-data systems and big-data applications.

53. **Course Name**: ITS and High-accuracy Positioning Technologies 智能交通高精度定位

Credits: 2; 32 teaching hour

Specific course information: The course will introduce common knowledge and the latest development of high-accuracy positioning in ITS. The course will cover the architecture and technologies of highly accurate positioning, including Global Navigation Satellite System, Inertial Navigation, Map Matching, and Optimal State Estimation Theories. During the course, students will practice programming robot positioning to help them master the theories, as well as they will make literature survey and present the results.

54. **Course Name**: Mobile and Pervasive Computing 移动设备和普适计算

Credits: 1; 16 teaching hour

Specific course information: This is a course exploring research issues in the newly emerging field of mobile computing. Many traditional areas of computer science and computer engineering are impacted by the constraints and demands of mobility. Examples include network protocols, power management, user interfaces, file access, ergonomics, and security. This will be an "advanced" course in the truest sense--most, if not all, the topics discussed will be ones where there is little consensus in the

research community on the best approaches. The course will also offer significant "hand-on" experience in this area. Each student will have to present and lead the discussion on a number of papers. Each student will also be required to write one of two documents: (a) a research proposal (similar in spirit to an NSF proposal) on an idea in mobile computing or (b) a short business plan for a commercial opportunity in mobile computing. Grading will be based on the quality of the presentations, and the proposal or business plan.

55. **Course Name**: Energy Systems and Control 能源系统与控制

Credits: 1; 16 teaching hour

Specific course information: Introduction to control system tools for students interested in energy system applications. Applications of interest include batteries, electric vehicles, renewable energy, power systems, and smart buildings/homes. Technical tools include system modeling, state-space representations, stability, parameter identification, state observers, feedback control, and optimization. Prerequisites: Graduate student standing, multivariable calculus, linear algebra, programming, physics-mechanics, physics-electromagnetism, thermodynamics.

56. **Course Name**: Analysis and Optimization on Logistics System 物流系统分析及优化

Credits: 2; 32 teaching hour

Specific course information: This course is aimed at introducing the basic models and algorithms, latest developments and practical applications associated with some typical logistics systems, such as seaborne transportation, regional distribution, logistics within factory, and so on. In the course, location and allocation problem, routing problem, lot-sizing problem, operation management in hub nodes and other topics of interest and relevance will be covered. Focuses will be concentrated on both theoretic research and practical application. Through the course, the students will have an in-depth understanding on the basic problems related to logistics systems and its latest developments in the literature and industrial application, and most importantly, the students will be able to utilize the proper mathematical tools, such as mixed integer programming, dynamic programming, heuristic algorithm, and so on, to solve the real-life problems. Therefore, this course will help enhance the following competences for the students: problem analysis, mathematical modeling, algorithm design and computer programming.

57. **Course Name**: Introduction to Advanced ITS 现代智能交通系统导论

Credits: 2; 32 teaching hour

Specific course information: The course will focus on the newly development of intelligent transportation systems in the world. The most advanced techniques will be explored to provide solutions to meet the global challenges of safety, efficiency and pollution. Beside the introduction of the theory for traffic flow, planning and design, the most advanced techniques will be explored to provide solutions to meet the global challenges of safety, efficiency and pollution, including data fusion, status perception, GPS, big data, smart city, intelligent vehicle-infrastructure cooperative systems, autopilot and information security, etc.

58. **Course Name**: Traffic Modeling and Simulation 交通建模与仿真

Credits: 2; 32 teaching hour

Specific course information: The course will cover various modeling and simulation approaches used in studying traffic dynamics and control in a transportation network. The model-based simulation tools discussed include dynamic macroscopic and microscopic traffic flow simulation and assignment models. Models will be analyzed for their performance in handling traffic dynamics, route choice behavior, and network representation.

59. **Course Name**: Hybrid System Design for Smart City 智慧城市混合系统设计

Credits: 2; 32 teaching hour

Specific course information: This course consists of three major sections: 1. System modeling and analysis, which includes basic structural dynamics, finite element method and experimental methods; 2. Data collection, processing and interpretation, including mobile sensor net, machine learning techniques and their applications on structural health monitoring; 3. Sustainability and resiliency that covers performance-based engineering, risk and reliability analysis, especially under extreme events, and their corresponding decision making for integrated/holistic design.

60. **Course Name**: Introduction to Nonlinear Optimization 非线性优化概述

Credits: 1; 16 teaching hour

Specific course information: The course cover theory and algorithms for nonlinear continuous optimization. We start with some examples of applications of nonlinear programming. Then we proceed with characterization of necessary and sufficient conditions for and optimum of unconstrained and constrained optimization problems, the KKT conditions, and specific results that hold under convexity assumptions. We then study local and global convergence theory with application to specific algorithms and explore the impact of structural properties of the objective function on algorithms' performance.

61. **Course Name**: Introduction to Quantitative Investment 量化投资概论

    Credits: 2; 32 teaching hour

    Specific course information: The emphasis in this course is basic theories and applications of Financial Engineering. The main topic areas (in order covered) are: (1) Introduction of financial markets (2) Time value and financial return (3) Volatility and financial risk (4) Financial Stochastic processes (5) Traditional and behavioral finance theories (6) Portfolio management (7) Pricing of financial instruments. At the end, an experiment will be held in financial engineering lab to introduce a computer software for practicing all knowledge in this course by several case studies.

62. **Course Name**: Optimization Theory and Machine Learning 优化理论和机器学习

    Credits: 1; 16 teaching hour

    Specific course information: The course covers several topics on optimization theory, numerical algorithms, machine learning, and different applications. It provides a basic understanding of the area and yet identifies important challenging problems for research. In particular, the students learn about the role of convex and conic optimization in machine learning and data science (such as lasso type algorithms) and how to apply these techniques to real-world data for human brain, transportation, power systems and many others. The course also discusses the design of efficient algorithms for solving large-scale learning problems.

63. **Course Name**: Compressive Sensing with Sparse Models:Theory, Algorithms, and Applications 压缩感知与稀疏模型：理论、算法与应用

Credits: 1; 16 teaching hour

Specific course information: This graduate level course introduces basic concepts and results in low-dimensional models for high-dimensional signal processing and data analysis, spanning basic theory, efficient algorithms, and diverse applications. We will discuss recovery theory mainly for sparse models. We will introduce principles and methods for developing efficient optimization algorithms, with an emphasis on simple and scalable first-order methods, covering state of the art convex and greedy algorithms. We will illustrate the theory and algorithms with numerous application examples, drawn from computer vision, image processing, communications. The course will provide ample mathematical and programming exercises with supporting algorithms, codes, and data. Throughout the course, we will discuss strong conceptual, algorithmic, and likely theoretical connections between low-dimensional models with other popular data-driven methods such as deep neural networks (DNN), providing some new perspectives to understand deep learning.

64. **Course Name**: Computational Methods for Electric Power Systems　电力系统计算方法

Credits: 2; 32 teaching hour

Specific course information:　　This course introduces various computational methods for power flow calculation and their convergence analysis. Students should be able to use Matlab to accomplish power flow calculation satisfying the requirements of computation speed and accuracy. Those are the common and practical problems in electrical power systems, which must be mastered by the students majoring in electrical power system and understood by students in other majors who are interested in power systems and numerical methods.

65. **Course Name**: Resilience-based Engineering of Smart Infrastructure Systems 基于弹性工程学的智慧建筑系统

Credits: 1; 16 teaching hour

Specific course information:　　This course consists of three major sections: 1. System modeling and analysis, which includes basic structural dynamics, finite element method and experimental methods; 2. Data-driven Structural Health Monitoring, including machine learning techniques and their applications on structural health monitoring; 3. Sustainability and resiliency that covers performance-

based engineering, risk and reliability analysis, especially under extreme events, and their corresponding decision making for integrated/holistic design.

66. **Course Name**: System Miscellanies 系统杂论

    Credits: 2; 32 teaching hour

    Specific course information: This graduate level course studies different types of systems from different viewpoints, mainly including dynamical systems, networked systems, and nonlinear systems. First on dynamical systems, students will learn several aspects of dynamical systems theory (e.g., equilibria, stability, bifurcation, chaos) and how it is applied in a range of examples. Second on networked systems, students will learn some of the best-studied networked systems and their properties (e.g., Internet congestion control schemes, synchronization in oscillator networks, consensus in multi-agent systems). Third on nonlinear systems, students will learn some techniques for analysis and control design for nonlinear systems (e.g., stability theory, passive systems).

67. **Course Name**: Power Systems and Market Operations 电力系统与市场运行

    Credits: 3; 48 teaching hour

    Specific course information: Currently, the first provincial electricity market in China is under construction here in Guangdong. This course will focus on power system operations and electricity markets, providing students who are interested in penitent areas with necessary basic knowledge. Namely, the content of this course includes but not limited to: (i) power system modeling and power flow analysis, (ii) energy management system, (iii) basic structure and design of electricity markets, (iv) market equilibrium and market power, (v) interregional market, retail market, and comprehensive energy market.

68. **Course Name**: Quantitative Method for Business and Policy Analysis 商业和政策 分析的定量方法

    Credits: 3; 48 teaching hour

    Specific course information: This course is a methodology disciplines for integration economics, mathematics, statistics and computer application. From the

application point of view, the econometric approach is to establish an econometric model. Econometric model is a mathematical simulation of the real economic environment. With one or a set of simultaneous equations to reflect the link between economic variables. The main content includes model design, estimation, testing, the econometric problems of basic assumptions contrary, model analysis and applies, use of econometrics package description.

69. **Course Name**: Large Network Steady-State Analysis 大型网络稳态分析方法

Credits: 3; 48 teaching hour

Specific course information: This course focuses on basic mathematical tools to study large scale networks under steady-state assumptions, such as the sparse matrix technique, the Woodbury matrix identity, update of factor tables after small disturbance, network partition and equivalence, and parallel and distributed computations. Power networks will be used as examples in many cases but methodologies presented in this course are applicable to a variety of engineering problems.

70. **Course Name**: Information Theory and Statistical Learning 信息论与统计学习

Credits: 3; 48 teaching hour

Specific course information: This is a course on the intersection of information theory and machine learning geared towards first or second-year graduate students who are interested in the fundamental aspects and the state-of-art developments of these subjects. The course is geared towards students who are interested in understanding machine learning, data mining, and information theory at a fairly sophisticated level, and to carry out research involving the applications of the mathematical frameworks to machine learning problems. One of the objectives of the course is to understand the fundamental perspectives and develop solid connections between mathematical theory and learning systems.

71. **Course Name**: SPECIAL ISSUES IN SEMICONDUCTOR OPTO-ELECTRONIC DEVICE MANUF 半导体光电器件制造中的特殊问题

Credits: 2; 32 teaching hour

Specific course information: While silicon ICs have become ubiquitous in many smart appliances, optoelectronic devices such as solar cells, LED lighting, LED displays, and 3D sensors that use VCSELs and other lasers are becoming increasingly visible, besides being the backbone of fiber-optic communications. This course will teach students already familiar with semiconductor devices about developing opto-electronic devices such as leds, lasers and photodiodes made from compound semiconductor materials.

72. **Course Name**: Reinforcement Learning for Energy Systems 能源系统的强化学习

Credits: 1; 16 teaching hour

Specific course information:　　Introduction to reinforcement learning for students interested in energy system applications, in addition to transportation, robotics, economics, and more. The objective is to provide students with the fundamental concepts to understand and apply reinforcement learning algorithms. Students will strengthen both their theoretical understanding, and experience applications of reinforcement learning through a course project.

73. **Course Name**: Machine learning, with application to medical and financial data 机器学习及其在医疗和金融数据上的应用

Credits: 1; 16 teaching hour

Specific course information: This seminar style course will cover the most recent research topics on theory and applications of machine learning, includinf some most recent research progress with respect to applications in the areas of medical diagnosis and financial risk management.

74. **Course Name**: Bayesian Learning and Data Analysis 贝叶斯学习与数据分析

Credits: 2; 32 teaching hour

Specific course information: The course introduces Bayesian statistics and its application to learning. It starts with the philosophical foundations of Bayesian theory. It gives a historical perspective and it proceeds to the development of the mathematical framework both analytically and numerically. It introduces Monte Carlo methods for the calculation of Bayesian estimation, starting from basic sampling methods progressing to Markov chain Monte Carlo methods including

Gibbs sampling. The course also studies model selection problem and discusses Reversible Jump MCMC method and shows its extension to beyond selection of model dimension. The course than presents Sequential Monte Carlo methods, namely Particle filtering for the solution of time-varying estimation problems

75. **Course Name**:　Random Processes 随机过程

Credits: 3; 48 teaching hour

Specific course information: The course starts with probability theory fundamentals, starting from a single random variable and its probabilistic description, then moving to two random variables and a random vector and then generalizing this discussion to a multiple random variables in a sequence hence a random or stochastic process. We will provide a characterization of random processes also in the transform domain and present spectrum analysis. Random walks such as Brownian Motion will be presented and its applications in various contemporary topics will be mentioned. The discussion will also be extended to Levy flights. This will lead to the discussion on normality of Gaussian processes and its extension to Levy-stable processes.

76. **Course Name**:　Advanced Signal Processing: Methods and Practice 高级信号处理：方法与实践

Credits: 3; 48 teaching hour

Specific course information: This course covers the signal representation/analysis, especially how to represent the complex signals in simple format either in time or frequency domain. Based on that, it also covers how signals behave after passing through various linear, time-invariant systems. It consists of following individual yet highly related sessions including Introduction, time-domain analysis on the linear, time-invariant systems, signal representation in frequency domain (Fourier analysis & Fourier transform), Laplace Transform, Discrete time-domain signals, Z-Transform, Discrete & Fast Fourier transform, the state space analysis of the linear systems, and etc. This course focuses on the basic theory and analytical method from time-domain to transform domain, from continuous to discrete, from the description of single-input-single-output to the state variables. It will lay down a solid foundation for the further study for courses including Digital Signal Processing, Stochastic Process, Communication Circuit, Principle of Communication.

77. **Course Name**: Nanogenerators and Self-powered Systems 纳米发电机与自驱动系统

Credits: 3, 48 teaching hour

Specific course information: Nanogenerators are the emerging frontier research in the field of nanotechnology and will enable the applications for IoT, human-machine interfacing and etc. This course will introduce the basic principles, structural construction, performance analysis of nanogenerators and self-powered sensing systems based on nanogenerators. The purpose is to enable graduate students to understand the physical mechanism of triboelectric charging and how nanotechnology can convert triboelectric charging into useful currents, expand students' knowledge of physics, enhance their knowledge of cutting-edge nanomaterials and sensor design, and lay the foundation for their subsequent research work.

78. **Course Name**: Time series analysis 时间序列分析

Credits: 3, 48 teaching hour

Specific course information: This course aims to compensate a missing dimension in Data Science/Machine Learning studies addressing the analysis of data which changes over time, that is time-series. It will provide students with the tools for analyzing time-series data. The course start by building a background on random/stochastic processes and frequency transforms. We will then discuss parametric process models for time-series such as AR, ARMA, etc and provide classical estimation methods. We will then extend the discussion to prediction and forecasting. Unlike classical courses on Time-Series Analysis we will cover also non-stationary time series, introducing methods and transforms. We will also extend multivariate analysis to graph time series. We aim to present also implementations using R or Python.

Track 3

79. **Course Name**: Design of Precision Medicine Platforms for Disease Diagnosis and Therapeutics 精准医疗平台的设计及其疾病诊断和治疗应用

Credits: 1; 16 teaching hour

Specific course information: This course provides fundamental understandings and introductory advances on the development of precision medicine. The course covers the topics in cancer biology and therapeutics, point-of-care diagnosis, biomarkers, biomicrofluidics and microreactors, biomaterials and biofabrication, organoids, personalised therapeutics, stem cell biology and therapy, molecular genetics and gene therapy, etc.

80. **Course Name**: Translational Research(C) 转化研究（C）

Credits: 1; 16 teaching hour

Specific course information: For the part I, introduce students to the general and technical aspects of noninvasive cancer markers. It covers imaging, cutting-edge molecular technologies for biomarker development, and noninvasive or minimally invasive sources of molecular markers, as well as quality control and ethical issues in cancer biomarker discovery. For the part II, introduce students to the use of nanotechnology in diagnostics ranging from single molecule diagnostics to cell based systems.

81. **Course Name**: Introduction to Mechanobiology 机械生物学介绍

Credits: 2; 32 teaching hour

Specific course information: This course provides fundamental understanding in the decisive roles of mechanical forces during development of tissues and organs, during remodelling following injury as well as in normal function. The course covers: mechanical properties of cytoskeletal polymers; mechanical properties of the cell membrane; roles of matrix mechanical properties on cell adhesion and function; effects of mechanical loading on cell cytoskeletal remodelling; mechanical testing of cell-populated matrices; cell migration behaviour in 3D matrices; roles of mechanics in cartilage development; roles of both cellular and external forces on tissue morphogenesis; roles of mechanical forces on tumour growth and cancer metastasis.

82. **Course Name**: Technology Advances for Regenerative Medicine 再生医学技术进展

Credits: 3, 48 teaching hour

Specific course information: The science of regenerative medicine and, in particular, the design of intelligent biomimetic materials that are capable of interacting with their biological environment have been evolving rapidly in the last two decades. Regenerative medicine uses a combination of approaches, including biomedical materials science, gene therapy, stem cell transplantation, tissue engineering and mechanical engineering. The overall course is designed to develop key research-based skills and, in particular, prepare students with knowledge of this rapidly evolving science and industry. Various processes on the cellular, tissue and organ levels will be used as illustrative examples to highlight conserved principles governing tissue repair and regeneration. The students will learn about technological breakthroughs in stem cell therapy, biotechnology, bio-inspired materials and genetic studies. This course will introduce the latest methods in regulating and modulating the biological, chemical and mechanical properties in novel bioengineered constructs, obtaining functional organ mimics.

83. **Course Name**: Introduction of biophotonics 生物光子学方法与实践

Credits: 3, 48 teaching hour

Specific course information: Introduction of biophotonics is a multidisciplinary course which can serves as a mandatory core course for graduate students of life science major, or an elective course for those from other related majors such information technology and manufacturing. The course includes brief introductions on the basic physics for photon-matter interactions and the corresponding physics observables, on different biophotonics sensing and imaging techniques which retrieve these observables and disentangle the encoded information on the structure and dynamics of the biological system, and on typical applications of these techniques in both biomedical and other related fields. The course includes laboratory practice which allows the students to know the essential hardware modules and the data processing techniques of biophotonics imaging and sensing apparatus, such as light sources, optical components, detectors, data processor and displays. The students will be prepared to incorporate into their own work the latest technological advances in optics and related fields, such as cloud computing and big data..

84. **Course Name**: Introduction to Computer-Aided Tissue Engineering 计算机辅助组织工程

Credits: 2; 32 teaching hour

Specific course information: Introduction to Computer-Aided Tissue Engineering (CATE) is designed for graduate and senior undergraduate students in engineering and bioengineering major who are interested in acquiring the knowledge and skill in utilizing computer-aided technologies for tissue engineering application. The course will introduce: 1) the engineering and bioengineering aspect of tissue regeneration; 2) basics of computer-aided design, computer-aided engineering, and computer-aided manufacturing (CAD/CAM/CAE); 3) knowledge on the use of integrated CAD/CAE/CAM technology in tissue engineering application; and 4) a hand-on experience on using enabling CAD, medical imaging processing and three-dimensional reconstruction software, and 3D Printing technology for tissue scaffold design, modeling, simulation, and freeform fabrication.

85. **Course Name**: Translational Research (B)）转化研究（B）

Credits: 1; 20 teaching hour

Specific course information: Stem cells can self-renew and differentiate into a variety of specialized cells. Regenerative medicine studies the function of stem cells in organ formation, tissue repair and methods to use stem cells to create de novo tissues and organs. The format of this course includes lecturing, literature discussion, laboratory experiments and essay writing. The aim of the course is to give students a comprehensive view of the basic knowledge, fundamental methods, milestone discoveries, and challenges in stem cell research and regenerative medicine.

86. **Course Name**: Introduction to Advanced Medical Device Design and Fabrication 高端医疗器械设计及制造概论

Credits: 1; 16 teaching hour

Specific course information: Introduction to Advanced Medical Devices Design and Fabrication(AMDDF) is designed for graduate and senior undergraduate students in engineering and bioengineering major who are interested in acquiring the knowledge and skill in advanced medical device technologies and their applications. The course will cover: 1) the engineering and biology aspects and fundamentals of advanced medical devices; 2) basics of design, engineering, and fabrication of In-vitro

diagnostics, advanced medical imaging systems, and implants; the development procedures and evaluation methodologies of medical devices; and 4) the quality controls and regulations of medical devices in different countries and regions.

87. **Course Name**: Tissue Engineering 组织工程

    Credits: 1; 16 teaching hour

    Specific course information: The goal of tissue engineering is to fabricate substitutes to restore tissue structure and functions. Understanding cell function in response to environmental cues will help us to establish design criteria and develop engineering tools for tissue fabrication. The objectives of this course are: (1) To introduce the basics of tissue engineering, including quantitative cell and tissue characterization, 3D fabrication, extracellular matrix and biomaterials, and immuno-modulation/isolation; (2) To illustrate the cutting-edge research in tissue engineering; (3) To build up the skills in analyzing and designing engineered tissue products. Lectures will be based on the reference books and recent literature. Students will have opportunities to interact with faculty and learn the basic theory and lab skills, as well as the state-of-the-art in this field.

88. **Course Name**: Soft Material Module 1: Biological Soft Materials 软质材料模块 1：生物软质材料

    Credits: 1; 16 teaching hour

    Specific course information: This course is designed for students to gain a fundamental understanding in the soft matter, biomaterials and their application toward biomaterials. Beginning with a brief introduction of the principles governing polymer and biomacromolecule's phase behavior in bulk, in thin films and at interfaces, the characterization techniques to assess their behavior under biologically relevant conditions, the course will provide general knowledge critical for students to build fundamental knowledge in how to design, engineering and validate biomaterials relevant to nanotechnology and biotechnology.

89. **Course Name**: Soft Material Module 2: Synthetic and Hybrid Soft Materials 软质材料模块 2: 合成、混合软材料

    Credits: 1; 16 teaching hour

Specific course information: This course is designed for students to gain a fundamental understanding in the soft matter, biomaterials and their application toward biomaterials. Beginning with a brief introduction of the principles governing polymer and biomacromolecule's phase behavior in bulk, in thin films and at interfaces, the characterization techniques to assess their behavior under biologically relevant conditions, the course will provide general knowledge critical for students to build fundamental knowledge in how to design, engineering and validate biomaterials relevant to nanotechnology and biotechnology.

90. **Course Name**: Soft Material Module 3: Fabrication of Biomaterials 软质材料模块 3：生物材料制造工程

    Credits: 1; 16 teaching hour

    Specific course information: This course is designed for students to gain a fundamental understanding in the soft matter, biomaterials and their application toward biomaterials. Beginning with a brief introduction of the principles governing polymer and biomacromolecule's phase behavior in bulk, in thin films and at interfaces, the characterization techniques to assess their behavior under biologically relevant conditions, the course will provide general knowledge critical for students to build fundamental knowledge in how to design, engineering and validate biomaterials relevant to nanotechnology and biotechnology.

91. **Course Name**: Vision and Imaging Science 视觉及影像科学

    Credits: 1; 16 teaching hour

    Specific course information: This is a 1-unit graduate level course about the eye vision research and imaging technology for understanding modern basic and translationalresearch.The course will review current knowledge and technological tools in cell and development biology, genetics, stem cell, tissue engineering and molecular and cellular imaging. Recent progress in biomedical detection and imaging as well as innovative approaches for the future will be explored. The primary goal of the course is to better prepare students for research activitiesin academia or industry. The focus is to promote their ability in research development and creative thinking. The course provides specific information to address students'research interests and assessments.

92. **Course Name**: Current Topics in Cancer Biology 癌症生物学的研究现状

Credits: 3; 48 teaching hour

Specific course information: Cancer is a heterogeneous multitude of diseases of varying aetiology. It is characterized by aberrant cell proliferation and survival combined with the propensity to invade surrounding tissues and metastasize to distant organs with metastatic complications being the predominant cause of mortality. The science of, and therapeutic approaches in oncology encompass multiple interdisciplinary approaches. These include genomics and proteomics, gene therapy, cell and organ biology, medicine, materials science, pharmaceutical chemistry and bioengineering among others. The aims of this course are multiple: (1) To improve students basic and clinical understanding of the disease; (2) To introduce students to relevant and topical areas of research interest in cancer; (3) To develop the analytic capacity of the students to identify areas of unmet research need in cancer; (4) To train students to confidently present, question and discuss science in both a formal and informal context.

93. **Course Name**: fMRI physics and practical data analysis 磁共振成像物理原理与数据分析

Credits: 3; 48 teaching hour

Specific course information: fMRI, one of the most developed form of neuroimaging technology, allows noninvasive assessment of brain activity and function. Imaging phenotype is critical for precision medicine in the brain due to the complex nature of brain diseases. In this course, I will introduce the basic physical principle of fMRI imaging, statistical method for data analysis, and the python programming for the implementation to analyze fMRI data.

94. **Course Name**: Experimental biology 实验生物学

Credits: 3; 48 teaching hour

Specific course information: This course is intended to provide a comprehensive and hands-on training on fundamental experimental skills and theoretical background behind. Students will learn the basic biological experimental skills including cell culture, cell storage, virus packing, virus transduction, gene cloning, DNA gel, protein expression, purification, characterization, protein gel, FPLC, et al. Each week's session will be composed of a 2.5-hour lectures and 5-hour laboratory.

Students will be arranged into 2-3 groups and perform three independent lab section. After they completed each section, they will switch to next section to learn all the fundamental biology techniques. As this is a graduate course, grades will reflect a certification of training, rather than a competition between students.

95. **Course Name**: The molecular basis of cancer 癌症的分子学基础

Credits: 3; 48 teaching hour

Specific course information: Introduction to the molecular basis of cancer covers current concepts and knowledge of cancer. This course will educate students on various genetic and molecular changes normal cells undergo during the transformation into malignant cancer cells. This course will explore the cellular and molecular mechanisms underlying cancer development with the aim of understanding how changes in the normal growth and division processes lead to the formation of tumors. Topics include the oncogenes, tumor suppressors, cell cycle regulation, DNA repair mechanisms, epigenetic changes, cellular immortalization, tumorigenesis, angiogenesis, metastasis, and current therapeutic approaches to cancer treatment.

96. **Course Name**: The Immunology of Emerging Infectious Diseases 新兴传染病的免疫学

Credits: 3; 48 teaching hour

Specific course information: Immunology underpins virtually every aspect of human health and disease, incl. in infectious diseases. This course will provide students with a fundamental understanding in immunology and infectious diseases in the context of modern societies. Students will learn about the immune system and how it can fight infection, and how an immune response can fail and contribute to severe disease outcomes in infectious diseases settings. Students will learn examples of different types of clinically relevant infectious agents and the type of immunity they activate. In addition, students will learn how infectious agents can overcome the natural immune response and cause disease. Importantly, students will learn about recent emerging infectious diseases of human health significance and the immune response toward these novel infectious diseases, exemplified by the novel 2019 coronavirus disease. The course will also illustrate how the immune response against these agents can be manipulated through the use of vaccines, incl. in host-directed immunotherapy which is becoming an increasingly important and relevant component in precision medicine and healthcare.

By the completion of the course, students are expected to have a fundamental knowledge in immunologic processes during the course of infectious diseases incl. those caused by emerging infectious diseases, and in relevant and topical areas of research interest in immunology and emerging infectious diseases. Moreover, students are expected to develop the analytic capacity to identify areas of unmet research need in immunology of emerging infectious diseases, and to confidently present, question, and discuss science in both a formal and informal context among peers.

97. **Course Name**: Introduction to traditional chinse medicine 中药基础理论

Credits: 2; 32 teaching hour

Specific course information: Traditional Chinese Medicine (TCM), which is the quintessence of the Chinese culture heritage, has a long history of 5000 years as that of the Chinese nation and has made an everlasting contribution to the Chinese Nation survival and producing offspring and prosperity. More and more problems cannot be solved by western medicine in the 21st Century. TCM theory emphasizes on the self-healing power of man for curing diseases and keeping fitness, and many of its therapies are employed for enhancing this power. This course is intended to introduce the fundamental theory of TCM. Students will learn the history, principle, and diagnosis of TCM. Grades is composed of participation in course sessions (10%), completion of in-class exercises (20%) and homework (35%), and two in-class quiz (25%). Auditors are welcome (and encouraged) to take the course, but regular attendance and participation is required.

Mandatory course

98. **Course Name**: 英语专业写作与表达 English Academic Writing and Communication

    Credits: 2; 32 teaching hour

    Specific course information: This course is designed for TBSI Chinese postgraduate students who aim to use English in the methods and aims of advanced-level research and scholarship. By the end of this course, participants will be able to achieve the following outcomes: • Provide critical evaluation of research-based, scholarly arguments and academic papers in the subject-related fields; • Write and publish scientific articles in academic English; • Learn to take into consideration the expectations of one's readership with regard to academic writing discourse; • Identify, locate, cite, and evaluate scholarly critical resources at postgraduate level; • Analyze and interpret an academic text with increasing sophistication; • Present and participate at international academic conferences.

99. **Course Name**: 中国文化概览 A Panoramic View of Chinese Culture

    Credits: 2; 32 teaching hour

    Specific course information: This course is designed for postgraduate students, which aims to improve the skills of English expression of Chinese culture.

100. **Course Name**: Professional Development and Presentation 职业发展与专业表达

    Credits: 2; 32 teaching hour

    Specific course information: This course offers students a variety of experiences that develop basic concepts of the oral and written communication process. The class includes scientific writing as well as speech preparation and delivery. It is the General Education requirements for PhD and Master's students at Tsinghua-Berkeley Shenzhen Institute and is a required course all students. The grade will be based on the work completed in each of three parts, namely writing training, debate, and oral presentation. Each unit consists of a variety of weekly assignments that will introduce students to communication theory and practice, as well as prepare students for the preparation of a formal scientific writing and delivery of a speech. This course

requires three mandatory essay assignments from each student in the first parts. Students will also be required to participate the debate over the assigned topics in the second part. In the third part, each student will be couched and deliver a 18-minute TED style talk. Through the above three parts, students will have the opportunity to enhance their ability to sharpen their ideas on scientific research and to present the ideas smoothly, efficiently, and convincingly. In addition to traditional classroom, students are encouraged to interact with each other and the instructor. The course is designed to foster a sense of community among classmates.

101. **Course Name**: Theory and Practice of Socialism with Chinese Characteristics 中国特色社会主义理论与实践研究

Credits: 2; 32 teaching hour

Specific course information: In addition to the basic content of the course recommended by the Ministry of Education "Science socialist theory and practice" teaching the provisions of the To teach, but also appropriate added to the contemporary world situation and the evolution of international political and economic history, causes and trends, the world socialist movement toward the concrete process and other aspects of history, in a bid to the international history of the evolution of social patterns Perspective on the evolution of modern times, the process of the socialist movement of history, achievements and problems of a full range of perspective and analysis, enabling students to a more broad historical background and international perspective on the history of socialism and the inevitable nature of the reasons to have a more profound Awareness

102. **Course Name**: Chinese Marxism and Contemporary World 中国马克思主义与当代

Credits: 2; 32 teaching hour

Specific course information: 中国马克思主义是马克思主义与发展着的时代和发展着的中国实际相结合的产物，它是马克思主义的中国化，是马克思主义在中国的继承、丰富、创新和发展。中国马克思主义包括着马克思主义中国化两次历史性飞跃所形成的伟大理论成果。马克思主义中国化第一次历史性飞跃所形成的伟大理论成果是毛泽东思想；马克思主义中国化第二次历史性飞跃所形成的伟大理论成果是中国特色社会主义理论体系（邓小平理论、"三个代表"重要思想、科学发展观）。《中国马克思主义与当代》课程，既不是单纯讲授中国马克思主义，也不是单纯讲授当代和当代问题，而是以中国马克思主义的当代视野、世界视野，以中国马克思主义的立场、观点、方法去透视当代，去分析当代的重大矛盾和问题，把中国马克思主义的立场、观点、方法渗透到对当代

的重大矛盾和问题的分析、回答和解决过程中，通过对当代的重大矛盾和问题的分析、回答和解决，使博士生更深刻地掌握中国马克思主义的立场、观点和方法。

103. **Course Name**: Introduction to Dialectics of Nature 自然辩证法概论

Credits: 1; 18 teaching hour

Specific course information: The Outline of Dialectics of Nature The Second Lecture: The Establishment and Development of Dialectical Materialism of nature The Third Lecture: on Science and Technology of Marxism The Fourth Lecture: Scientific Knowledge Production and Innovation-oriented Country The Fifth Lecture: Science and Technology and The Harmonious Development of Society The Sixth Lecture: Scientific Development and Ecological Civilization

104. **Course Name**: Introduction to Creativity, innovation, startup, makers and venture capitals 创意创新创业与创客创投概论

Credits: 1; 16 teaching hour

Specific course information: "Creativity, innovation, startup, makers and venture captals" is a novel course introducing the total process of starting a new startup company, including creative thinking, innovative consciousness, makers, entrepreneurship ability and venture capitals. This course will be practical and invite experts and enterprising men for lectures and discussions. The course has five topics, including creative thinking, innovative consciousness, makers, entrepreneurship ability and venture capitals. Each topic will be hold for 3 hours. Last lesson will be the roadshows of students, and winners will be rewarded with venture fund and startup fields.

105. **Course Name**: Capstone Project 创新训练营

Credits: 1; 16 teaching hour

Specific course information: Capstone Project is an innovation research course open for all TBSI doctoral students. Students will be provided with advisors' guidance and team support so as to conduct research on global major challenges. More importantly, students will learn how to use their initiative and exercise their leadership. All the

students are expected to fully utilize their practical knowledge to bring forward a proposal for resolution of the challenge through effective teamwork in innovative research, which will increase their research and innovation capability.

106. **Course Name**: Elementary Chinese 初级汉语

   Credits: 2; 32 teaching hour

   Specific course information: The points we will study are emphasize the words and drills used in daily life.

107. **Course Name**: Intermediate Chinese 中级汉语

   Credits: 2, 32 teaching hour

   Specific course information: mainly focus on special spoken sentence patterns and words, discuss complicated issues related to life, study, social culture, etc.ssuch as the parents-kids relationship, respect life and so on, in order to possess the students with the communication abilities to speak Chinese.