Description of Postgraduate Courses -- Research Postgraduate Course Sharing Scheme (Spring Term 2024-2025)

Last Update: 15 January 2025

Important Information about HKUST Courses:

Level of Courses

All courses offered in this scheme are at postgraduate level.

Course Vector and Credits

Each course is assigned a course vector which indicates the number of instructional hours required and credits to be earned. The course vector is presented in the form of [L-T-Lab:C] where

L = lecture hours per week
T = tutorial, seminar or recitation hours per week
Lab = laboratory or field study hours per week
C = number of course credits

For example, a course vector of [3-1-2:3] denotes a course that requires 3 lecture hours, 1 tutorial/seminar/recitation hour, and 2 laboratory/field study hours each week, and carries 3 credits.

Medium of Instruction

The medium of instruction is English. Some courses will have the following notations in the course description to specify the language of reading materials or permitted spoken language (dialect) used in teaching.

[C] Courses may required students to read materials in Chinese. Students who have difficulty reading materials in Chinese should consult the instructor concerned prior to enrolling in these courses.

[Pu] / [Ca] Courses approved to be taught in Chinese carry a *[Pu]* or *[Ca]* notation in the course description, which indicates the spoken language used in teaching: *[Pu]* stands for Putonghua; and *[Ca]* for Cantonese.

Postgraduate Grades

Students receive a grade in each course in which they are enrolled. Grades range in equal increments from A+ to F (i.e. A+, A, A-, B+, B, B-, C+, C or F). The Pass, Ungraded (P) grade is given only for courses that are indicated in the course description that they will be graded as such.

CHEM

CHEM 5130	Asymmetric Catalysis	3-0-0:3
This course teaches the basic concepts and general modes of action of asymmetric catalysis and synthesis. Asymmetric catalysis is an essential tool in organic synthesis, which is used daily in various industries, such as pharmaceutical, chemical, agriculture, materials, etc. The course will provide in-depth explanation of how catalysts work in organic reactions and how asymmetric control is accomplished in different scenarios. Lectures will focus on mechanistic details of chirality control using case studies. Students are expected to be able to use this important tool to solve various synthetic problems. Background: Students		

are expected to have solid knowledge of organic chemistry, especially common reaction mechanisms, for example, CHEM 3120 Organic Chemistry II with a grade of B+ or higher, or equivalent.		
CHEM 5160	Advanced Medicinal Chemistry	3-0-0:3
Drug design, structure-activity relations, chemistry and biological effects of major classes of physiologically active and psycho-active drugs.		
CHEM 6030C	Chemistry of Energy	3-0-0:3
This course will cover topics in chemistry related to energy production, storage and transport. This will include theoretical, including quantum mechanical and thermodynamical, descriptions of energy processes for chemical energy storage, light harvesting, charge storage, energy and charge transfer, heat storage and transfer, and other material processes, while touching upon selected practical aspects of energy production and storage, such as material synthesis, device fabrication, and the relative economics of energy technologies and energy policy.		

CIVL

CIVL 5110	Engineering Risk, Reliability and Decision	3-0-0:3
Advanced reliability methods in engineering decision; Bayesian methods, system reliability and design, risk analysis, probabilistic observational method, Markov and availability models, random field, large-scale system simulation, decision with multiple objectives. Exclusion(s): CIEM 5810 Prerequisite(s): CIVL 2160 or equivalent		
CIVL 5230	Finance and Operations in Civil Engineering	3-0-0:3
[Previous Course Code: CIVL 6100E] This course introduces essential knowledge and skills in engineering financial management. Topics cover interactions of engineering, business and society, analysis of financial statements of engineering and technology companies, engineering investment, and financial and operational management.		
CIVL 5460	Landfill Engineering and Design	3-0-0:3
Practical aspects of solid waste collection methods and equipment, current available disposal techniques with emphasis on complete engineering design of landfill systems, and landfill leachate treatment will be included. Prerequisite(s): CIVL 2410		
CIVL 5550	Modeling Fluid Systems	3-0-0:3
The course focuses on the physical processes in fluid systems and their mathematical representation; includes the fundamental laws of classical mechanics and thermodynamics and how these principles are applied to fluid flow problems. The processes of waves and mixing in fluids are emphasized. The type of fluid systems to be studied varies from year to year depending on the students' interest and can range from natural to engineered systems including fluid based renewable energy systems.		
CIVL 5640	Discrete Choice Experiments and Data Analysis	3-0-0:3
[Previous Course Code: CIVL 6100M] Discrete choice modeling and stated choice methods are used in many fields to study individual, household, and organizational behavior. This course covers advanced		

discrete choice model construction, estimation, and stated choice experimental design theory and practice.		
CIVL 5730	Theoretical and Computational Soil Mechanics	3-0-0:3
Advanced soil models and recent developments in numerical methods in geotechnical modeling, including constitutive laws, critical state soil mechanics, multiple yield surface models, finite elements for boundary value problems, diffusion and consolidation problems. Background: CIVL 3740		
CIVL 6050L	Civil Engineering Seminar I	1-0-0:0
Discussion of current research by faculty members, and guest lectures on recent advances in civil engineering. Graded P or F.		

COMP

COMP 5111	Fundamentals of Software Testing and Analysis	3-0-0:3
The goal of this course is to introduce how various analysis techniques can be used to manage the quality of a software application. Students will acquire fundamental knowledge of program abstraction, features, verification, testing, refactoring, concurrency, reliability, aspect orientation, and fault analysis. The course will also discuss how to carry out the empirical experimentation for program analysis. Wherever applicable, concepts will be complemented by tools developed in academia and industry. This enables students to understand the maturity and limitations of various analysis techniques.		
COMP 5112	Parallel Programming	3-0-0:3
Introduction to parallel computer architectures; principles of parallel algorithm design; shared-memory programming models; message passing programming models used for cluster computing; data-parallel programming models for GPUs; case studies of parallel algorithms, systems, and applications; hands-on experience with writing parallel programs for tasks of interest. Background: COMP 3511 AND COMP 3711/COMP 3711H Exclusion(s): COMP 6111B, COMP 6511A, COMP 6611A, MSBD 5009		
COMP 5212	Machine Learning	3-0-0:3
Introduction to major learning paradigms and techniques, basic applied statistics and information theory, decision trees, neural networks, Bayesian classification, kernel methods, clustering, density estimation, feature selection and extraction, hidden Markov models, reinforcement learning, case-based learning, model selection and various applications. Background: COMP 2012, probability theory and linear algebra Exclusion(s): CSIT 5910, MSBD 5012		
COMP 5214	Advanced Deep Learning Architectures	3-0-0:3
[Co-list with ELEC 5680] [Previous Course Code: COMP 6211D] This course focuses on advanced deep learning architectures and their applications in various areas. Specifically, the topics include various deep neural network architectures with applications in computer vision, signal processing, graph analysis, and natural language processing. Different state-of-the-art neural network models will be introduced, including graph neural networks, normalizing flows, point cloud models, sparse convolutions, and neural architecture search. The students have the opportunities to implement deep learning models for some AI-related tasks such as visual perception, image processing and generation, graph processing, speech enhancement, sentiment classification, and novel view synthesis. Exclusion(s): ELEC 5680		

COMP 5221	Natural Language Processing	3-0-0:3
Techniques for parsing, interpretation, context modeling, plan recognition, generation. Emphasis on statistical approaches, neuropsychological and linguistic constraints, large text corpora. Applications include machine translation, dialogue systems, cognitive modeling, and knowledge acquisition. Background: COMP 3211 Exclusion(s): MSBD 5018		
COMP 5311	Database Architecture and Implementation	3-0-0:3
Introduction to the relational model and SQL. System architectures and implementation techniques of database management systems: disk and memory management, access methods, implementation of relational operators, query processing and optimization, transaction management and recovery. Hands on experience with building the components of a small DBMS. Background: COMP 3511		
COMP 5421	Computer Vision	3-0-0:3
Introduction to techniques for automatically describing visual data and tools for image analysis; perception of spatial organization; models of general purpose vision systems; computational and psychological models of perception. Background: COMP 3211; knowledge in linear algebra		
COMP 5422	Deep 2D and 3D Visual Scene Understanding	3-0-0:3
[Previous Course Code: COMP 6411B] Visual scene understanding is an important and fundamental field for advanced application scenarios such as self-driving, robotics, and AR/VR. This course majorly focuses on delivering deep learning-based visual scene understanding techniques in both 2D and 3D perspectives. In the 2D part, it introduces topics including image and scene classification, semantic segmentation, and object detection/tracking. In the 3D part, it delivers how 3D scene understanding can be performed through learning from 2D images, point clouds or multi-modal data, involving topics such as scene depth estimation, camera pose prediction, 3D scene reconstruction, and visual SLAM. Representative deep scene understanding architectures and frameworks in supervised, self-supervised, and open-world learning settings will also be introduced. Background: Basic knowledge about computer vision and deep learning fundamentals		
COMP 5423	Deep Learning for Medical Image Analysis	3-0-0:3
[Previous Course Code: COMP 6211H] Nowadays medical image analysis is rapidly growing and plays an indispensable role in healthcare. Recent advances of deep learning techniques have made significant breakthroughs in medical image analysis applications. This course will cover fundamental knowledge of medical imaging and various medical image analysis tasks, including computer-aided detection, segmentation, diagnosis and prognosis. Deep learning methods for solving these tasks will be introduced and state-of-the-art methods will be discussed. The remaining significant challenges and limitations will also be presented, including limited amount of labeled data, deep learning with interpretation and generalization issues, etc. This course will equip students with practical knowledge of medical imaging and analysis with deep learning techniques. Background: Basic knowledge about image processing and machine learning are beneficial Exclusion(s): BEHI 5011		
COMP 5631	Cryptography and Security	3-0-0:3
Classical encryption techniques, block and stream ciphers, public-key cryptography, authentication, nonrepudiation, key management, digital signatures, public key infrastructure, cryptographic protocol, secret sharing, electronic mail security, IP security, Web security, Firewalls, Intrusion detection. Background: Computer networks Exclusion(s): CSIT 5710		

COMP 5712	Introduction to Combinatorial Optimization	3-0-0:3
An introduction to the basic tools of combinatorial optimization, including network flow and the max-flow min-cut theorem, linear programming, matching, spanning trees and matroids, dynamic programming, algorithms and data structures, graph algorithms. Background: COMP 3711 or equivalent, linear algebra		
COMP 5911	Entrepreneurial Me	3-0-0:3
[Previous Course Code: COMP 6613D] While entrepreneurship is a career choice, its mindset is for everyone. This is a course covering the mindset and elements of founding new and innovative business ventures in information technology sector. Topics include the entrepreneurial risk-taking value-creation mindset, market identification and go-to-market strategies, business models and development, business plan, fundraising and investment, role and protection of intellectual properties, technology-market gap and product-market fit, and growth and exit strategies. Case studies of successful and unsuccessful ventures will be discussed. In-class student participation and presentation are expected. Business and non-engineering students interested in starting IT-related companies are also welcome. Research postgraduate students are encouraged to develop proof-of-concept prototypes and business plans based on their research findings.		
COMP 6411C	Advanced Topics in Multimodal Machine Learning	3-0-0:3
This course provides a comprehensive introduction to recent advances in multimodal machine learning, with a focus on vision-language research. Major topics include multimodal translation, multimodal reasoning, multimodal alignment, multimodal information extraction, and recent deep learning techniques in multimodal research (such as graph convolution network, Transformer architecture, deep reinforcement learning, and causal inference). The course structure will primarily consist of instructor presentation, student presentation, in-class discussion, and a course project.		
COMP 6611C	Advanced Topics in Embedded AI Systems	3-0-0:3
This course will enable students to have an in-depth understanding of embedded AI algorithms and their implementation in real systems and applications. The major topics include 1) basics on machine learning; 2) data and system challenges in embedded AI 3) AI techniques and their implementation on cutting-edge platforms 4) real-world applications, such as smart health and smart buildings. The course structure will primarily consist of instructor presentations, student presentations, paper summaries, and a course project. Students will work on an individual or team project to build an end-to-end system. Students will also read and discuss the latest publications in the areas of embedded AI, Internet of Things, mobile systems, and ubiquitous computing.		

ECON

ECON 5630	Empirical Industrial Organization	4-0-0:4
[Previous Course Code: ECON 6120I] This course covers various econometric methods used in industrial organization that is often referred to as the structural estimation approach. These methods have been gradually developed since 1980s in parallel with the modernization of industrial organization based on the game theory and now widely applied in antitrust policy, business strategy, and neighboring fields such as labor economics and international economics. This course presumes a good understanding of PhD-level microeconomics and microeconometrics. Participants are expected to understand at least UG-level industrial organization. This course requires participants to write programs mostly in R and sometimes in C++ to implement various econometric methods. Corequisite(s): ECON 5210 AND ECON 5300		

ELEC

ELEC 5050	Advanced CMOS Devices	3-0-0:3
Principles and characteristics of semiconductor devices found in State-of-the-Art ICs. Emphasis is on deep-submicron MOS device design, characterization and modeling. Important issues such as short channel effects, high-field behavior, hot carrier effects, reliability and device scaling for present and future technology will be covered. Prerequisite(s): ELEC 3500		
ELEC 5080	Integrated-Circuit Fabrication Laboratory	2-0-6:4
Laboratory course requiring hands-on work in fabricating MOS transistors. Process modules including photolithography, dry etching, wet etching, metal sputtering, oxidation, diffusion and low-pressure chemical-vapor deposition will be covered. Student will also learn to characterize the fabricated devices. Prerequisite(s): ELEC 5070		
ELEC 5140	Advanced Computer Architecture	3-0-0:3
[Previous Course Code: ELEC 6910K] The course introduces the important building blocks in modern computing systems including superscalar processor pipeline, memory hierarchies, network design in the multicore-processors. The design techniques, evaluation metrics and optimization techniques will be discussed in detail with the example of real computer systems. The students will gain not only theoretical knowledge through lectures, but also hands-on experiences through projects. Background: Background knowledge in ELEC 2300 (Computer Organization) or COMP 2611 (Computer Organization)		
ELEC 5160	Digital VLSI System Design and Design Automation	3-0-0:3
Structured design styles; specification, synthesis and simulation using Hardware Descriptive Language (HDL); Structural chip design and system design; Circuit design of system building blocks: arithmetic unit, memory systems; clocking and performance issues in system design; Design-Automation tools and their applications. Background: ELEC 2200 Exclusion(s): EESM 5020 Prerequisite(s): ELEC 3410		
ELEC 5240	Advanced Display Technologies	3-0-0:3
[Previous Course Code: ELEC 6910V] Introduction of the human visual system, Colorimetry and photometry, Introduction of the modern TFTs, Modern AMLCD, AMOLED, Fluorescence and phosphorescence, Introduction of Electrophoretic displays, Color electrophoretic displays, Nano-material for displays, Electroluminescence and Photoluminescence, Quantum dot, Quantum rods, State-of-the-art development in the area of display technology: High-resolution displays (4k, 8k, and 10k), Local backlight dimming, Introduction to AR/VR display solutions, Holographic displays, Flexible displays etc. Background: Basic understanding of calculus and algebra.		
ELEC 5460	Stochastic Optimization for Wireless Systems and Federated-Learning	3-0-0:3
Stochastic Optimization plays a critical role in radio resource optimization of wireless networks, optimal control theory as well as financial engineering (portfolio optimization). This course will focus on the stochastic optimization theory and the application to the design and optimization of next generation wireless systems and federated learning applications. Topics covered include (A) Physical Layer Modeling: review of information theory for wireless fading channels, MIMO spatial diversity and spatial multiplexing, (B) Theory of Stochastic Optimization: classifications and motivating examples of stochastic optimizations [Type I stochastic Optimization and Type II stochastic optimization problems], theory of Stochastic Approximation, Stochastic Gradient, (C) Applications of Type I SO: Robust optimizations and Federated		

Learning: (D) Applications of Type II SO: Markov Decision Process, Stochastic Stability and Delay-optimal wireless resource control. Background: ELEC 4110 or equivalent		
ELEC 5650	Introduction to Networked Sensing, Estimation and Control	3-0-0:3
[Previous Course Code: ELEC 6910E] The course gives an introduction to the analysis and design of sensing, estimation and control systems in a networked setting. It consists of three parts: the first part introduces necessary background knowledge in communication networks, sensor networks, linear state estimation, MAP and ML estimators, Kalman filtering, and modern control theory; the second part focuses on analysis of network effect to remote state estimation and control; the third part presents some advanced topics including distributed state estimation and resource allocation through scheduling. Background: ELEC 2600 AND ELEC 3200		
ELEC 5660	Introduction to Aerial Robotics	3-0-3:3
[Previous Course Code: ELEC 6910P] This course gives a comprehensive introduction to aerial robots. The goal of this course is to expose students to relevant mathematical foundations and algorithms, and train them to develop real-time software modules for aerial robotic systems. Topics to be covered include rigid-body dynamics, system modeling, control, trajectory planning, sensor fusion, and vision-based state estimation. Students will complete a series of projects which combine into an aerial robot that is capable of vision-based autonomous indoor navigation. Background: Linear algebra; Probability; MATLAB programming skills; C++ programming skills		
ELEC 5680	Advanced Deep Learning Architectures	3-0-0:3
[Co-list with COMP 5214] [Previous Course Code: ELEC 6910T] This course focuses on advanced deep learning architectures and their applications in various areas. Specifically, the topics include various deep neural network architectures with applications in computer vision, signal processing, graph analysis, and natural language processing. Different state-of-the-art neural network models will be introduced, including graph neural networks, normalizing flows, point cloud models, sparse convolutions, and neural architecture search. The students have the opportunities to implement deep learning models for some AI-related tasks such as visual perception, image processing and generation, graph processing, speech enhancement, sentiment classification, and novel view synthesis. Exclusion(s): COMP 5214		
ELEC 5810	Introduction to Bioinformatics Algorithms	3-0-0:3
This is an introductory course on computational biology at the molecular level. It will cover basic biological knowledge, important biological questions, common data acquisition techniques, popular data analysis algorithms and their applications. The major content of this course is computation-oriented.		
ELEC 5820	Microfluidics and Biosensors	3-0-0:3
[Co-list with BIEN 5820] [Previous Course Code: ELEC 6910D] Introduction to Microfluidics and Biosensors; Overview of microfabrication materials & techniques; microfluidic principles; miniaturized biosensors; micro total analysis system (μTAS) & lab-on-a-chip (LOC) for clinical and research applications. Background: Basic Physics Exclusion(s): BIEN 5820		
ELEC 5900	Modern Engineering Research Methodologies	3-0-0:3
The course provides a high-level description of modern engineering research practices. It covers topics including research mentality, the scientific method, evaluating research topics, literature search, report writing, presenting data, publication, research management, research ethics and technology transfer. Exclusion(s): EESM 5770		

ELEC 6910D	Electronic Design Automation for VLSI Design	3-0-0:3
The course introduces Electronic Design Automation (EDA) techniques for VLSI digital IC design. The modern RTL to GDS-II design flow and related tools will be explained in detail. Classical automated algorithms adopted in logic synthesis, floorplanning, placement, CTS, routing, etc. will be covered. Simulation and optimization techniques of key design objectives and constraints will be presented.		
ELEC 6910I	Internet Video Streaming	3-0-0:3
This course will introduce how YouTube, Zoom, cloud gaming, VR, and many video streaming applications work. Prerequisite(s): COMP 4621 OR ELEC 3120		
ELEC 6910J	Deep Reinforcement Learning	3-0-0:3
This course covers theoretical foundations and state-of-the-art algorithms, and pratical applications in DRL, including machine learning basics, value-based methods, policy gradients, actor-critic methods, exploration, model-based RL, multi-agent RL, offline RL, inverse RL, and students will explore other recent research developments in RL contexts. The course emphasizes both theoretical rigor and practical implementation, featuring paper readings, critical discussions of recent research works, programming assignments using modern DRL frameworks, and a substantial research project. Upon completion, students will be equipped to understand current research literature, implement and analyze advanced DRL algorithms, and conduct independent research in the field.		
ELEC 6910Z	Modern Solid State Devices	3-0-0:3
This course aims to provide students with the up-to-date research and development progress of solid state devices and technologies in the 21st century, with a focus on emerging materials and physical phenomena of modern electronics and optoelectronics. Emphasis will be placed on the interdisciplinary nature of present solid-state research, bridging the gap between fundamental physics, materials science, and practical device engineering.		

ENEG

ENEG 5400	Transport Phenomena and Its Application in Energy Systems	3-0-0:3
[Co-list with MECH 5280] Elementary statistical concepts; ensembles and postulates; partition functions and their properties; calculation of thermodynamic properties; kinetic theory of transport process; fluctuation-dissipation theorem; Langevin equation; mass and heat transfer in fuel cells. Exclusion(s): MECH 5280		

HUMA

HUMA 5160	Chinese Phonetics and Phonology	3-0-0:3
This course is an introduction to the study of sounds in Mandarin Chinese. The course will cover fundamental concepts in phonetics and phonology and compare the sounds of Mandarin with those of other languages. Other topics include: methodology, the typology, learning and evolution of sounds, the subgrouping of Chinese dialects, etc. **[Pu][C]** Exclusion(s): HMMA 5002		
HUMA 5240	Chinese Dialectology	3-0-0:3

This course will provide an introductory survey of the phonology of Chinese dialects, including Mandarin, Wu, Xiang, Gan, Hakka, Yue and Min. **[Pu][C]**		
HUMA 5450	Taiwan and Hong Kong Fiction	3-0-0:3
A critical study of development, trends, characteristics of narrative literature in Taiwan and Hong Kong from the late 1960 to the present from cultural, historical, and gender perspectives. **[Pu][C]**		
HUMA 5850	Taoism	3-0-0:3
This course introduces the students to the Taoist tradition through guiding them to the major Taoist texts, their representative commentaries, and the important scholarly works in the field.		
HUMA 6002U	Marco Polo and Eurasian Globalization	3-0-0:3
Marco Polo's travel to China 700 years ago led to the first reliable account of Central and East Asian economies and cultures to circulate in Europe. This course will focus on a complete reading Marco Polo's short book in English translation accompanied by selected readings situating Marco Polo in his historical context, discussing his connections with the Silk Road and the first Eurasian Globalization as well as the debates surrounding the reliability of his account.		

MARK

MARK 5410	Seminar in Quantitative Modeling	3-0-0:3
Overview of the literature on modeling marketing phenomena.		
MARK 5470	Seminar in Consumer Behavior II	3-0-0:3
Overview of advanced topics in psychology and consumer behavior research. An information processing approach is used to help students develop expertise on a range of diverse topics such as attitude formation and change, culture, information processing, motivation and goals, emotion, consumer decision making.		

MATH

MATH 5030	Complex Function Theory	3-0-0:3
Review of basic properties of analytic functions. Phragmen-Lindelof principle, normal family, Riemann mapping theorem. Weierstrass factorization theorem, Schwarz reflection principle, analytic continuation, harmonic function, entire function, Hadamard factorization theorem, Picard theorem. Background: MATH 3033 and MATH 4023		
MATH 5112	Advanced Algebra II	3-0-0:3
Advanced topics in algebra: group representations, associative algebras, commutative algebra, homological algebra, algebraic number theory. Background: MATH 5111		
MATH 5261	Algebraic Geometry II	3-0-0:3
Derived functors, cohomology of coherent sheaves on schemes, extension groups of sheaves, higher direct image of sheaves, Serre duality, flat morphisms, smooth morphisms, and semi-continuity, basics of curves		

and surfaces. Background: MATH 5111 or equivalent postgraduate algebra Prerequisite(s): MATH 5251		
MATH 5312	Advanced Numerical Methods II	3-0-0:3
Direct and iterative methods. Programming techniques and softwares libraries. Sparse solvers, Fast algorithms, multi-grid and domain decomposition techniques. Prerequisite(s): MATH 5311		
MATH 5352	Mathematical Methods in Science and Engineering II	3-0-0:3
Asymptotic methods and perturbation theory for obtaining approximate analytical solutions to differential equations. Topics include: local analysis of solutions to differential equations, asymptotic expansion of integrals, global analysis and perturbation methods, WKB theory, multiple-scale analysis, homogenization method. Prerequisite(s): MATH 5351		
MATH 5432	Advanced Mathematical Statistics II	3-0-0:3
Theory of statistical inference in hypothesis testing. Topics include: uniformly most powerful tests, unbiasedness, invariance, minimax principle, large-sample parametric significance tests. Concept of decision theory also covered.		
MATH 5470	Statistical Machine Learning	3-0-0:3
[Previous Course Code: MATH 6450A] This course covers methodology, major software tools and applications in statistical learning. By introducing principal ideas in statistical learning, the course will help students understand conceptual underpinnings of methods in data mining. The topics include regression, logistic regression, feature selection, model selection, basis expansions and regularization, model assessment and selection; additive models; graphical models, decision trees, boosting; support vector machines; clustering. Exclusion(s): MFIT 5010, MSDM 5054		
MATH 5473	Topological and Geometric Data Reduction and Visualization	3-0-0:3
[Co-list with CSIC 5011][Previous Course Code: MATH 6380Q] This course is a mathematical introduction to data analysis and visualization with a perspective of topology and geometry. Topics covered include: classical linear dimensionality reduction, the principal component analysis (PCA) and its dual multidimensional scaling (MDS), as well as extensions to manifold learning, topological data analysis, and sparse models in applied math/high dimensional statistics. Extensive application examples in biology, finance, and information technology are presented along with course projects. Exclusion(s): CSIC 5011		

MECH

MECH 5230	Computational Fluid Dynamics and Heat Transfer	3-0-0:3
Numerical simulation of viscous incompressible flows and heat transfer; finite-difference and finite element methods; accuracy and stability; grid generation; stream function and primitive-variable formulations; application to internal, external flows, diffusion, convection, and dispersion problems. Background: Basic programming background (e.g. C/C++/Matlab) Prerequisite(s): MECH 2210 or equivalent AND MECH 3310 or equivalent		
MECH 5280	Transport Phenomena and Its Application in Energy Systems	3-0-0:3

[Co-list with ENEG 5400] Elementary statistical concepts; ensembles and postulates; partition functions and their properties; calculation of thermodynamic properties; kinetic theory of transport process; fluctuation-dissipation theorem; Langevin equation; mass and heat transfer in fuel cells. Exclusion(s): ENEG 5400		
MECH 5320	Convective Heat and Mass Transfer	3-0-0:3
Laminar and turbulent boundary layer heat transfer by similarity, integral and superposition methods; effects of roughness, curvature, transpiration and high turbulence; forced and free convections, free-shear flows and buoyant flows; numerical methods. Background: MECH 3310 Prerequisite(s): MECH 5210		
MECH 6910U	Sustainable Engineering and Energy	3-0-0:3
What business can generate long-term profit? What is the most important topic in this era? What are the most critical challenges to our human society? All these go to sustainability. The rise of solar power, the surge in popularity of electric cars, and the debates surrounding genetically modified food are all indicative of the complex and interrelated issues we face today. Extreme weather events and the ever-pressing threat of climate change further compound the urgency of our situation. This course aims to equip you with the necessary tools to address these challenges. We will introduce and elucidate the fundamental design concepts, methods, tools, and technologies associated with lean and green manufacturing systems, supply chains, and green energy. It will also encompass the evaluation, design, and maintenance of environmentally friendly products, processes, services, and policies.		

PHYS

PHYS 5310	Statistical Mechanics I	3-0-0:3
[Co-list with NANO 5320] Laws and applications of thermodynamics, kinetic theory, transport phenomena, classical statistical mechanics, canonical and grand canonical ensemble, quantum statistical mechanics, Fermi and Bose systems, non-equilibrium statistical mechanics. Exclusion(s): NANO 5320		
PHYS 5370	Solid State Physics II	3-0-0:3
[Previous Course Code: PHYS 6810B] This is a second course on postgraduate level solid state physics. The thermal, electronic, magnetic and optical properties of solid will be studied. Semiconductor devices and electronics will be discussed. The theory of conventional and unconventional superconductors will be introduced. Special topics related to current research in solid state physics will be covered. These special topics include graphene, topological insulators, transition metal dichalcogenides and topological superconductors. Background: Students should have good understanding in undergraduate level quantum mechanics and undergraduate level solid state physics before taking this course.		
PHYS 5810	Modern Semiconductor Physics	3-0-0:3
[Co-list with NANO 5200] Detailed explanations of the electronic, vibrational, transport, and optical properties of semiconductors based on quantum mechanics. Emphasis on nanostructured heterostructures, quantum size and low-dimensional effects, and application to modern electronics and opto-electronics. Background: PHYS 4052 or equivalent Exclusion(s): NANO 5200		

SOSC

SOSC 5170	Qualitative Research Methods	3-0-0:3
This course explores links between theory and practice in qualitative research. It combines learning about selected methods of qualitative inquiry (participant-observation, in-depth interview, oral history) and analysis (grounded theory, ethnography, and discourse analysis). Enrollment by students from outside the Division of Social Science by instructor permission. Background: Knowledge in Social Science Prerequisite(s): SOSC 5110		
SOSC 5440	Economics of Development	3-0-0:3
This course covers the microeconomics of development, focusing on empirical applications. Topics include household models, human resource issues (health and education), intrahousehold economics, rural institutions in land, labor, and credit markets, technology adoption, risk-coping strategies, and evaluation of development projects. Lectures will concentrate on theoretical models and rigorous application of empirical methods, discussing important journal articles. Background: ECON 5110 OR ECON 5130, ECON 5280 OR ECON 5300 OR SOSC 5090		
SOSC 5500	Computational Social Science	3-1-0:3
The increasing use of the Internet and online communities in the last decade has led to an explosion of social data capturing every aspect of our daily activities. The new digital data have in turn led to the rise of Computational Social Science, an emerging field that aims to empirically study social behavior by applying computational methods, algorithms, and models on "big data". This course introduces the methods and ideas of computational social sciences. The course consists of lectures, projects and tutorials. Students will learn and evaluate the new possibilities and challenges that digital data have created for studying social phenomena. Students will also learn and practice essential methods that are needed to analyze digital data, from data collection to techniques and methods to analyze big data. Background: Knowledge of at least one programming language, such as Python or R. Prerequisite(s): SOSC 5090		
SOSC 6030Q	International Law and China	3-0-0:3
Public international law (IL) is based on rules for relations among states (countries), as well as the human rights of people. It covers almost every aspect of human activity and is mainly studied by analysing legal cases and international agreements (treaties). The topics involve current events of world-wide importance. Students will learn the basic principles of IL and, using a student-led seminar format, will discuss the ways in which China interacts with the most important current issues in IL. They will also present group research papers on one discrete issue of their choice.		

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