COURSE SYLLABUS

2024-2025 Autumn Semester

International College of UCAS

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Course title

MATHEMATICAL METHODS FOR PHYSICS

Credits: 2.5

Instructor(s)-in-charge:

Prof. Yu-Feng Zhou (together with prof. Huai-Ke Guo)

Course type:

Lecture

Course Schedule:

See Schedule of the course

Course Assessment:

Homework: many assignments

Grading Policy:

Typically 40% homework, 60% final.

Course Prerequisites:

Basic mathematics at undergraduate level

Catalog Description:

This course includes mathematical methods commonly used in physics and engineering. I will begin with mathematical preliminaries such as calculus, vector analysis, and complex numbers. The main part of the course consists of complex variable theory, differential equations and special functions.

Contents of the course (60 hours)

1 Preliminaries
   - 1.1 Infinite series, series of functions
   - 1.2 Vectors, complex numbers,
   - 1.3 Determinants and Matries

2 Vector analysis
   - 2.1 Review of basics properties
   - 2.2 Differential vector operators
   - 2.3 Vector integrations, potential theory

3 Tensors and differential forms (part)
   - 3.1 Tensor analysis
   - 3.2 Tensor in General Coordinates
   - 3.3 Jacobians

4 Vector spaces
   - 4.1 Vector in Function Spaces
   - 4.2 Operators
   - 4.3 Transformations of Operators

5 Eigenvalue problems
   - 5.1 Eigenvalue Equations
   - 5.2 Matrix Eigenvalue Problems
   - 5.3 Hermitian Eigenvalue Problems

6 Ordinary differential equations
  6.1 First - Order Equations
  6.2 Second - Order Linear ODEs
  6.3 Inhomogeneous Linear ODEs
7 Partial differential equations
  7.1 First - Order Equations
  7.2 Second - Order Equations
  7.3 Separation of Variables
8 Complex variable theory
  8.1 Cauchy - Riemann Conditions, Cauchy's Integral Theorem
  8.2 Laurent Expansion, Singularities
  8.3 Calculus of Residues, Evaluation of Definite Integrals
9 Fourier series and Fourier transforms
  9.1 General Properties, Application of Fourier Series
  9.2 Fourier Transforms, Properties of Fourier Transforms
  9.3 Fourier Convolution Theorem, Discrete Fourier Transforms
10 PROBABILITY AND STATISTICS
  10.1 Random Variables
  10.2 Binomial Distribution, Poisson Distribution, Gauss' Nomal Distribution
  10.3 Transformation of Random Variables, Statistics

Reference textbooks

1 MATHEMATICAL METHODS FOR PHYSICISTS (A COMPREHENSIVE GUIDE), 7th Edition, Arfken, Weber and Harris, ELSEVIER

2 MATHEMATICAL METHODS FOR PHYSICS AND ENGINEERING, 3rd Edition, K.F. Riley, M.P. Hobson and S.J. Bence, CAMBRIDGE

3 COMPLEX VAIABLES, 3rd Edition, David Wunsch ADDISON WESLEY

Course title

Overview of Recent Development of Physics

Instructor(s)-in-charge:

Prof. Yin Zhang & Prof. Xiaoyong Chu

Course type:

Lecture

Course Schedule:

24 hrs in total by Prof. Xiaoyong Chu; 27 hrs in total by Prof. Yin Zhang.

Course Assessment:

Homework: 6 assignments, 1 projects

Grading Policy:

Typically 30% homework, 20% attendances, 30% final presentation, performance 20%.

Course Prerequisites:

The basic knowledge of College Physics, Calculus, and Mechanics

Catalog Description:

This course mainly divides into two parts. The first part will introduce some basic concepts and frontiers of some theoretical physics directions. It will mainly focus on high-energy physics and its connections with modern cosmology, include general relativity, black hole physics, dark energy, dark matter and standard cosmological model, standard model of particle physics and beyond, Bose-Einstein condensation, phases and superconductivity in condensed matter, and so on. The second part will introduce some basic theory of mechanics for the non-mechanics students who are interested in the mechanics-related problems in their future research work., include the development of Mechanics, some basic concepts of Elastic mechanics, Contact mechanics, Fracture mechanics and Fluid mechanics firstly. Then some applications and implications of mechanics will be discussed in different scientific field, such as industrial architecture, mechanical design, 3D/4D printing, cellular mechanics and so on. Moreover, the course will introduce the basic ideas of finite element and the operations of computer software (COMSOL) to do some practice of introductory examples.

Schedule of the course

section	content	hours	
1	The Standard Model of particle physics	9	Prof. Xiaoyong Chu
2	The standard model of cosmology	9	Prof. Xiaoyong Chu
3	Connecting the particle physics and Cosmology	6	Prof. Xiaoyong Chu
4	Introduction of the basic concepts of mechanics, the implications, classical mechanics, Newtonian mechanics, Lagrangian mechanics	4	Prof. Yin Zhang

5	Elastic mechanics, entropic elasticity	4	Prof. Yin Zhang
6	3D/4D printing, strength of materials, plastic mechanics	4	Prof. Yin Zhang
7	Contact mechanics, fracture mechanics	4	Prof. Yin Zhang
8	Basic concepts of fluid mechanics, microfluidics	4	Prof. Yin Zhang
9	Finite Element Method Introduction to Numerical Discretization	4	Prof. Yin Zhang
10	Final Presentation of every student	3	Prof. Yin Zhang
total		51	

Contents of the course

Section 1: The Standard Model of particle physics

-- Introduction to elementary particles

-- The symmetry principles

--Gauge interactions between elementary particles

-- Electroweak interaction, the Higgs mechanism

-- Gravitation and relativity

Section 2: The standard model of cosmology

-- Introduction to Cosmology

-- Evolution of the Universe, the Freedman euqation

-- Thermal history of the Universe

-- The original of matter

Section 3: Connecting the particle physics and Cosmology

-- Dark matter problem

-- Dark matter detection

Section 4: Introduction of the basic concepts of mechanics, the implications, classical mechanics, Newtonian mechanics, Lagrangian mechanics

-- What is Mechanics?

-- The development of Mechanics

-- Some implications of Mechanics

-- Basic concepts

Section 5: Elastic mechanics, entropic elasticity

-- Basic concepts of elastic mechanics

-- Entropic Elasticity

Section 6: 3D/4D printing, strength of materials, plastic mechanics

-- 3D/4D printing

-- Strength of materials

-- Plasticity

Section 7: Contact mechanics, fracture mechanics

-- Contact mechanics

-- Fracture mechanics

Section 8: Basic concepts of fluid mechanics, microfluidics

-- Elementary Ideas

-- Fundamental Equations and Prototypical Flows

Section 9: Finite Element Method

-- Introduction to Numerical Discretization

-- Direct Approach for Discrete Systems

-- The Finite Element Method

-- Introductory Examples

Section 10: Final Presentation of every student

Textbook and any related course material:

S. Weinberg, Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, Wiley, 1972 (https://archive.org/details/WeinbergS.GravitationAndCosmology..PrinciplesAndApplicationsOfTheGeneralTheoryOf)

F. Bower, Applied Mechanics of Solids, CRC Press, 2009 (http://solidmechanics.org);

Ya-Pu Zhao (赵亚溥), Lecture on Mechanics (力学讲义), 科学出版社, 2018

Expected level of proficiency from students entering the course:

Calculus: strong

College Physics: basic

Mechanics: basic

Course title

Density Functional Theory and Its Applications

Instructor(s)-in-charge:

Prof. Shixuan Du & Prof. Yuyang Zhang

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 10 hrs in total by Prof. Shixuan Du; 30 hrs in total by Prof. Yuyang Zhang.

Course Assessment:

Homework: 4 assignments

Grading Policy:

Typically 40% homework, 20% attendances;40% open-book exam.

Course Prerequisites:

quantum mechanics, solid state physics, or related courses (e.g. structural chemistry)

Catalog Description:

This course is an elective course for graduate students major in condensed matter physics and computational materials. It focuses on the establishment of the density functional theory (DFT), the framework of DFT, and its applications. It provides basic and practical knowledge of computational condensed matter physics for graduate students who will be engaged in physics, chemistry, materials, and biology. It will cover the following topics:

Schedule of the course

section	content	hours	
1	**Introduction to density functional theory** Why density functional theory; Basic concepts in solid-state physics.	3	Prof. Shixuan Du
2	**Density functional theory** The atomic unit; The Born-Oppenheimer approximation; The Hartree approximation and Hartree-Fock approximation; The Thomas-Fermi Theory; The Hohenberg-Kohn theorems; The Kohn-Sham equation; The exchange-correlation functionals and local density approximation; The self-consistent solution of Kohn-Sham equations; The advantage and shortcomings of density functional theory.	9	Prof. Yu-Yang Zhang
3	**The total energy pseudopotential method: plane-wave basis-set** The atomic pseudopotential;	6	Prof. Yu-Yang Zhang

	The Kohn-Sham equation in the momentum space; The supercell approximation and k-space sampling; The introduction of VASP and Quantum Espresso code.		
4	**The total energy pseudopotential method: local-orbital basis-set** The atomic orbital; The matrix elements and total energies with local orbital basis-set; The introduction of SIESTA/ABACUS code.	5	Prof. Yu-Yang Zhang
5	**The tight-binding method and empirical force fields** The tight-binding method; The empirical force fields; The molecular mechanics and molecular dynamics.	4	Prof. Yu-Yang Zhang
6	**The applications in simple systems** Calculations for simple solids; Calculations for surfaces of solids; Calculations of vibrational frequencies; Calculations of molecules; Calculations of two-dimensional systems; Calculations of nano-particles.	6	Prof. Yu-Yang Zhang
7	**The applications in complex systems** The adsorptions of molecules on metal substrates; The reaction barrier of chemical reactions; The phase transitions of solid-state materials.	7	Prof. Shixuan Du
total		40	

Contents of the course

Section 1: Introduction to density functional theory

1. Why density functional theory;
2. Basic concepts in solid-state physics.

Section 2: Density functional theory

1. The atomic unit;
2. The Born-Oppenheimer approximation;
3. The Hartree approximation and Hartree-Fock approximation;
4. The Thomas-Fermi Theory;
5. The Hohenberg-Kohn theorems;
6. The Kohn-Sham equation;
7. The exchange-correlation functionals and local density approximation;

8. The self-consistent solution of Kohn-Sham equations;
9. The advantage and shortcomings of density functional theory.

Section 3: The total energy pseudopotential method: plane-wave basis-set

1. The atomic pseudopotential;
2. The Kohn-Sham equation in the momentum space;
3. The supercell approximation and k-space sampling;
4. The introduction of VASP and Quantum Espresso code.

Section 4: The total energy pseudopotential method: local-orbital basis-set

1. The atomic orbital;
2. The matrix elements and total energies with local orbital basis-set;
3. The introduction of SIESTA/ABACUS code.

Section 5: The tight-binding method and empirical force fields

1. The tight-binding method;
2. The empirical force fields;
3. The molecular mechanics and molecular dynamics.

Section 6: The applications in simple systems

1. Calculations for simple solids;
2. Calculations for surfaces of solids；
3. Calculations of vibrational frequencies；
4. Calculations of molecules；
5. Calculations of two-dimensional systems；
6. Calculations of nano-particles.

Section 7: The applications in complex systems

1. The adsorptions of molecules on metal substrates;
2. The reaction barrier of chemical reactions;
3. The phase transitions of solid-state materials.

Textbook and any related course material:

[1] Computer Simulations of Molecules and Condensed Matters: From Electronic Structures to Molecular Dynamics, Edited by Xinzheng Li and Eng Wang, Peking University Press, 2014

[2] Density Functional Theory: A Practical Introduction， Edited by David Sholl and Janice A Steckel, John Wiley & Sons, Inc. 2009

[3] Electronic Structure，Edited by Richard Martin, Cambridge University Press, 2004

Expected level of proficiency from students entering the course:

Quantum mechanics: basic
Solid state physics: basic
or structural chemistry: basic

Course title

Radiation Semiconductor Detectors

Instructor(s)-in-charge:

Prof. Xin Shi

Course type:

Lecture

Course Schedule:

4hrs/week by instructors. 40 hrs in total by Prof. Xin Shi

Course Assessment:

Homework: 5 assignments

Grading Policy:

Typically, 50% homework, 30% attendances; 20% final presentation.

Course Prerequisites:

College Physics, Basic Computing

Catalog Description:

This course offers an introduction to radiation semiconductor detectors which are mainly used for particle physics, space science, and other related fields which involve radiation environment. Students will learn the basics of semiconductor material, silicon as the main device used as particle detector on the modern collider experiments, and finally introduce the wide-band gap semiconductor such as SiC used for future detector development. It will cover the following topics:

Schedule of the course

section	content	hours	
1	**Introduction of Particle Physics** Introduction to particle physics; Particle Accelerator; Particle Detectors	3	Prof. Xin Shi
2	**Physics of Semiconductors** Crystal Structure; Energy Bands and Energy Gap; Carrier Concentration and Transport	3	Prof. Xin Shi
3	**Properties of Semiconductors** Phonon, Optical, and Thermal Properties; Heterojunctions and Nanostructures	3	Prof. Xin Shi
4	**P-N Junctions** Depletion Region; Current-Voltage Characteristics; Junction Breakdown; Transient behavior	3	Prof. Xin Shi
5	**Metal-Semiconductor Contacts** Formation of Barrier; Current Transport Processes, Device Structures,	3	Prof. Xin Shi

	Ohmic Contact		
6	**Metal-Insulator-Semiconductor Capacitors** Ideal MIS Capacitor, Silicon MOS Capacitor	3	Prof. Xin Shi
7	**Mid-Term Presentations** 3-5 minutes per student, the student can choose any topic in the past lectures and discuss their understanding and thoughts.	2	Prof. Xin Shi
8	**Semiconductor Detectors** Particle detection; Single-sided silicon detectors Double-sided microstrip detectors Hybrid/Monolithic pixel detectors.	3	Prof. Xin Shi
9	**Timing with silicon detectors** Timing basics; Si-LGADs;	3	Prof. Xin Shi
10	**Experimental Techniques** Static characterization, Transient Current Technique, beta-source setup, read-out electronic boards	3	Prof. Xin Shi
11	**Radiation damage** Substrate damage; Implications for detector operation; Surface damage; Measures for radiation hardening	3	Prof. Xin Shi
12	**Numerical Modelling and Simulation** Physical modelling of semiconductor devices; numerical treatment of models; Resistive AC-coupled silicon detectors design	3	Prof. Xin Shi
13	**Silicon Carbide** Wide-bandgap materials; Silicon Carbide	3	Prof. Xin Shi
14	**Students Final Presentation** 3-5 minutes per student, the student can choose any topic in this course and discuss their understanding and thoughts.	2	Prof. Xin Shi
Total		40	

Textbook and any related course material:

Physics of Semiconductor Devices, 3rd Edition, Edited by S. M. Sze and Kwok K. Ng
Particle Detectors, 1st Edition, Edited by H. Kolanoski and N. Wermes
An Introduction to Ultra-Fast Silicon Detectors, by M. Ferrero, R. Arcidiacono, M. Mandurrino, V. Sola, N. Cartiglia

Course title

Organometallic Chemistry and Catalysis

Instructor(s)-in-charge:

Prof. SUN Wenhua & Associate Prof. MA Yanping

Course type:

Lecture

Course Schedule:

3hrs/week by instructors.

Course Assessment:

Homework: 15 assignments

Grading Policy:

Typically 40% homework, 10% evaluation，30% for assessment (2 times, 15% each), 20% final. 5% plus to student presentation

Course Prerequisites:

General chemistry

Catalog Description:

Chemistry is the center of sciences, and organometallic chemistry is the useful tool for chemists to understand how organic molecules or groups interact with compounds of the inorganic elements. On the base of Organometallic Chemistry, the industries of chemical, petrochemical, pharmacy and organic materials have been continuously developing. A catalyst increases the rate of a reaction without being consumed and without changing the thermodynamics of the reaction, providing bases for modern chemical industries. With regard to Periodic Table of Elements, main group elements consisting of the s and p blocks and the transition elements of the d and f blocks would be discussed, respectively. Those organometallic compounds have been useful building blocks for nanoparticles and assembling materials. Importantly, organometallic compounds have been stoichiometric reagents and (pre)catalysts in tremendously industrial processes. Therefore organometallic chemistry and catalysis are the Capital Stone for scientists in chemistry, material science and industry.

Schedule of the course

section	content	hours
1	Definition & Scope of Organometallic chemistry Interests in OM chemistry and OM products in life 18 electron rule and in OM	3
2	Coordination chemistry: from complex to coordination by Nobel Laureate Werner Coordination Number, ligand Number and Dentate Number Importance of Coordination Cores in Natural Enzymes One Hundred Years of Vitamins —A Success Story of the Natural Sciences Syntheses of Vitamin C	3
3	Alkali Metal Organometallics: Li, Na, K, Rb, Cs; preparation, reactivity and structures Alkaline Earth Metal Organometallics: Be, Mg, Ca, Sr, Ba; preparation, reactivity and structures Unusual lithium precatlysts to the ROP of rac-lactide	3

	Biodegradable poly(caprolactone)	
4	Zinc, Cadmium, and Mercury Organometallics: properties and applications Stoichiometric reactions Zirconocene-Promoted Organic Methodologies Monsanto Acetic Acid Process	3
5	Special topic on application of Organometallics Oxidative coupling of unsaturated substrates based on the Reaction Chemistry of Zirconocene Complexes Selective cleavage of C–H, C–C and C–X bonds catalyzed by transition-metal compounds towards Synthesis of Cyclic Compounds CO2 Activation and Transformation	3
6	Organometallics of the Boron Group: Transmetallation, reactions and uncommon bonding Aluminium organometallics: Cyclopentadienylaluminium, reactivity, structures Aluminum(I) diketiminates	3
7	Organometallics of the Carbon Group: Synthesis, reactivity, bondings Compounds of Low-valent Silicon: Silyl Anions, Cyclosilanes, Silicocene, Silylenes, Silyl radicals and silyl cations Lead Compounds:, synthesis and Structures of Lead Compounds, Toxicity of tin(IV) reagents Cyclopentadienyltin(II) compounds Cyclopentadienyllead Derivatives	3
8	Organometallics of Transition Metals Various ligands Electron counting and coordination geometries Types of metallocene complexes Nobel Prize in Chemistry 2019 and discussion Semi-test	3
9	Metal Hydrides; Bonding in metal hydrides; Preparation of TM carbonyl hydrides; General points about oxidative addition; Experimental identification; Importance of TM metal-carbon bonds; Metal-alkyl complexes – history; bonding and stability	3
10	Metal-Alkyl Complexes: Stability of TM-alkyls vs. MG-alkyls, 8 Essential OM Reaction Steps; Preparation of stable TM-alkyl complexes; Strategies for blocking β-H elimination Preparation and reaction of Metal-Alkyl Complexes And the application of the 8 Essential OM Reaction Metal-Alkyl Complexes: Stability of TM-alkyls vs. MG-alkyls, 8 Essential OM Reaction Steps; Preparation of stable TM-alkyl complexes; Strategies for blocking β-H elimination Preparation and reaction of Metal-Alkyl Complexes And the application of the 8 Essential OM Reaction Metal-Alkyl Complexes: Stability of TM-alkyls vs. MG-alkyls, 8 Essential OM Reaction Steps; Preparation of stable TM-alkyl complexes; Strategies for blocking β-H elimination Preparation and reaction of Metal-Alkyl Complexes	3

	And the application of the 8 Essential OM Reaction	
11	Metal alkene (olefin) complexes: bonding, preparation, and reactions Metal alkyne complexes: bonding, preparation, and reactions Their applications	3
12	TRANSITION METAL-CARBON MULTIPLE BONDS: Metal carbenes – in organic synthesis and polymerisation; Metal carbenes Fischer versus Schrock: synthesis, reactivity; Metal carbenes – spectroscopic features of metal carbenes; Synthesis of metal carbenes – low oxidation state metal carbenes; Synthesis of metal carbenes – high oxidation state metal carbenes; Reactivity of metal carbene complexes; Conversion of a Fischer carbyne to a Schrock carbyne	3
13	Basics of Organometallics; Historical Background in Organometallics; Charges and corresponding coordination numbers for typical ligands; Relationships between oxidation states and dn configulations; Electron Count on the basis of the 18 electron rule; Crystal Field Splitting; Relating the Colors of Coordination Complexes to the Spectrochemical Series;Phosphine Ligands; Coordination & Dissociation	3
14	CATALYSIS INTRODUCTION AND DESCRIPTIONS; Mode of Action of a Catalyst; Catalyst Performance; Homogeneous versus Heterogeneous Catalysis; Important Examples of Heterogeneous Catalysis; Heterogeneous catalysis; Important Examples of Homogeneous Catalysis; Reasons for industrial preference for Heterogeneous Catalysis; Methods For Studying Catalysis; Hydrogenation & Hydroformylation; ACETIC ACID	3
15	CO ETHYLENE COPOLYMERISATION; CO/alkene Copolymerisation; CO/C2H4 Copolymerisation; Mechanism; Propagation; OLEFIN OLIGOMERISATION; Industrial processes	3
16	OLEFIN POLYMERISATION; RING OPENING POLYMERISATION	3
17	Final test	2
total		50

Course title

Organometallic Chemistry

Instructor(s)-in-charge:

Prof. SUN Wenhua & Associate Prof. MA Yanping

Course type:

Lecture

Course Schedule:

3hrs/week by instructors.

Course Assessment:

Homework: 15 assignments

Grading Policy:

Typically 40% homework, 10% evaluation， 30% for assessment (2 times, 15% each), 20% final. 5% plus to student presentation

Course Prerequisites:

General chemistry

Catalog Description:

Chemistry is the center of sciences, and organometallic chemistry is the useful tool for chemists to understand how organic molecules or groups interact with compounds of the inorganic elements. On the base of Organometallic Chemistry, the industries of chemical, petrochemical, pharmacy and organic materials have been continuously developing. With regard to Periodic Table of Elements, main group elements consisting of the s and p blocks and the transition elements of the d and f blocks would be discussed, respectively. Those organometallic compounds have been useful building blocks for nanoparticles and assembling materials. Importantly, organometallic compounds have been stoichiometric reagents and (pre)catalysts in tremendously industrial processes. In addition, organometallic compounds are also considerable for molecule biology. Therefore organometallic chemistry is a Capital Stone for scientists in chemistry, material science and nano-science.

Schedule of the course

section	content	hours
1	Definition & Scope of Organometallic chemistry Interests in OM chemistry 18 electron rule and in OM	3
2	Coordination chemistry: from complex to coordination by Nobel Laureate Werner Coordination Number, ligand Number and Dentate Number Importance of Coordination Cores in Natural Enzymes One Hundred Years of Vitamins —A Success Story of the Natural Sciences	3
3	Alkali Metal Organometallics: Li, Na, K, Rb, Cs; preparation, reactivity and structures Alkaline Earth Metal Organometallics: Be, Mg, Ca, Sr, Ba; preparation, reactivity and structures	3
4	Zinc, Cadmium, and Mercury Organometallics: properties and applications Stoichiometric reactions Zirconocene-Promoted Organic Methodologies	3

5	Special topic on application of Organometallics Oxidative coupling of unsaturated substrates based on the Reaction Chemistry of Zirconocene Complexes Selective cleavage of C–H, C–C and C–X bonds catalyzed by transition-metal compounds towards Synthesis of Cyclic Compounds CO2 Activation and Transformation	3
6	Organometallics of the Boron Group: Transmetallation, reactions and uncommon bonding Aluminium organometallics: Cyclopentadienylaluminium, reactivity, structures	3
7	Organometallics of the Carbon Group: Synthesis, reactivity, bondings Compounds of Low-valent Silicon: Silyl Anions, Cyclosilanes, Silicocene, Silylenes, Silyl radicals and silyl cations Lead Compounds:, synthesis and Structures of Lead Compounds, Toxicity of tin(IV) reagents Cyclopentadienyltin(II) compounds Cyclopentadienyllead Derivatives	3
8	Organometallics of Transition Metals Various ligands Electron counting and coordination geometries Types of metallocene complexes Nobel Prize in Chemistry 2019 Semi-test	3
9	Metal Hydrides; Bonding in metal hydrides; Preparation of TM carbonyl hydrides; General points about oxidative addition; Experimental identification; Importance of TM metal-carbon bonds; Metal-alkyl complexes – history; bonding and stability	3
10	Metal-Alkyl Complexes: Stability of TM-alkyls vs. MG-alkyls, 8 Essential OM Reaction Steps; Preparation of stable TM-alkyl complexes; Strategies for blocking β-H elimination Preparation and reaction of Metal-Alkyl Complexes	3
11	Metal alkene(olefin)complexes: bonding,preparation,and reactions Metal alkyne complexes: bonding, preparation, and reactions	3
12	TRANSITION METAL-CARBON MULTIPLE BONDS: Metal carbenes – in organic synthesis and polymerisation; Metal carbenes Fischer versus Schrock: synthesis, reactivity; Metal carbenes – spectroscopic features of metal carbenes; Synthesis of metal carbenes – low oxidation state metal carbenes; Synthesis of metal carbenes – high oxidation state metal carbenes; Reactivity of metal carbene complexes; Conversion of a Fischer carbyne to a Schrock carbyne	3
13	Basics of Organometallics; Historical Background in Organometallics; Charges and corresponding coordination numbers for typical ligands; Relationships between oxidation states and dn configulations; Electron Count on the basis of the 18 electron rule; Crystal Field Splitting; Relating the Colors of Coordination Complexes to the Spectrochemical Series;Phosphine Ligands; Coordination & Dissociation	3
14	CATALYSIS INTRODUCTION AND DESCRIPTIONS; Mode of Action of a	3

	Catalyst; Catalyst Performance; Homogeneous versus Heterogeneous Catalysis; Important Examples of Heterogeneous Catalysis; Heterogeneous catalysis; Important Examples of Homogeneous Catalysis; Reasons for industrial preference for Heterogeneous Catalysis; Methods For Studying Catalysis; Hydrogenation & Hydroformylation; ACETIC ACID	
15	CO ETHYLENE COPOLYMERISATION; CO/alkene Copolymerisation; CO/C2H4 Copolymerisation; Mechanism; Propagation; OLEFIN OLIGOMERISATION; Industrial processes	3
16	OLEFIN POLYMERISATION; RING OPENING POLYMERISATION	3
17	Final test	2
total		50

Textbook and any related course material:
Organometallics and Catalysis: An Introduction Edited by Manfred Bochmann. Oxford University Press 2015.
THE ORGANO METALLIC CHEMISTRY OF THE TRANSITION METALS
Sixth Edition, Edited by Robert H. Crabtree. John Wiley & Sons, Inc 2014.

Course title

Fundamentals of Modern Astronomy

Instructor(s)-in-charge:

Dr. Lijun Gou, Dr. Lan Wang

Teaching assistant:

Dr. Lu Feng (Jacobfeng@bao.ac.cn)

Course type:

Lecture

Course Schedule:

3 hrs/week by instructors

Pre-requisites and Co-requisites:

None

Credits:

2.5

Course Content:

This course is designed primarily for the non-astronomy student who wishes to explore in depth a single topic in astronomy without becoming involved in detailed mathematical developments. In the process, we will see how scientific ideas develop and how scientists think about or approach problems.

This course is an introduction to our modern view of the universe, its contents, and how they got to be the way they are. Among the topics we will discuss are galaxies, quasars, stars, and black holes as well as the modern cosmology. For each of these objects, we will talk about what they are, how they are observed, how they form, and how they fit into the overall scheme of things in the universe. Due to the constraints of time, there are a number of topics, which we will not be able to discuss in detail. These omissions are made not because the subjects are of no interest to astronomers, but rather because we will not have time to discuss all of the interesting and important topics in astronomy.

Classical topics in astronomy, such as constellations and the appearance of the night sky, will not be covered in this course.

The topics are arranged as:

Section	Content	Hours	Teachers
1	Overview （Chap.1-4） Overview of modern Astronomy	3	Prof. Lijun Gou
2	Light and Matter （Chap.5） Reading messages from the Cosmos	3	Prof. Lan Wang
3	Planet & its formation (Chap.7-13) Solar system, extrasolar system and their formation	3	Prof. Lan Wang
4	The Sun (Chap. 14)	3	Prof. Lan Wang

	A close look at the sun		
5	Surveying the stars(Chap.15) Properties of stars	3	Prof. Lan Wang
6	Star formation (Chap. 16) Where, why and how stars form	3	Prof. Lan Wang
7	Stellar evolution (Chap. 17) The life stages of stars with different masses	3	Prof. Lijun Gou
8	Stellar remnants (Chap. 18) The end of the stars	3	Prof. Lijun Gou
9	Milky Way galaxy (Chap. 19) Properties of our Galaxy and its history	3	Prof. Lijun Gou
10	Galaxies and Cosmology (Chap. 20) Different types of galaxies and the foundation of modern cosmology	3	Prof. Lan Wang
11	Galaxy formation and evolution (Chap. 21) How do we learn the life stages of galaxies	3	Prof. Lan Wang
12	Beginning of the Universe (Chap. 22) The Birth of our Universe	3	Prof. Lijun Gou
13	Dark Matter & Dark Energy (Chap. 23) The invisible but important part of our University	3	Prof. Lijun Gou
14	Life in the universe (Chap. 9,10，13 etc.) Where and how can we search for extrasolar lifes	3	Prof. Lijun Gou
15	Trip to Xionglong Observatory for LAMOST and other telescopes	8	Prof. Lijun Gou

Course Objectives:

By the conclusion of this course, students should be able to:

•Explain the scientific process and how scientific theories are developed and tested.

•Recall basic physical concepts such as gravitational and conservation laws, and how light and matter interact.

•Describe the general characteristics of the universe.

•Apply scientific thinking to the natural world to understand, e.g. what powers the sun, why galaxies differ, and how the universe began.

•Formulate a scientific hypothesis, identify a testable prediction, verify by carrying out an experiment, and assess the results.

Textbook:

The Cosmic Perspective, 7 th Edition by Bennett, Donahue, Schneider, & Voit; Pearson Press.

Course title

Remote Sensing Image Processing

Instructor(s)-in-charge:

Prof. Jiang Xiaoguang, Assoc Prof. Jiang Yazheng & Assoc Prof. Hu Ronghai

Course type:

Lecture

Course Schedule:

3 hrs/week by instructors. 20 hrs in total by Jiang Xiaoguang; 16 hrs in total by Assoc Prof. Jiang Yazheng & 16 hrs in total by Assoc Prof. Hu Ronghai.

Course Assessment:

Homework: 3 assignments

Grading Policy:

Typically 50% homework; 50% final exam.

Course Prerequisites:

Introductory courses related to geography and remote sensing

Catalog Description:

Combining theory with practice, this course includes two interrelated parts - lectures and laboratory practice. The lectures introduce the basic principles and methods of remote sensing science and remote sensing image processing briefly. The laboratory practice is the key points of the course, which is designed to help students to master the remote sensing image analysis software ENVI by a number of exercises on image processing, image management and image analysis. This course will cover the following topics:

Schedule of the course

section	content	hours	Date
1	**Remote Sensing Overview** Basic Concepts of Remote Sensing Technology; Remote Sensing Category; Resolutions and Their Significance to Applications; Remote Sensors and Remote Sensing Data; Image Display and Header File of Remote Sensing Image; Map Projection; The Basic Process of Remote Sensing; Basic Steps for Remote Sensing Applications; The Development Trend of Remote Sensing Technology.	9	Prof. Jiang Xiaoguang
2	**Preliminary Knowledge of Remote Sensing Image Processing** Related Concepts of Remote Sensing Image Processing; The Color of Image; Geometric Correction of Remote Sensing Image; Remote Sensing Image Mosaic; Remote Sensing Data Fusion; Remote Sensing Data Format.	3	Prof. Jiang Xiaoguang

	Homework 1		
3	**The Basic Operation of Image** Introduction to ENVI; Image Display and Management;. Coordinate Systems; Image Subset.	6	Prof. Jiang Xiaoguang
4	**Image Registration and Geometric Correction** Image Registration; Image Geometric Correction; Image Orthorectification; Image Registration Workflow; Image Mosaicking.	6	Assoc Prof. Jiang Yazheng
5	**Band Math and Image Fusion** Band Math; Image Fusion.	3	Assoc Prof. Jiang Yazheng
6	**Image Classification** Image Supervised Classification; Image Unsupervised Classification; Image Classification with Decision Tree Classifier; Post Classification; Homework 2	7	Assoc Prof. Jiang Yazheng
7	**Radiometric Correction** Radiometric Calibration; Atmospheric Correction.	3	Assoc Prof. Hu Ronghai
8	**Vegetation Analysis and Spectral Analysis** Vegetation Analysis; Spectral Analysis.	3	Assoc Prof. Hu Ronghai
9	**Terrain Analysis** Terrain Analysis and Visualization; DEM Extraction of Stereo Tie Points.	3	Assoc Prof. Hu Ronghai
10	**Remote Sensing Dynamic Monitoring** Spatial Change Analysis; Temporal Change Analysis; Homework 3	7	Assoc Prof. Hu Ronghai
	Exam	2	Prof. Jiang Xiaoguang
Total		52	

Contents of the course

Section 1: Remote Sensing Overview

1. Basic concepts of remote sensing technology;
2. Remote sensing category;
3. Resolutions and their significance to applications;
4. Remote sensors and remote sensing data;
5. Image display and the information in header file of image;

6. Map projection;

7. The basic process of remote sensing;

8. Basic steps for remote sensing applications;

9. The development trend of remote sensing technology.

Section 2: Preliminary Knowledge of Remote Sensing Image Processing

1. Related concepts of remote sensing image processing

Image, digital image, representation of image, image processing

2. The color of image

Color addition principle, color space, IHS Transformation, color density segmentation

3. Geometric correction of remote sensing image

Geometric rough correction, geometric precision correction

4. Resampling of remote sensing image

Nearest neighbor interpolation, Bilinear interpolation, Cubic convolution interpolation

5. Remote sensing image mosaic

Concept, key technology of remote sensing image mosaic, the steps of remote sensing image mosaic

6. Remote sensing data fusion

Data fusion, remote sensing data fusion, the significance of remote sensing data fusion, methods of remote sensing data fusion

7. Remote sensing data format

BSQ, BIL, BIP, FAST, DIMAP, HDF etc.

Section 3: The Basic Operation of Image

1. Introduction to ENVI

2. Image display and management

3. Coordinate systems

4. Image subset

Section 4: Image Registration and Geometric Correction

1. Image registration

2. Image geometric correction

3. Image orthorectification

4. Image registration workflow

5. Image mosaicking

Section 5: Band Math and Image Fusion

1. Band Math

2. Image fusion

Section 6: Image Classification

1. Image Supervised Classification

2. Image Unsupervised Classification

3. Image Classification with Decision Tree Classifier

4. Post Classification

Section 7: Radiometric Correction

1. Radiometric calibration

2. Atmospheric correction

Section 8: Vegetation Analysis and Spectral Analysis

1. Vegetation analysis
2. Spectral analysis

Section 9: Terrain Analysis

1. Terrain analysis and visualization
2. DEM extraction of Stereo Tie Points

Section 10: Remote Sensing Dynamic Monitoring

1. Spatial change analysis
2. Temporal change analysis

Textbook and any related course material:

ENVI User's Guide

Expected level of proficiency from students entering the course:

Remote Sensing: basic

Geosciences: middle

Computer Sciences: middle

Course title

Development Geography

Instructor(s)-in-charge:

Prof. DENG Xiangzheng & Prof. DONG Jinwei & Associate Prof. SONG Wei & Associate Prof. WU Feng

Course type:

Lecture

Course Schedule:

3hrs/week by instructor

Course Assessment:

Homework: 4 assignments；student presentation

Grading Policy:

Typically 30% homework, 30% student presentation, 40% final.

Course Prerequisites:

NULL

Catalog Description:

Development geography is a subdiscipline of geography that studies human development and quality of life. Based on geography, development geography integrates disciplines such as management, economics, ecology, etc., and has the characteristics of integrity and interdisciplinary. Development Geography facilitates a more integrated understanding of development and places development problems within the context of the global economy and society. Its topics cover the concepts, theories and approaches, and development trend etc., which ranges from population and culture to agricultural and industrial development. Specifically, the contents of the courses include the concepts and progress of development geography, overview of geographical development differences; and specific analysis of geographical distribution and differences in income inequality and poverty, population, education and health, culture, resource and environment carrying capacity, rural and agricultural development, urban and industrial development, and the regional differences of globalization and international and regional development, etc. Further, case studies will be presented to highlight the possible solutions, as well as the problems, at local, national and international levels.

Schedule of the course

Section	Content	Hours
1	Concepts and progress of development geography	3
2	Overview of development geography	3
3	Overview of geographical differences in regional development geography	6
4	Income inequality and poverty	3
5	Geographical distribution of population in China	3
6	Land use policy and management in China	3

7	Agriculture and food security in China	3
8	Student presentation and discussions	3
9	Resource and environmental carrying capacity and regional differences	6
10	Geographic development differences in rural areas and agriculture	3
11	Geographic development differences in cities and industry	3
12	Student presentation and discussions	3
13	Review on globalization and regionalization development	3
14	International trade, cooperation and regional development	3
15	The balance of payments, financial stability and regional development	3
16	The national cases: China, Brazil and India	3
17	Student presentation and discussions	3
18	Exam	3
Total		60

Contents of the course

Section 1: Understanding Development Geography

1. Concepts and progress of development geography
    1. Concepts, discipline classification and development of geography
    2. Overview of geographical research and development
    3. Concepts relating to geography
    4. Tools applied in geography
2. Overview of development geography
    (1) Concepts and research objects of development geography
    (2) Role of development geography in geography
    (3) Theories in development geography
    (4) Theoretical and practical significance of development geography
    (5) Research prospects in development geography
3. Overview of geographical differences in regional development geography
    (1) Indicators for geographic regional development differences measure
    (2) Geographic regional development differences in China
    (3) Development differences between developing and developed countries
    (4) Reasons for regional development difference and the theoretical origins

Section 2: Social and Economic Development

4. Income inequality and poverty
    (1) Fundamentals of income inequality and poverty
    (2) Measurement and representation of income inequality
    (3) Measurement and representation of poverty

(4) Policies to address income inequality and poverty

5. Geographical distribution of population in China
   (1) Characteristics of population growth
   (2) Characteristics of population structure
   (3) Spatial and geographical distribution of population
   (4) Population growth and migration policy
6. Land use policy and management in China
   (1) Evolution of land use policies in China
   (2) Effectiveness and impacts of major land use policies in China
   (3) Discussion on land system reform
7. Agriculture and food security in China
   (1) Role of agriculture and food security
   (2) Spatial distribution of agricultural production and regional difference
   (3) Reform of agricultural policies

Section 3: Environmental and Rural-Urban Development

8. Resource and environmental carrying capacity and regional differences
   (1) The effect of environmental protection and ecological civilization construction on geographical development
   (2) Measurement and characterization of environmental capacity and resources and environmental carrying capacity
   (3) Measurement and characterization of ecological development efficiency
   (4) Research on the convergence of regional economic development
   (5) Ecological civilization construction and sustainable development strategic spatial layout
   (6) Transformation path and policy choices in underdeveloped areas
9. Geographic development differences in rural areas and agriculture
   (1) The role of cities and industry in geographic development
   (2) Urbanization process and spatial distribution differences
   (3) Industrial development status and spatial distribution differences
   (4) Urbanization development and industrial reform policies
10. Geographic development differences in cities and industry
    (1) The role of cities and industry in geographic development
    (2) Urbanization process and spatial distribution differences
    (3) Industrial development status and spatial distribution differences
    (4) Urbanization development and industrial reform policies

Section 4: Globalization, trade and regional development

11. Review on globalization and regionalization development
    (1) Role of globalization on geography development
    (2) Current international geographical differences
    (3) Status of China in the globalization process
    (4) Policy choice of developing countries in the process of globalization
12. International trade, cooperation and regional development
    (1) Theory of international trade for the development of the geographical environment

(2) International cooperation organizations and institutions
(3) Geopolitics and protectionism
(4) Trade policy comparison between countries

13. The balance of payments, financial stability and regional development
    (1) International financial stability for the role of regional development
    (2) Balance of payments deficit and trade war
    (3) Effects of the global financial crisis on developing countries
    (4) Financial system reform and promoting the development of regional policy
14. The national cases: China, Brazil and India
    (1) National development in the future
    (2) China's development present situation and the future
    (3) Brazil's development present situation and the future
    (4) India's development present situation and the future

Textbook and any related course material:

Hodder, R. (2000). Development Geography. Psychology Press.
Potter, R., Conway, D., Evans, R., & Lloyd-Evans, S. (2012). Key Concepts in Development Geography. Sage Publications.
Lawson, V. (2014). Making Development Geography. Routledge.

Expected level of proficiency from students entering the course:

Geography: Medium
Economics: Primary

Course title

Geographic Information Systems-A

Credits/Hours:

2.5 credits/51 hours

Instructor(s)-in-charge:

Prof. SONG Xianfeng, Dr. SONG Ci and Dr. YI Jiawei

Course type:

Lecture

Course Schedule:

3hrs/week by instructor

Course Assessment:

Homework: 2 assignments

Grading Policy:

Typically 40% homework, 20% attendances; 40% final.

Course Prerequisites:

Introductory courses related to geography, environmental sciences, and cartography.

Catalog Description:

This course presents a thorough overview of the principles of Geographical Information System, exploring both the theoretical basis of GIS lectures, and their use in practice. The lectures introduce the conceptual frameworks for GIS, spatial data management, spatial Analysis and GIS Modeling. The laboratory practice is designed to help students to master a GIS software (i.e. ArcGIS desktop or QGIS) by a number of experiences on spatial data management, analysis and presentation.

Schedule of the course

chapter	content	hours	
1 2	Nature of Geographic data Coordinate Systems	2	Prof. Xianfeng Song
3	Vector Data Model	2	Prof. Xianfeng Song
4	Raster Data Model	2	Prof. Xianfeng Song
5	Spatial Data Acquisition	1	Prof. Xianfeng Song
6	Geometric Transformation	2	Prof. Xianfeng Song
7	Spatial Date Edition	3	Prof. Xianfeng Song
8	Attribute Data Management	2	Prof. Xianfeng Song
9	Cartography and GIS Mapping	3	Prof. Xianfeng Song
	Homework 1		Prof. Xianfeng Song
10	Data Exploration	4	Assoc Prof. Ci Song
11	Vector Data Analysis	4	Assoc Prof. Ci Song
12	Raster Data Analysis	3	Assoc Prof. Ci Song
13	Spatial Interpolation	6	Assoc Prof. Ci Song
	Homework 2		Assoc Prof. Ci Song
14	Terrain Mapping and Analysis	2	Assoc Prof. Ci Song
15	Viewshed and Watershed Analysis	3	Assoc Prof. Jiawei Yi
16	Least Cost Path and Network Analysis	3	Assoc Prof. Jiawei Yi
17	GIS Models and Modeling	6	Assoc Prof. Jiawei Yi
	Q&A		Assoc Prof. Jiawei Yi
	Exam	3	Assoc Prof. Jiawei Yi

Total		51	

Contents of the course

Section 1: Conceptual Frameworks for GIS

1 Nature of Geographic data

Components of GIS, Elements of GIS, Application of GIS

2 Coordinate Systems

Geographic coordinate system, Map projections, Projected coordinate system, Commonly used map projections.

3 Vector Data Model

Object-based data model, Topology and geo-relational data model

4 Raster Data Model

Elements of raster data model, Raster data structure, Satellite image and other types of raster data

Section 2: Spatial Data Management

5 GIS Data Acquisition

Existing GIS data, Metadata, Data conversion, Creation of new data

6 Geometric Transformation

Geometric Transformation, Control points, Georeferencing, Raster data resampling

7 Spatial Data Accuracy and Quality

Location errors, Topological Errors, Spatial data editing

8 Attribute Data Management

Relational model, Joins and relates, Spatial joins

9 Data Display and Cartography

Cartographic representation, Types of quantitative maps, Typography, Map design

Section 3: Spatial Analysis

10 Data Exploration

Descriptive statistics, data visualization and graphs, Map-based data manipulation, Attribute data query, Spatial query

11 Vector Data Analysis

Buffering, Overlay, Distance measurement, Pattern analysis

12 Raster Data Analysis

Local operations, Neighborhood operations, Zonal Operations, Map algebra

13 Spatial Interpolation

Elements of spatial interpolation, global methods, local methods, Kriging, Comparison of spatial interpolation

14 Terrain Mapping and Analysis

Terrain data types, Terrain mapping, Slope and aspect, Surface curvature

15 Viewshed and Watershed Analysis

Viewshed analysis, watershed analysis, Applications

16 Least Cost Path and Network Analysis

Source raster, cost raster, cost distance measures, and application of least cost path

Link and link impedance, Junction and turn impedance, network analysis, the applications using shortest path analysis

Section 4: GIS Modeling

17 GIS Models and Modeling

Basic elements of GIS modeling, binary models, index models, regression models, process models, appellations on case studies

Textbook and any related course material:

Introduction to Geographic Information Systems, 8th Edition, 2016
Edited by Kang-tsung Chang.
Geospatial Analysis: a comprehensive guide to principles, techniques and software tools, 6th Edition, 2018
http://www.spatialanalysisonline.com/HTML/index.html
Edited by Michael J de Smith, Michael F Goodchild, Paul A longley

Expected level of proficiency from students entering the course:

Geosciences: strong
Computer Sciences: middle

Course title

Land Change Science

Instructor(s)-in-charge:

Prof. DONG Jinwei, Prof. FENG Min, Prof. CUI Huijuan, and Prof. PENG Shushi

Course type:

Lecture

Course Schedule:

4hrs/week by instructor.

Course Assessment:

Homework: 5 assignments and 1 final project

Grading Policy:

Typically 20% Attendance, 30% homework, 30% Oral Presentation, 20% final.

Course Prerequisites:

Geography, Geoinformatics, Remote Sensing

Catalog Description:

Land cover and land use change is a fundamental component of global environmental change and sustainability research, so called land change science (LCS) which is considering as an increasingly important interdisciplinary science. This course introduces the emerged land change science, including 1) observation and monitoring, 2) process and pattern, 3) causes and driving factors, and 4) consequences of land cover and land use changes from regional to global scales. The course will be organized from the four topics of LCS as following: The observation and monitoring of land use changes will introduce basics of remote sensing like widely-used sensors, and also cover the cutting-edge algorithms of land classification and the application of the planetary-scale geospatial analysis platform (e.g., Google Earth Engine); The causes of land use changes will be analyzed by considering both natural and human drivers using case studies across the world, and also using a comprehensive review of land change modeling which will help an understanding of the land change process; The process and pattern of rapid land use change in China since Reform and Opening-up will be introduced; The ecological, climate, hydrological consequences of land use changes (e.g., deforestation, afforestation, land reclamation, urbanization) from the classic and highly-cited studies will be discussed in the classes.

Schedule of the course

section	content	hours	Instructor
1	**Course Introduction, Introductory Lecture** Concepts of Land Change Science (LCS) Current International Research Programs on LCS State-of-the-art and perspective of LCS Existing global land cover/use maps and their applications	3	Dong
2	**Observation and monitoring of land change** Introduction of cloud computing platform (Google Earth Engine)	3	Dong

	Introduction on main sensors (GF, Landsat, MODIS)		
3	**Observation and monitoring of land change** Field data collection (field photos, apps, & visual interpretation) Accuracy Assessment	3	Feng
5	**Observation and monitoring of land change** Land cover classification (machine learning; phenological approach; deep learning) Land change detection (CCDC, VCT, BFAST, LandTrendr)	6	Feng
6	**Process and pattern of land change** Theme I: Agricultural land use change Theme II: Deforestation and afforestation	3	Dong
7	**Process and pattern of land change** Theme III: Urbanization Theme IV: Surface water dynamics	3	Feng
8	**Student presentation** Literature review and topic selection for final project	3	Dong/Feng/Cui
9	**Causes and driving factors of Land change: China and Global perspective** Land use changes in China Natural and human drivers of land use changes in China Modelling land use change in China	3	Dong
10	**Consequences of land change: Ecological perspective** Earth greening Effects of land change on carbon cycle	6	Peng
11	**Student presentation** Final project progress report and Q&A	6	Dong/Feng/Cui
12	**Consequences of land change: Climate perspective** Land–Climate interactions Climate effects of deforestation and afforestation	3	Peng
13	**Consequences of land change: Hydrological perspective** Impact of Land Use Change on water cycle Land change and water/food security	6	Cui
14	**Land use/management and sustainable development** Land related mitigation and adaptation response	6	Cui

	Land management and socioeconomic development		
15	**Student presentation** Presentations on final project	6	Dong/Feng/Cui
total		60	

Contents of the course

Section 1: Observation and monitoring of land change

1. Concepts of Land Change Science (LCS)
2. Current International Research Programs on LCS
3. Start-of-the-art and perspective in land change science
4. Existing land cover/use maps and their applications
5. Introduction of cloud computing platform (Google Earth Engine)
6. Introduction on main sensors (GF, Landsat, MODIS)
7. Reference data collection (Google Earth, Field Photos, and Visual Interpretation of images)
8. Land use mapping (machine learning; phenological approach; deep learning, etc)
9. Land change detection (CCDC, VCT, BFAST, LandTrendr, etc.)
10. Accuracy assessment

Section 2: Process and pattern of land change

1. Theme I: Agricultural land use change
2. Theme II: Deforestation and afforestation
3. Theme III: Urbanization
4. Theme IV: Global water dynamics

Section 3: Causes and driving factors of land change

1. Land use changes in China and Global perspective
2. Natural and human drivers of land use changes in China
3. Modelling land use change in China

Section 4: Consequence of land change

1. Consequences of land change: Ecological perspective
    a) Earth greening
    b) Effects of land change on carbon cycle
2. Consequences of land change: Climate perspective
    a) Land–Climate interactions
    b) Climate effects of deforestation and afforestation
3. Consequences of land change: Hydrological perspective
    a) Impact of Land Use Change on Hydrologic Processes
    b) Land change and water/food security

4. Land use/management and sustainable development
    a) Land related mitigation and adaptation response
    b) Land management and socioeconomic development

Textbook and any related course material:

1. Garik Gutman, 2012, LAND CHANGE SCIENCE: Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface

2. John R. Jenson, 2007, Remote Sensing of the Environment: An Earth Resource Perspective

3. Ten journal papers will be assigned for student's homework. Students can select five papers from the list we provide or through the Web of Science.

1) *Chen, C., Park, T., Wang, X.H., Piao, S.L., Xu, B.D., Chaturvedi, R.K., Fuchs, R., Brovkin, V., Ciais, P., Fensholt, R., Tommervik, H., Bala, G., Zhu, Z.C., Nemani, R.R., & Myneni, R.B. (2019). China and India lead in greening of the world through land-use management. Nature Sustainability, 2, 122-129*
2) *DeFries, R.S., Rudel, T., Uriarte, M., & Hansen, M. (2010). Deforestation driven by urban population growth and agricultural trade in the twenty-first century. Nature Geoscience, 3, 178-181*
3) *Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., & Gibbs, H.K. (2005). Global consequences of land use. Science, 309, 570-574*
4) *Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O., & Townshend, J.R. (2013). High-resolution global maps of 21st-century forest cover change. Science, 342, 850-853*
5) *Luyssaert, S., Marie, G., Valade, A., Chen, Y.Y., Njakou Djomo, S., Ryder, J., Otto, J., Naudts, K., Lanso, A.S., Ghattas, J., & McGrath, M.J. (2018). Trade-offs in using European forests to meet climate objectives. Nature, 562, 259-262*
6) *Peng, S.S., Piao, S.L., Zeng, Z.Z., Ciais, P., Zhou, L.M., Li, L.Z.X., Myneni, R.B., Yin, Y., & Zeng, H. (2014). Afforestation in China cools local land surface temperature. Proc Natl Acad Sci U S A, 111, 2915-2919*
7) *Song, X.P., Hansen, M.C., Stehman, S.V., Potapov, P.V., Tyukavina, A., Vermote, E.F., & Townshend, J.R. (2018). Global land change from 1982 to 2016. Nature, 560, 639-643*
8) *Tucker, C.J., Townshend, J.R.G., & Goff, T.E. (1985). African Land-Cover Classification Using Satellite Data. Science, 227, 369-375*
9) *Turner, B.L., Lambin, E.F., & Reenberg, A. (2008). Land Change Science*

Special Feature: The emergence of land change science for global environmental change and sustainability (vol 104, pg 20666, 2007). Proc Natl Acad Sci U S A, 105, 2751-2751

10) *Zou, Z., Xiao, X., Dong, J., Qin, Y., Doughty, R.B., Menarguez, M.A., Zhang, G., & Wang, J. (2018). Divergent trends of open-surface water body area in the contiguous United States from 1984 to 2016. Proceedings of the National Academy of Sciences, 201719275*

Expected level of proficiency from students entering the course:

Prior to taking this course, students need to have basic GIS and imagery process skills, the final project will require quantitative problem-solving skills and might entail working with small land cover/use maps.

Course title

Eco-Environmental Informatics

Instructor(s)-in-charge:

Prof. Tianxiang Yue

Course type:

Lecture, including seminar and practices on computer

Course Schedule:

6hrs/week

Course Assessment:

Homework: 4 assignments

Grading Policy:

Typically 40% homework, 20% attendances; 40% final exam.

Course Prerequisites:

Mathematics, geography, ecology, environmental sciences, GIS, Remote sensing

Catalog Description:

This course mainly introduces eco-environmental informatics, methods for high accuracy surface modelling (HASM) and the fundamental theorem for eco-environmental surface modelling (FTEEM), upscaling and downscaling, data fusion, spatial interpolation, model-data assimilation, surface modelling of climatic change, surface modelling of ecosystems and biodiversity, and surface modelling of soil properties. The first section provides the general introduction to background, conception and general view on eco-environmental informatics. The sections two to six provide knowledges on the fundamental theorem for eco-environmental surface modelling and its corollaries corresponding to spatial interpolation, spatial upscaling, spatial downscaling, data fusion and model-data assimilation. The seventh section provides different methods to simulate climate change trend and scenarios as well as their impacts on ecosystems. In the eighth section, students would know how to construct surface models of ecosystems and biodiversity. In the ninth section, students would learn spatial prediction of soil properties.

Schedule of the course

section	content	hours	
1	**A General Introduction** ♦ Conception of eco-environmental informatics ♦ Related International Organizations ♦ Related International Programmes ♦ Related Models ♦ Integrated Models ♦ Modelling Platforms	3	Prof. Tianxiang Yue
2	**The Fundamental Theorem for Eco-Environmental Surface Modelling** ♦ Introduction ♦ HASM and FTEEM	3	Prof. Tianxiang Yue

	♦ Quantum computing and quantum machine learning ♦ Significant applications ♦ Summary		
3	**Spatial interpolation** ♦ Introduction ♦ Filling voids on remotely sensed XCO_2 surfaces ♦ Filling voids on SRTM elevation surfaces ♦ Spatial interpolation of LiDAR point clouds ♦ Spatial interpolation of soil properties ♦ Spatial interpolation of observed data from meteorological stations ♦ Spatial interpolation of ecological diversity ♦ Summary	3	Prof. Tianxiang Yue
4	**Upscaling and Downscaling** ♦ Introduction ♦ Spatial upscaling ♦ Spatial downscaling ♦ Summary	3	Prof. Tianxiang Yue
5	**Data Fusion** ♦ Introduction ♦ Elevation surface ♦ XCO_2 surfaces ♦ CO_2 surfaces ♦ Surface of carbon stocks ♦ Summary	3	Prof. Tianxiang Yue
6	**Model-Data Assimilation** ♦ Introduction ♦ A framework for model-data assimilation ♦ Dynamic global vegetation models ♦ Algorithms for model-data assimilation ♦ Summary	3	Prof. Tianxiang Yue
7	**Surface modelling of soil properties** ♦ Progress and Prospect of Surface Modelling of Soil Properties ♦ Mapping soil properties combined with environmental information ♦ Mapping soil compositional data ♦ Mapping soil compositional data combined with environmental information	15	Prof. Wenjiao Shi
8	**Surface modelling of ecosystems and biodiversity**	15	Prof. Zemeng Fan

	♦ Data and information sources ♦ Social Change trends and scenarios of terrestrial ecosystems network data ♦ Change trends and scenarios of land cover ♦ Spatial distribution and scenarios of biodiversity		
9	**Surface modelling of climatic change** ♦ Introduction ♦ Methods and models ♦ Change trends and scenarios of climate variables ♦ Understanding climate events ♦ Impacts of climate change on ecosystems ♦ Discussion and summary	15	Prof. Na Zhao
10	**Summary & final examination**	6	Prof. Tianxiang Yue
total		69	

Textbook and any related course material:

- TianXiang Yue. 2011. Surface Modelling: High Accuracy and High Speed Methods. New York: CRC Press
- TianXiang Yue, Na Zhao, Yu Liu, et al. 2020. A fundamental theorem for eco-environmental surface modelling and its applications. Science China-Earth Sciences 63(8), 1092-1112.
- TianXiang Yue, Yi Liu, ZhengPing Du, et al. 2022. Quantum machine learning of eco-environmental surfaces. Science Bulletin 67, 1031-1033.
- TianXiang Yue, ChenChen Wu, Yi Liu, et al. 2023. HASM quantum machine learning. Science China-Earth Sciences (in press).
- Na Zhao, Tianxiang Yue. 2021. High Accuracy Surface Modeling Method: the Robustness. Springer.
- Zemeng Fan, Bin Fan, Tianxiang Yue, 2019. Terrestrial ecosystem scenarios and their response to climate change in Eurasia. Science China-Earth Sciences, 62, 10: 1607–1618
- Wenjiao Shi, Jiyuan Liu, Zhengping Du, Yinjun Song, Chuanfa Chen, Tianxiang Yue. 2009. Surface modelling of soil pH. Geoderma, 150(1): 113-119.

Expected level of proficiency from students entering the course:

Ecology: basic
Environmental Sciences: basic
Geography and Mathematics: basic
GIS: basic
Remote Sensing: basic: basic

Course title

Geographic Information Systems-B

Instructor(s)-in-charge:

Prof. Xiang Zhou, Assoc Prof. Zui Tao, Assoc Prof. Hongga Li and Assoc Prof. Tingting Lv

Course type:

Lecture

Course Schedule:

3hrs/week by instructors.

Course Assessment:

Homework: 3 assignments

Grading Policy:

Typically 50% homework, 20% attendances; 30% final exam.

Course Prerequisites:

Introductory courses related to Geography, Environmental sciences, Cartography and Basic computer programming

Catalog Description:

Geographic Information System (GIS) is a computer system used to store, manage, analyze, and display spatial data in order to support comprehensive decision-making. GIS-B is a graduate-level course that provides a comprehensive course on geographic information systems, remote sensing, spatial analysis, and geographic spatial modeling, and more. In addition to lectures, this course also includes hands-on practice and case studies to enhance students' skills in handling and managing spatial data, ultimately improving their understanding and comprehension of geographic phenomena. The course will cover the following topics:

Schedule of the course

section	content	hours	
1	**Nature of Geographic data：** 1. What is GIS 2. Contents of GIS 3.Applications of GIS **Hand-on：** 1. Introduction to ArcCatalog 2. Introduction to ArcMap	3	*Prof. Xiang Zhou*
2	**Coordinate Systems：** 1. Geographic Coordinate System 2. Map Projection and Commonly Used Projections 3.Projected Coordinate Systems 4.Options for Coordinate Systems in GIS Projections and Coordinate Systems.pdf **Hand-on：** 1.Project from a Geographic to a Projected Coordinate System 2 Import a Coordinate System 3.Projet Using a Predefined Coordinate System	3	*Assoc Prof. Hongga Li*
3	**Geo-data Organization (vector)：** 1. Representation of Spatial Features:	3	*Assoc Prof. Zui Tao*

	point\line\polygon 2. Georelational Data Model:Coverage\Shape 3. Object-Based Data Model: Geodatabase **Hand-on：** 1.Examine and view the Data File Structure of Coverage and Shape 2 Create File Geodatabase, Feature Dateset and Feature Class 3. Convection between shape/coverage and Geodatabase		
4	**Geo-data Organization(Raster):** 1.Elements of the Raster Data Model 2.Satellite Images,DEM and Other Types of Raster Data 3.Data Conversion and Integration **Hand-on：** 1.View a satellite Image and view a Land Cover Image 2.Convert Vector Data to Raster Data	3	*Assoc Prof. Zui Tao*
5	**Spatial Data Acquisition：** 1. Existing GIS Data 2. Conversion of Existing Data 3.Creating of New Data **Hand-on：** 1.Download RS data 2.Digitize on Screen 3.Add XY Data 4.Kmz Files and Display in Google Earth	3	*Prof. Xiang Zhou*
6	**Geometric Transformation：** 1. Geometric Transformation 2. Root Mean Square (RMS) Error 3. Interpretation of RMS Errors on Digitized Maps 4. Resampling of Pixel Values **Hand-on：** 1.Georeference and Rectify a Scanned Map 2. Perform Image to Map Transformation	3	*Prof. Xiang Zhou*
7	**Attribute Data Management：** 1. Attribute Data in GIS 2. Joint, Relates and Relationship Classes 3. Manipulation of Fields and Attribute Data **Hand-on：** 1. Use Validation Rule for Entering Attribute Data 2. Join Tables\ Relate Tables 3. Create New Attribute by Data Classification 4. Create New Attribute by Data Computation	3	*Assoc Prof. Zui Tao*
8	**Cartography and GIS Mapping：** 1.Cartographic Representation 2.Types of Quantitative maps 3.Map Design 4.Map Production **Hand-on：** 1. Make a Choropleth Map 2. Use Graduated Symbols, Line Symbols, Highway Shield Symbols, and Text Symbols	3	*Assoc Prof. Zui Tao*

Homework1			
9	**Data Exploration：** 1.Data Exploration 2.Map-Based Data Manipulation 3.Attribute Data Query 4. Spatial Data Query 5.Raster Data Query **Hand-on：** 1. Select Features by Location 2. Make Dynamic Chart 3. Query Attribute Data from a Joint Table 4. Query Attribute Data from a Relational Database 5. Combine Spatial and Attribute Data Queries 6.Perform Spatial Join 7. Query Raster Data	3	*Assoc Prof. Zui Tao*
10	**Vector Data Analysis：** 1.Buffering 2.Overlay 3.Distance Measurement 4.Pattern Analysis 5.Feature Manipulation **Hand-on：** 1.Perform Buffering and Overlay 2.Overlay Multicomponent Polygons 3.Perform Areal Interpolation 4.Compute General and Local G-Statistics 5.Perform Select and Clip 6.Perform Dissolve	3	*Assoc Prof. Tingting Lv*
11	**Raster Data Analysis：** 1 Data Analysis Environment 2 Local Operations 3 Neighborhood Operations 4 Zonal Operations 5 Physical Distance Measure Operations 6 Other Raster Data Operations 7 Map Algebra 8 Comparison of Vector- and Raster-Based Data Analysis **Hand-on：** 1. Perform a Local Operation 2. Perform a Combine Operation 3. Perform a Neighborhood Operation 4. Perform a Zonal Operation 5. Measure Physical Distances 6. Perform Extract by Attributes and by Mask 7.Run Map Algebra	3	*Assoc Prof. Tingting Lv*
12	**Terrain：** 1 Data for Terrain Mapping and Analysis 2 Terrain Mapping 3 Slope and Aspect 4 Surface Curvature 5 Raster Versus TIN **Hand-on：**	3	*Assoc Prof. Tingting Lv*

	1. Use DEM for Terrain Mapping 2. Derive Slope, Aspect,and Curvature from DEM 3.Build and Display a TIN 4. Convert LiDAR Data to Raster		
13	**Viewshed and Watershed Analysis：** 1. Viewshed Analysis 2.Parameters of Viewshed Analysis 3.Applications of Viewshed Analysis 4.Watershed Analysis 5.Applications of Watershed Analysis **Hand-on：** 1.Perform Viewshed Analysis 2.Create a New Lookout Shapefile for Viewshed Analysis 3.Delineate Areawide Watersheds	3	*Assoc Prof. Hongga Li*
Homework 2			
14	**Spatial Interpolation：** 1.Elements of Spatial Interpolation 2.Global Methods 3.Local Methods 4.Kriging 5.Comparison of Spatial Interpolation Methods **Hand-on：** 1. Use Trend Surface Model for Interpolation 2.Compute Kernel Density Estimation 3.Use IDW for Interpolation 4.Use Ordinary Kriging for Interpolation 5.Use Universal Kriging for Interpolation	3	*Assoc Prof. Hongga Li*
15	**Least Cost Path and Network Analysis：** 1.Least-Cost Path Analysis 2.Applications of Least-Cost Path Analysis 3.Network 4.Assembly of a Network 5.Network Analysis **Hand-on：** 1.Compute the Least Accumulative Cost Distance 2. Compute the Path Distance 3.Run Shortest Path Analysis 4.Build a Geodatabase Network Dataset 5.Find Closest Facility 6.Find Service Area	3	*Assoc Prof. Hongga Li*
16	**GIS Models and Modeling：** 1.Basic Elements of GIS Modeling 2.Binary Models 3.Index Models 4.Regression Models 5.Process Models **Hand-on：** 1.Build a Vector-Based Binary Model 2.Build a Raster-Based Binary Model 3.Build a Vector-Based Index Model 4.Build a Raster-Based Index Model	3	*Prof. Xiang Zhou*
Homework 3			

17	Exam	3	*Prof. Xiang Zhou*
total		**51**	

Textbook and any related course material:

Introduction to Geographic Information Systems, 9th Edition, Edited by Kang-tsung Chang, 2019, McGraw-Hill Education.

Expected level of proficiency from students entering the course:

Students entering the course should have a basic understanding of computer systems and software applications. Some prior knowledge or experience in Geography, Environmental sciences and Ecology would be advantageous but not necessarily required.

Course title

Urban planning and sustainable development

Instructor(s)-in-charge:

Prof. YANG Zhenshan, Dr. QI Wei

Course type:

Lecture

Course Schedule:

3hrs/week

Course Assessment:

Homework: some assignments

Grading Policy:

20% Class Participation, 40% discussion, 40% final Exams (Open-book).

Course Prerequisites:

None

Catalog Description:

The aim of this course is to introduce knowledge and practice on-edge on sustainable development with focus on cities, as cities are key areas at stake for the development in most countries and regions. It equips and encourage students to think how to achieve sustainable development with planning and policy tools. It includes five sections: Fundamentals of Understanding Cities Towards Sustainable Development, Landscapes and Dimensions of Cities in Sustainable Development, and other three sections of Planning for Sustainable Cities, including Urban Systems, China's Programs and its Contributions to the World, and Tools and strategies. The first section introduces basic ideas and concepts of cities and sustainable development, preparing knowledge for students to be engaged into planning process for sustainable agendas. The second section lectures the key dimensions of cities in details, including demographic, economic, social, natural and ecological aspects. The third section takes a systematic view to examine the city alongside sustainable agendas with students, covering energy, transportation, water, and environmental systems. The fourth section shares practices in China, including experiences and lessons and comparisons to the world, which is expected to generate deliverables for students from other countries. The last section relates to tools and strategies, such as smart cities, ecological cities and shrinking cities, which are emerging as new but important topics in city development. The course requires only basic pre-knowledge but quite intensive as it expands on city sustainable development step by step.

Schedule of the course

Section	Content	Hours
1	**Fundamentals of Understanding Cities Towards Sustainable Development**	6
2	**Landscapes and Dimensions of Cities in Sustainable Development**	9
3	**Planning for Sustainable Cities: Urban Systems**	15
4	**Planning for Sustainable Cities: China's Programs and its Contributions to the World**	12

5	**Planning for Sustainable Cities: Tools and strategies (incl. exam)**	18
Total		60

Contents of the course

Module I: Fundamentals of Understanding Cities Towards Sustainable Development

1. Introduction: key concepts and idea for sustainable development
2. Planning cities for sustainable development

Module II: Landscapes and Dimensions of Cities in Sustainable Development

3. The social and demographic landscape of the city: Changing concepts and theories
4. The economic landscape of the city: Key concepts and theories
5. The nature and ecological landscape of city: Changing concepts and theories

Module III: Planning for Sustainable Cities: Urban Systems

6. History of world urbanization: Cities in developed vs. developing world
7. Cities as a mirror of energy
8. Sustainable transportation systems
9. Sustainable agricultural system for cities
10. Urban ecology, green networks and ecological design
11. Discussion: Key theme in urban sustainable development

Module IV: Planning for Sustainable Cities: China's Programs and its Contributions to the World

12. Planning systems in China: Planning as a tool to promote sustainability
13. Creating and shaping economic competitiveness: Socioeconomic plan and special economic zones
14. Discussion: Changes of spatial planning in China and compared to the rest of the world: Explorations towards sustainable development

Module V: Planning for Sustainable Cities: Tools and strategies

15. Assessing urban sustainability: Indicators and measurements
16. Smart cities and planning practices
17. Ecological cities and planning practice
18. Residential differentiation and planning for social inclusion
19. Discussion: Pathways, programs and policies of urban planning towards sustainable development
20. Exam

Textbook and any related course material:

David Pijawka, Martin A. Gromulat. 2013. Understanding Sustainable Cities: Concepts, Cases and Solutions. Kendall Hunt. ISBN: 978-1465203441 (USC)

David H. Kaplan, Steven R. Holloway, & James O. Wheeler. 2014. Urban Geography (Third Ed.). Wiley. ISBN: 978-1-118-57385-3. (UG)

Stanley D. Brunn, et al. Cities of the World: Regional Patterns and Urban Environments (6th ed.). Rowman & Littlefield. ISBN: 978-1-4422-4916-5. (CW)

Knox and McCarthy. Urbanization: An Introduction to Urban Geography (3rd ed.).

Pearson. (UAUG)
Pacione, M. 2009. Urban Geography: A Global Perspective (3rd ed.) Routledge. ISBN: 978-0415462020. (UGGP)
Other readings will be assigned in class.
Expected level of proficiency from students entering the course:
Geography: beginning-middle level
Planning or Management: basic

Course title

Radar Hydrology – Principles, Models, and Applications

Instructor(s)-in-charge:
Prof. Qi Youcun, Associate Prof. Zhao Zhanfeng
Assistant: Donghuan Li
Course type:
Lecture
Course Schedule:
3hrs/week by instructor plus 1hr/week discussion using WeChat Group.
Course Assessment:
Homework: 2 assignments
Grading Policy:
Typically 20% Attendance, 40% homework, 20% Oral Presentation, 20% final.
Course Prerequisites:
Remote Sensing, Radar QPE, Hydrology
Catalog Description:
This course provides graduate students (Master and PhD), forecasters, and researchers with a theoretical framework and practical knowledge of radar precipitation estimation and hydrological modeling. This course would provide a brief introduction to radar. Focuses on the processing of radar data to arrive at accurate estimates of rainfall. Addresses advanced radar sensing principles and applications. Covers radar technologies for observing each component of the hydrologic cycle. Examines state-of-the-art hydrologic models and their inputs, parameters, state variables, calibration procedures, and outputs. Discusses contemporary approaches in data assimilation. Concludes with methods, case studies, and prediction system design. This course will aid in understanding the physical systems and detection tools, as well as designing prediction systems.

Schedule of the course

section	content	hours	Instructor
1	**Introduction to basic radar principles** Radar components, Radar beam, Radar pulse, Signal Processing	4	Youcun Qi
2	**Single-Pol radar Quantitative Precipitation Estimation** Radar calibration, Quality Control, Precipitation Type	4	Youcun Qi
3	**Single-Pol radar Quantitative Precipitation Estimation** VPR correction, Multi radar mosaic, Rain gauge adjustment	4	Youcun Qi
4	**Single-Pol radar Quantitative Precipitation**	4	Youcun Qi

	Estimation Multi precipitation products merging, Space-Time aggregation, Remaining Challenges, Uncertainty estimation		
5	**Polarimetric radar Quantitative Precipitation Estimation** Polarimetric radar variables, Polarimetric radar data quality control, Hydrometeor Classification	4	Youcun Qi
6	**Polarimetric radar Quantitative Precipitation Estimation (QPE)** Polarimetric Radar-based QPE, Microphysical Retrievals	4	Youcun Qi
7	**Student presentation on applications**	4	Youcun Qi
8	**Advanced radar Technologies for Quantitative Precipitation Estimation** Mobile or Gap-filling radar, Spaceborne radar, and Phased-Array radar	4	Youcun Qi
9	**Radar Technologies for observing the water cycle** The hydrologic cycle, surface water, subsurface water	4	Zhanfeng Zhao
10	**Radar QPE for Hydrologic Modeling** Overview of hydrological models, hydrological model evaluation	4	Zhanfeng Zhao
11	**Radar QPE for Hydrologic Modeling** Hydrological model simulation, hydrological evaluation of radar QPE	4	Zhanfeng Zhao
12	**Radar QPE for Hydrologic Modeling** Overview of urban flash flood models, and urban flash flood modeling evaluation of radar QPE	4	Zhanfeng Zhao
13	**Flash flood forecasting** Flash flood guidance, history, lumped flash flood guidance, flash flood index, gridded flash flood guidance	4	Zhanfeng Zhao
14	**Presentation of the Final project**	4	Youcun Qi
15	**Office hour** **Final Exam**	2 2	Youcun Qi
total		60	

Contents of the course

Section 1: Basic of Radar Principles

1. Radar Components
2. Radar Antenna and Beam
3. Radar Pulse

4. Signal Processing

Section 2: Single-Pol Radar Quantitative Precipitation (QPE)

5. Radar Calibration
6. Quality Control-Signal Processing
7. Quality Control- Precipitation and Non-Precipitation Radar Echo Segregation
8. Surface Precipitation Type Segregation
9. Vertical Profile of Reflectivity
10. Rain Gauge Adjustment
11. Space-Time Aggregation, Remaining Challenges, and Uncertainty Estimation

Section 3: Polarimetric Radar Quantitative Precipitation Estimation

12. Polarimetric Radar Quality Control (Noise effect and reduction, Clutter detection)
13. Polarimetric Radar Attenuation Correction and Calibration
14. Polarimetric Radar Hydrometer Classification (Characteristics and algorithms)
15. Polarimetric Radar QPE and Microphysical Retrievals

Section 4: Advanced radar Technologies for Quantitative Precipitation Estimation

16. Gap-Filling radar: X-band Polarimetric Radar
17. Gap-Filling radar: X-band Polarimetric Phased Array Radar
18. Spaceborne Radar: Dual-Frequency Precipitation Radar aboard NASA GPM
19. S-band Phased Array radar

Section 5: Radar Technologies for Observing the Water Cycle

20. The Hydrologic Cycle
21. Surface Water: Stream Water Radar, Surface Water Altimetry and Synthetic Aperture Radar
22. Subsurface Water: L-band Radar, C-band Radar, Ground Penetrating Radar and Subsurface Water

Section 6: Radar QPE for Hydrologic Modeling

23. Overview of Hydrological models
24. Model Parameters
25. Model State Variables and Data Assimilation
26. Hydrological Model Evaluation of Radar QPE
27. Overview of Urban Flash Flood Models
28. Urban Flash Flood Modeling and Evaluation of Radar QPE

Section 7: Flash Flood Forecasting

29. Flash flood guidance
30. Flash flood guidance – history
31. Lumped flash flood guidance
32. Flash flood index
33. Gridded flash flood guidance

Textbook and any related course material:

1, Guifu Zhang, 2016, Weather Radar Polarimetry

2, Yang Hong and Jonathan J. Gourley, 2014, Radar Hydrology

3, Five journal papers will be assigned for student's individual research project. Students can find these papers from the list we provide or through the Web of Science.

Expected level of proficiency from students entering the course:
Prior to taking this course, students need to have basic program skills, the final project will require quantitative problem-solving skills and might entail working with small datasets.

Course title

Modern Hydrology

Instructor(s)-in-charge:

Prof. Yongqiang ZHANG and Prof. Suxia LIU

Course type:

Lecture

Course Schedule:

4hrs/week by instructor. 1 hr/week by teaching assistant. 27 hrs in total by Prof. ZHANG Yongqiang; 24 hrs in total by Prof. LIU Suxia

Course Assessment:

class quize，attendance, presentation, exam

Grading Policy:

30% class quize, 15% attendance, 15% presentation, 40% final exam

Course Prerequisites:

Hydrology, remote sensing, physical geography, atmosphere and climate sciences

Catalog Description:

We are living in a rapidly changing world, with hydrological science quickly developing. One of particular examples is that geophysical datasets are being created at fast increasing rates, and to advance hydrological science, hydrologists need to use these datasets for understanding hydrological processes in various climate, vegetation, soil and anthropogenic-influenced regimes. To adapt the development, we will introduce a new course 'modern hydrology' that covers not only traditional hydrology, but also numerical hydrological modelling and remote sensing hydrology. We wish that master or phd students can comprehensively understand basic hydrological knowledge, hydrological modelling, and learn the opportunities and challenges faced in modern hydrological science.

Schedule of the course

Section	Content	Hours	Lecture
1	Basic understanding of hydrology	3	Prof. ZHANG
2	Advances in soil moisture and infiltration	6	Prof. LIU
3	Advances in surface water and basics for runoff formation	3	Prof. LIU
4	Runoff formation calculation	3	Prof. LIU
5	Runoff routine: the lumped	3	Prof. LIU
6	Runoff routine: the distributed	6	Prof. LIU
7	Runoff prediction in ungauged or poorly gauged catchment	3	Prof. LIU
8	Evapotranspiration modelling	5	Prof. ZHANG
9	Student presentations	5	Prof. ZHANG
10	Basic remote sensing theory	4	Prof. ZHANG
11	Remote sensing application in	4	Prof. ZHANG

	hydrology		
12	Hydrological modelling based on remote sensing	4	Prof. ZHANG
13	Exam	2	Prof. ZHANG
total		51	

Contents of the course

Chapter 1: Basic hydrology

1. Hydrological cycle
   (1) Precipitation
   (2) Evapotranspiration
   (3) Runoff
   (4) Soil water
   (5) Groundwater
   (6) Glacier
2. Soil moisture and infiltration
   (1) Soil moisture data
   (2) Darcy's Law
   (3) Infiltration
3. Runoff formation
   (1) River flow measurement
   (2) Basic for runoff formation
   (3) Runoff formation calculation
4. Runoff routine
   (1) The lumped routine
   (2) The distributed routine

Chapter 2 Advances in modern Hydrology

5. Runoff prediction in ungauged or poorly gauged catchments (PUB)
   (1) "Borrowing" method
   (2) "Substituting" method
   (3) "Generating" method
   (4) Application of the VIP model in PUB
6. Evapotranspiration modelling
   (1) Water balanced modelling
   (2) Temperature-based models
   (3) Conductance-based models
   (4) A case introduction
7. Student presentations
   (1) Literature review and summary
   (2) PPT presentations
   (3) Q & A

Chapter 3: Remote sensing hydrology

8. Basic remote sensing theory

(1) Radiation and electromagnetic spectrum
(2) Remote sensing sensor types
(3) Shortwave remote sensing for vegetation
(4) Active/passive microwave remote sensing (snow, soil moisture, canopy water content, rainfall)
(5) Thermal remote sensing (evapotranspiration)

9. Remote sensing application in hydrology
   (1) Dynamic monitoring of water surface
   (2) Glacier and snow
   (3) Precipitation
   (4) Evapotranspiration
   (5) Soil moisture
10. Hydrological modelling based on remote sensing
   (1) Overview
   (2) Model input preparation based on remote sensing
   (3) Model calibration and validation against remote sensing data
   (4) Hydrologic remote sensing data assimilation
11. Exam

Textbook and any related course material:

Hydrology an introduction, Wilfried Brutsaert
Handbook of Hydrology: David Maidment
Rainfall-Runoff Modelling: Keith Beven
Remote Sensing in Hydrology and Water Management, Shultz and Engman
Runoff Prediction in Ungauged Basins: Synthesis across Processes, Places and Scales: Günter Blöschl et al.

Expected level of proficiency from students entering the course:
Mathematics: strong
Hydrology: strong
Remote sensing: good

Course title
Remote Sensing Information Processing and Urban Application

Instructor(s)-in-charge:

Prof. Qingyan Meng

Course type:

Lecture

Course Schedule:

3hrs/time, 2times/week by instructor.

Course Assessment:

Homework: 1assignments

Grading Policy:

Class attendance10%, Class performance 20%, Class presentation 70%.

Course Prerequisites:

Principles of Remote Sensing

Catalog Description:

The course will systematically teach the application theory and method of remote sensing technology of urban environment, which includes urban green space(multidimensional information extraction of vegetation----green space measurement----multi-scale perception - comprehensive evaluation of remote sensing), urban heat(urban heat island effect and industrial production infrared remote sensing monitoring), urban grey (fine classification and change detection of urban ground objects, impervious surface, road network, fine extraction of urban built-up areas), urban humidity(urban water extraction and water quality monitoring), urban brightness(nighttime light remote sensing, housing vacancy, poverty monitoring), urban livability, etc., and demonstrate with typical application cases. In addition, the course will systematically introduce the current development status and trends of earth observation systems in China and abroad, as well as the latest technical progress and business needs of multi-field remote sensing (agriculture, forestry, water conservancy, land using, city construction, environment, disaster mitigation, meteorology, ocean, earthquake, etc.) And focusing on the GF-6 satellite to introduce the latest advanced technology and development trends of thematic classification and change detection for specific ground targets.

Schedule of the course

Section	Content	Credit Hours
1	Urban Remote Sensing Basics And High-resolution Earth Observation System	3
2	Earth Observation System in China And Abroad	6
3	Multi-domain Thematic Remote Sensing Application Technology（1）	3
4	Multi-domain Thematic Remote Sensing Application Technology（2）	3
5	Remote Sensing Classification And Change Detection Technology	3
6	Remote Sensing Object Change Detection Technology	3

7	**Urban Green Space Remote Sensing**	**9**
8	**Urban Heat Space Remote Sensing**	**9**
9	**Urban Grey Remote Sensing**	**6**
10	**Urban Humidity Remote Sensing**	**3**
11	**Urban Brightness Remote Sensing Remote Sensing Assessment of Urban Environment Livability**	**3**
12	**Class Report: Research Progress and Development Trend of Urban Environmental Remote Sensing Related Directions**	**3**
13	**Visiting Study of 2 organization(China Center for Resources Satellite Data and Application or PIESAT International Information Technology Limited Company, China Meteorological Administration or China Remote Sensing Satellite Ground Station or National Disaster Reduction Center of China or other organization)**	**6**
Total		**60**

Course Catalog

Section 1: Urban Remote Sensing Foundation/ Basics and High-resolution Earth Observation System

15. Course Introduction

16. Urban Remote Sensing Foundation/ Basics

17. High-resolution Earth Observation System

Section 2: Earth Observation System in China and Abroad

18. Earth Observation System in China

19. Earth Observation System Abroad

Section 3: Multi-domain Thematic Remote Sensing Application Technology（1）

20. Remote Sensing Application Technology of Agriculture

21. Remote Sensing Application Technology of Forestry

22. Remote Sensing Application Technology of Water Conservancy

23. Remote Sensing Application Technology of Land Using

24. Remote Sensing Application Technology of City Construction

Section 4: Multi-domain Thematic Remote Sensing Application Technology（2）

25. Remote Sensing Application Technology of Environment Protection

26. Remote Sensing Application Technology of Disaster Mitigation

27. Remote Sensing Application Technology of Ocean

28. Remote Sensing Application Technology of Earthquake Forecasting

Section 5: Remote Sensing Classification and Change Detection Technology

29. Remote Sensing Image Classification Technology

30. Remote Sensing Object Change Detection Technology

Section 6: Remote Sensing Object Change Detection Technology

31. Land Cover Monitoring and Change Detection Technology Based on GF-6 Satellite Wide-camera Data

32. *Land Cover Change Detection Technology*
33. *Major Engineering Detection Technology (Airport, Golf Course, Wind Turbine, Solar Photovoltaic Array)*
34. *Cultivated Land Change Automatic Detection Technology*
35. *Crop Change Automatic Detection Technology*

Section 7: Urban Green Space Remote Sensing

36. *Multi-dimension Urban Green Retrieval Technology*
37. *Multi-method Urban Green Measurement Technology*
38. *Multi-perspective Urban Green Perceiving Technology*
39. *Accessibility and Equity of UGS*

Section 8: Urban Heat Space Remote Sensing

40. *Basis of Thermal Infrared Remote Sensing*
41. *Application of Thermal Infrared Remote Sensing*
42. *Multi-temporal Remote Sensing of Urban Thermal Environment*
43. *Remote Sensing of Industrial Capacity Reduction*

Section 9: Urban Grey Remote Sensing

44. *Urban Road Network Extraction*
45. *Main Urban Built-up Area Extraction from Remote Sensing Images*
46. *Urban Impervious Surface Remote Sensing Extraction and Application Technique*

Section 10: Urban Humidity Remote Sensing

47. *Automatic extraction of Urban Fine Water（Identification and Assessment of Non-point Source Pollution Risks in Drinking Water Sources）*
48. *Remote Sensing extraction of Urban Black Smelly Water*
49. *Water Change Automatic Detection Technology*

Section 11: Urban Brightness Remote Sensing

50. *Nighttime Light Remote Sensing*
51. *Housing Vacancy Monitoring Based on Nighttime Light Data*
52. *Poverty Measurement and its Spatiotemporal Evolution Based on Nighttime Light Data*

Section 12: Remote Sensing Assessment of Urban Environment Livability

53. *Spatial Quantitative Analysis of the Potential Driving Factors of Land Surface Temperature in Different "Centers" of Polycentric Cities*
54. *Remote Sensing Assessment of Urban Land Surface Environment Livability*

Section 13: Class Report

Section 14: Field Visiting study

55. *Field study to China Center for Resources Satellite Data and Application or PIESAT International Information Technology Limited Company or others*
56. *Field study to China Meteorological Administration or China Remote Sensing Satellite Ground Station or National Disaster Reduction Center of China or others*

Textbook and any related course material:

Textbook:

Remote Sensing of Urban Green Space, authored by Qingyan Meng
Publication:

1. *Li, X., Zhang, C., Li, W., Ricard, R., Meng, Q. and Zhang, W., 2015. Assessing street-level urban greenery using Google Street View and a modified green view index. Urban Forestry & Urban Greening, 14(3), pp.675-685.*
2. *Wang, X., Meng, Q., Zhang, L. and Hu, D., 2021. Evaluation of urban green space in terms of thermal environmental benefits using geographical detector analysis. International Journal of Applied Earth Observation and Geoinformation, 105, p.102610.*
3. *Meng, Q., Zhang, L., Sun, Z., Meng, F., Wang, L. and Sun, Y., 2018. Characterizing spatial and temporal trends of surface urban heat island effect in an urban main built-up area: A 12-year case study in Beijing, China. Remote Sensing of Environment, 204, pp.826-837.*
4. *Hu, D., Meng, Q., Zhang, L. and Zhang, Y., 2020. Spatial quantitative analysis of the potential driving factors of land surface temperature in different "Centers" of polycentric cities: A case study in Tianjin, China. Science of the total environment, 706, p.135244.*
5. *Liu, W., Meng, Q., Allam, M., Zhang, L., Hu, D. and Menenti, M., 2021. Driving factors of land surface temperature in urban agglomerations: A case study in the pearl river delta, china. Remote Sensing, 13(15), p.2858.*
6. *Meng, Q., Qian, J., Schlink, U., Zhang, L., Hu, X., Gao, J. and Wang, Q., 2023. Anthropogenic heat variation during the COVID-19 pandemic control measures in four Chinese megacities. Remote Sensing of Environment, 293, p.113602.*
7. *Gao, J., Meng, Q., Hu, D., Zhang, L., Hu, X. and Qian, J., 2023. A uniform methodology of local cooling and warming effects for different urban site types: multi-perspective assessment based on four northern Chinese cities. Sustainable Cities and Society, 96, p.104652.*
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10. *Zhao, M., Meng, Q., Zhang, L., Hu, X. and Bruzzone, L., 2023. Local and long-range collaborative learning for remote sensing scene classification. IEEE Transactions on Geoscience and Remote Sensing.*
11. *Meng, Q., Shi, W., Li, S. and Zhang, L., 2023. PanDiff: A Novel Pansharpening Method Based on Denoising Diffusion Probabilistic Model. IEEE Transactions on Geoscience and Remote Sensing.*
1. *Hu D, Guo F, Meng Q, et al. A novel dual-layer composite framework for downscaling urban land surface temperature coupled with spatial autocorrelation and spatial heterogeneity[J]. International Journal of Applied Earth Observation and Geoinformation, 2024, 130: 103900.*

2. *Wu J, Gao L, Meng Q, et al. Effect of land cover pattern on rainfall during a landfalling typhoon: A simulation of Typhoon Hato[J]. Atmospheric Research, 2024: 107329.*
3. *Wu J, Meng Q, Gao L, et al. A deep learning framework for 3D vegetation extraction in complex urban environments[J]. International Journal of Applied Earth Observation and Geoinformation, 2024, 129: 103798.*
4. *Zhao M, Hu X, Zhang L, et al. Beyond Pixel-level Annotation: Exploring Self-supervised Learning for Change Detection with Image-Level Supervision[J]. IEEE Transactions on Geoscience and Remote Sensing, 2024.*
5. *Zhao M, Meng Q, Wang L, et al. Towards robust classification of multi-view remote sensing images with partial data availability[J]. Remote Sensing of Environment, 2024, 306: 114112.*
6. *Su C, Hu X, Meng Q, et al. A multimodal fusion framework for urban scene understanding and functional identification using geospatial data[J]. International Journal of Applied Earth Observation and Geoinformation, 2024, 127: 103696.*
7. *Meng Q, Gao J, Zhang L, et al. Coupled cooling effects between urban parks and surrounding building morphologies based on the microclimate evaluation framework integrating remote sensing data[J]. Sustainable Cities and Society, 2024: 105235.*
8. *Qian J, Zhang L, Schlink U, et al. High spatial and temporal resolution multi-source anthropogenic heat estimation for China[J]. Resources, Conservation and Recycling, 2024, 203: 107451.*
9. *Allam M, Meng Q, Elhag M, et al. Atmospheric Correction Algorithms Assessment for Sentinel-2A Imagery over Inland Waters of China: Case Study, Qiandao Lake[J]. Earth Systems and Environment, 2024, 8(1): 105-119.*

Expected level of proficiency from students entering the course:
Principles of Remote Sensing: medium

Course title

Overview of Climate Change Sciences

Instructor(s)-in-charge:

Prof. KANG Shichang et al.

Course type:

Lecture

Grading Policy:

Part one: Attendance (20%)

Part two: Presentation (20%)

Part three: Homework (20%)

Part four: Final Exam (40%)

Catalog Description:

*Climate Change Science 2024 fall semester is designed as an introductory course in the **climate system change and related Issues** for graduate students majored in Earth Sciences. The class will give students an overview of climate system and its changes and impacts, mitigation and adaptation of climate changes as well as some updated developments in selected fields. As a course for graduate students, a mini-seminar series are incorporated into the course to provide examples of research conducted in selected fields. This course covers the components of the climate system including atmosphere, cryosphere, hydrosphere, biosphere, anthroposphere, and their changes as well as mechanisms, forcing, attribution and predictions of the changes, multisphere interactions in Earth surface. Impacts, mitigation and adaptation of climate changes and regional and global sustainable development are also introduced. The course is structured as a series of lectures and mini-seminars in which individual research cases are discussed with faculty tutors.*

Schedule of the course and contents

Section	content	Hours	
1	**Overview of Climate Change** ● Weather, climate and climate system ● What has climate system changed ● Why has it changed ● How will it change	6	Prof. Shichang Kang
2	**Paleo-climate Change** ● Archives and Proxies ● Glacial and interglacial cycle ● Holocene ● Past 2000 years ● Anthropocene	6	Prof. Qianggong Zhang
3	**Changes in Atmospheric Composition** ● Short-lived gases ● Well-mixed greenhouse gases ● Aerosols and precursors ● Toxic species	6	Prof. Qianggong Zhang
4	**Changes in Atmospheric Circulation** ● Global atmospheric circulation	3	Prof. Lan Cuo

	● Stratospheric circulation ● Mid to high latitude circulation ● Tropical circulation ● Monsoon system ● Climate pattern		
5	**Changes in Climate Extremes** ● Background ● Warming patterns ● Climate extremes ● Tropical storms	3	Prof. Lan Cuo
6	**Changes in the Cryosphere** ● Introduction to the cryosphere ● Global importance of the cryosphere ● Changes in the cryosphere ● Impacts and risks of cryospheric change	6	Prof. Shichang Kang
7	**Changes in Hydrological Cycle** ● Hydrological (water) cycle ● Surface and tropospheric humidity ● Clouds ● Precipitation ● Evapotranspiration ● Streamflow and runoff	6	Prof. Lan Cuo
8	**Impacts, Vulnerability of Climate Change** ● Assessment methods of impacts and vulnerability ● Major fields and regions of impacts and vulnerability ● Resilience in response to climate change	3	Prof. Xiaoming Wang
9	**Mitigation and Adaptation of Climate Change** ● Mitigation approaches ● International policies for mitigation ● Adaptation under sustainable development	3	Prof. Xiaoming Wang
10	**Modeling Climate Change and Prediction** ● History of numerical weather forecast ● Recent progress of coupling climate models ● CMIP5 and CMIP 6	6	Assoc Prof. Zhenming Ji

	● Regional climate model ● Application of modelling approaches		
11	**Flipped Classroom:** Question, discussion and presentation	3	Prof. Shichang Kang
12	**Flipped Classroom:** Question, discussion and presentation	3	Prof. Lan Cuo
13	**Flipped Classroom:** Question, discussion and presentation	3	Prof. Qianggong Zhang
14	**Flipped Classroom:** Question, discussion and presentation	3	Prof. Shichang Kang

Contents of the course

Section 1: Overview of Climate Change

1. Weather, climate and climate system
2. What has climate system changed
3. Why has it changed
4. How will it change

Section 2: Paleo-climate Change

1. Archives and Proxies
2. Glacial and interglacial cycle
3. Holocene
4. Past 2000 years
5. Anthropocene

Section 3: Changes in Atmospheric Composition

1. Short-lived gases
2. Well-mixed greenhouse gases
3. Aerosols and precursors
4. Toxic species

Section 4: Changes in Atmospheric Circulation

1. Global atmospheric circulation
2. Stratospheric circulation
3. Mid to high latitude circulation
4. Tropical circulation
5. Monsoon system
6. Climate pattern

Section 5: Changes in Climate Extremes

1. Background
2. Warming patterns
3. Climate extremes
4. Tropical storms

Section 6: Changes in the Cryosphere

1. Introduction to the cryosphere
2. Global importance of the cryosphere
3. Changes in the cryosphere
4. Impacts and risks of cryospheric change

Section 7: Changes in Hydrological Cycle

1. Hydrological (water) cycle
2. Surface and tropospheric humidity
3. Clouds
4. Precipitation
5. Evapotranspiration
6. Streamflow and runoff

Section 8: Impacts, Vulnerability of Climate Change

1. Assessment methods of impacts and vulnerability
2. Major fields and regions of impacts and vulnerability
3. Resilience in response to climate change

Section 9: Mitigation and Adaptation of Climate Change

1. Mitigation approaches
2. International policies for mitigation
3. Adaptation under sustainable development

Section 10: Modeling Climate Change and Prediction

1. History of numerical weather forecast
2. Recent progress of coupling climate models
3. CMIP5 and CMIP 6
4. Regional climate model
5. Application of modelling approaches

Section 11: Flipped Classroom: Question, discussion and presentation

Section 12: Flipped Classroom: Question, discussion and presentation

Section 13: Flipped Classroom: Question, discussion and presentation

Section 14: Flipped Classroom: Question, discussion and presentation

Related course material:

IPCC Fourth Assessment Report, IPCC Fifth Assessment Report, IPCC Sixth Assessment Report

Course title

Introduction of Weather and Climate

Instructor(s)-in-charge:

Prof. Chen Guanghua & Prof. Li Xichen

Course type:

Lecture

Course Schedule:

3hrs/week by lecturer

Grading Policy:

20% attendances; 80% final presentation

Course Prerequisites:

Basic mathematics, physics, and earth science

Catalog Description:

In this course, we will introduce the interesting topics in the weather and climate. We will cover the following main topics. The atmospheric structure, temperature and energy cycle and so on will be introduced. The basic concept of atmospheric motion and instability will be presented to understand some major weather phenomena, such as mid-latitude front, tropical monsoon weather, typical synoptic and mesoscale systems, and tropical cyclone. In terms of climatic aspects, we also give the impacts of the greenhouse gases and the aerosols on the global warming and the sea level rise. We will also discuss the uncertainty and the complexity of the spatial and the temporal variabilities of these climate effect. In addition, we will introduce several important climate variabilities and events, including the El Niño Southern Oscillation, the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation, etc. We will briefly introduce the physical processes and mechanisms in the atmosphere-ocean interactions and the atmospheric teleconnections. Finally, we will provide a brief introduction to the climate observational system and the climate numerical models, which are frequently used in the climate research.

Schedule of the course

section	content	hours	
1	Introduction of Meteorology: Structure, temperature, Energy, etc.	3	Prof. Chen
2	General Principles of Atmospheric Motion	3	Prof. Chen
3	Remote Sensing for weather	3	Prof. Chen
4	Mid-latitude Front and Tropical Monsoon Weather	3	Prof. Chen
5	Mesoscale Convective System	3	Prof. Chen
6	Tropical Cyclone	3	Prof. Chen
7	Global Warming and the Hiatus	3	Prof. Li
8	Global Sea Level Rise	3	Prof. Li
9	Interannual to Decadal Variability of the Global Climate System	3	Prof. Li

10	Atmosphere-Ocean Interactions and Atmospheric Teleconnections	3	Prof. Li
11	Effect of Aerosols	3	Prof. Li
12	A Introduction to the fundamental methods and techniques in climate sciences: observation, analysis, and numerical models	3	Prof. Li
13	**Students Final Presentation** 10-15 minutes per student, the student can choose any topic in weather and climate to discuss their understanding and thoughts.	4	Prof. Chen & Prof. Li
total		40	

Contents of the course

57. Introduction of Meteorology: Structure, temperature, Energy, etc.
    (1) The vertical structure in the atmosphere
    (2) The temperature and moisture distribution
    (3) The energy balance and the role in the atmosphere
58. General Principles and circulation of atmospheric motion
    (1) General Principles of atmospheric motion
    (2) General circulation of atmospheric motion
59. Remote Sensing for weather
    (1) Introduction to remote sensing
    (2) Weather radar detection
    (3) Satellite detection of water vapor, clouds and precipitation
60. Mid-latitude front and monsoon weather
    (1) Middle-latitude front structure and evolution
    (2) Typical monsoon weather system
61. Mesoscale convective systems
    (1) Mesoscale convective system formation
    (2) Mesoscale weather system structure and impacts
62. Tropical cyclone
    (1) Global distribution and monitoring of tropical cyclone
    (2) Three-dimensional structure and precipitation
    (3) Tropical cyclone formation, intensity and motion
63. Global Warming and the Hiatus: Effects of the External Forcing and the Internal Variability
    5. Introduce the impacts of the greenhouse gases on the global energy balance.
    6. Discuss the complexity of the spatial and temporal variability of the global warming
    7. Introduce the effect of the internal climate variability on the recent observed global warming hiatus
64. Global Sea Level Rise

(1) A brief introduction to the observed global sea level rise and its impacts
(2) Discuss the main sources of the recent observed sea level rise
(3) Introduce the regional sea level rise and the main driver

65. Interannual to Decadal Variability of the Global Climate System
    (1) Introduce several important interannual climate variability of the earth system, including El Niño Southern Oscillation, the Indian Ocean dipole mode, and the Atlantic Niño
    (2) Introduce the main decadal climate variability, including the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation.
66. Atmosphere – Ocean Interactions and Atmospheric Teleconnections
    (1) Briefly introduce several key processes and feedbacks in the atmosphere – ocean interactions, including the wind-evaporation-SST feedback and the Bjerknes feedback
    (2) Introduce the stationary Rossby wave theory
    (3) Introduce the mechanisms how the tropical ocean variabilities impact on the mid- and high- latitude climate through atmospheric teleconnections
67. Effect of Aerosols
    (1) Introduce the recent observed changes in the global and regional aerosol concentration
    (2) Briefly introduce the environmental effect of the aerosols
    (3) Introduce the climate effect of the aerosols
68. A brief Introduction to the fundamental methods and technic in climate sciences: observation, analysis, and numerical models
    (1) Briefly introduce the observational systems, including the weather stations, the ocean floats, and the satellite-based observations.
    (2) Briefly introduce some basic statistical method used to analyze the observational data
    (3) Briefly introduce the climate models. Answer two questions: what is climate models, and how can we use them to simulate the earth system.

Course title

Introduction to Geodynamics

Instructor(s)-in-charge:

Prof. Shimin Wang

Course type:

Lecture

Course Schedule:

6 hrs/week by instructor

Course Assignments:

8 homework assignments and 1 final report

Grading Policy:

20% class attendance, 40% homework, 40% final report.

Course Prerequisites:

Calculus, General Physics

Catalog Description:

This course will introduce the field of geodynamics, the study of dynamical processes of the solid Earth. As such, it is rooted in fundamental physics and highly interdisciplinary. Mathematics is the central tool used to apply physical theories and create predictive models of the Earth. Geodynamics provides the quantitative foundation for the theory of Plate Tectonics, the basic organizing paradigm for our understanding of the solid Earth.

Schedule of the course

Chapter	Content	Hours	Date
1	Plate Tectonics	15	
2	Stress and Strain	6	
3	Elasticity and Flexure	6	
4	Heat Transfer	9	
5	Gravity	6	
6	Fluid Mechanics	12	
7	Rock Rheology	6	
8	Faulting and Earthquake	6	
9	Flows in Porous Media	6	
total		72	

Contents of the course

Chapter 1: Plate Tectonics

69. Structure of the Earth
70. Basic concepts and origin of plate tectonics theory
71. Processes and characteristics of plate boundaries
72. Plate motion models
73. Plate motion calculations
74. Comparative planetology

Chapter 2: Stress and Strain

1. Stress analysis
2. Strain analysis
3. Measurements of crustal stresses and displacements

Chapter 3: Elasticity and Flexure

1. Linear elasticity
2. Thin plate bending and applications to lithospheric flexure
3. Thickness of elastic lithosphere

Chapter 4: Heat Transfer

1. Heat transfer in solid earth
2. Heat conduction and Fourier's law
3. Thermal structure of lithosphere
4. Thermal structure of mantle

Chapter 5: Gravity

1. Gravity and gravity anomalies
2. Isostatic geoid anomalies and ridge push
3. Gravity measurements

Chapter 6: Fluid Mechanics

1. Governing equations of fluid mechanics
2. 1D viscous fluid flows
3. 2D viscous fluid flows and geodynamic examples
4. Stokes flows and mantle plume modeling
5. Mantle convection

Chapter 7: Rock Rheology

1. Microscopic mechanism for rock rheology
2. Rock viscosity and macroscopic characteristics
3. Viscoelastic models and examples
4. Elastic-plastic models and examples

Chapter 8: Faulting and Earthquake

1. Classification of faulting
2. Elastic rebound and stick-slip of faulting
3. Co-seismic and inter-seismic elastic solutions

Chapter 9: Flows in Porous Media

1. Darcy's law
2. Solutions to porous flows
3. Thermal convection in porous media

Textbook:

Geodynamics, *3rd Edition*, Donald L. Turcotte & Gerald Schubert, Cambridge University Press, 2014.

Reference book:

Mantle Convection in the Earth and Planets, Gerald Schubert, Donald L. Turcotte & Peter Olson, Cambridge University Press, 2001.

Course title

Earth System Science （One course including two parts）

Part I-Introduction to Remote Sensing

Instructor(s)-in-charge:

Prof. CHEN Fang

Course type:

Lecture

Course Assessment:

Homework: 2 assignments

Grading Policy:

The grading for this course will be based on:

- Participation (30% of grade)

- Assignments (30% of grade)

-Short presentation (20% of grade)

-Comprehensive final exam (20% of grade)

**Participation in lectures, discussions, and other activities is an essential part of the instructional process. Students are expected to attend class regularly. Those who are compelled to miss class should inform the instructor and TA of the reasons for absences. Unexcused late assignments will have at a minimum 5 points deducted. To avoid this penalty you must contact the instructor and TA prior to the due date. Each student is expected to give a presentation on the topical area of Assignment-2 in front of the class. The presentation will be followed by discussion during which other students are expected to ask questions and engage. The presentations may be limited to 5-10 minutes and Q&A will be limited to 2-5 minutes (depend on the number of students). Students will be graded both as presenters and participation in discussion.*

Course Prerequisites:

This course does not have any pre-requisites.

Catalog Description:

This course is intended to provide an introduction to remote sensing, with particular attention to the role of remote sensing for the monitoring the Earth's land surface. It will introduce the basic principles of image interpretation, remote sensing, and digital data processing in relation to optical, thermal, and microwave remote sensing systems. Examples of remote sensing applications will be resented along with methods for obtaining quantitative information from remotely sensed imagery.

Writing Assignments

1. *Assignment-1-- Write a short (3-4 page) paper on **a topic of your understanding of remote sensing** related to the class subject matter. DUE in class, October 14.*
2. *Assignment-2-- Write a short (3-4 page) paper on the topic of **the use of remote sensing for disaster management**. DUE in class, November 4.*

Keys to Success:

This course is challenging for many students because of the highly quantitative nature of the field of remote sensing. In order to assist all students in the course, I have identified several keys to success in this course:

1. *Attend all lectures which are critical components of this class. Attending*

lecture will make the difference of an entire grade.

2. *Read the assigned text chapters/sections before coming to class.*
3. *During lectures, focus on listening to the material being presented and synthesizing this information by taking notes that summarized the key points.*

Schedule of the course

Section	Content	Date	Assignments Due
1	*Introduction to Remote Sensing*	*September 9*	
2	*Image Processing/RS Applications*	*September 23*	
3	*Remote Sensing for Disaster Management*	*September 30*	
4	*Remote Sensing of Vegetation-Spectral/Temporal Characteristics, Indices, and Change Detection*	*October 14*	*Assignment-1 due by beginning of class*
5	*Remote Sensing of Water, Soil, and Urban Areas*	*October 21*	
6	*Students presentation*	*October 28*	
7	*Students presentation*	*November 4*	*Assignment-2 due by beginning of class*

Textbook and any related course material:

Jensen, J. R., 2007, Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall series in Geographic information Science, NJ. (ISBN: 0-13-188950-8)

Essay Template

TITLE: ESSAY TEMPLATE FOR THE INTRODUCTION TO REMOTE SENSING COURSE (TITLE IN CAPS, 12PT BOLD CENTERED)

First Author[1,2] (10pt bold centered)

[1] *Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, China*

[2] *Voeikov Main Geophysical Observatory, Roshydromet, Russian Federation (10pt italicized centered)*

Abstract Summary: This section should briefly summarize the main contents of your essay.

Recommended length is 10 lines using Time New Roman 9pt.

Keywords: *Disaster, Flooding (9pt in italics, maximum five words)*

1. INTRODUCTION (headline in CAPITALS, 10pt Bold)

In order to have a similar format for all essays in the assignments, we are offering some recommendations to the authors for composing their essay.

The essay should be in A4 format with page margins of 25 mm on the left and right sides and 25 mm on the top and bottom. The maximum allowed length is 4 pages. Pages must not be numbered. The first page must begin with the essay title in capital letters, centered. Authors' name and affiliations must appear just below the title. A summary and keywords should directly follow.

The text should be divided in several sections, and main contents includes: 1) natural hazard and disaster mitigation in your country or region; 2) the development of remote sensing technology in your country or region; 3) your opinion on technologies that might significantly improve current disaster mitigation in your country or region, 4) challenges and recommendations of advancing disaster risk management with remote sensing technologies in your country or region.

The title of each section should be in capital letters. The text must be in a single column format. For the body, the text must be single-spaced and justified, using Times New Roman font. Font sizes are specified at various locations. It should be structured in paragraphs; each new paragraph should begin with an indent without an empty line between paragraphs. The paper should be written in English.

Tables and figures could be added in your essay. A caption must be provided for each table and figure you choose to include. Captions should be below the figures/tables and must be numbered (Tab. 1; Fig. 1).

References will appear at the end of the extended abstract. Given size constraints, only limited key references need to be included. List all citations alphabetically in the reference section. Two examples of citations are given in this document (Bougeault et al. 2001, Schwitalla et al. 2007).

Table 1 Most meaningful example of a data table with columns and lines filled with a minimum of quantitative information
(Table entries in 10pt; caption in 9pt).

Test Table	Column 1	Column 2	Column 3	Column 4
Line 01	1	2	3	4
Line 02	5	6	7	8
Line nn				

Figure 1 Two photos of polar bears. Left: Figure explanation; Right: Figure explanation (9pt)

2. NATURE HAZARDS AND DISASTER MITIGATION IN YOU COUNTRY (headline in CAPITALS, 10pt Bold)

3. REMOTE SENSING IN YOUR COUNTRY (headline in CAPITALS, 10pt Bold)

4. TECHNOLOGIES REQUIREMENT FOR… (headline in CAPITALS, 10pt Bold)

To reduce risk and vulnerability, to mitigation the effects of natural disaster, and to improve rescue operations, we must use science and technology to explore the potentially positive aspects...

5. CHALENGES AND RECOMMENDATIONS… (Headline in CAPITALS, 10pt Bold)

Provide a scientific and practical guide to Academies of Sciences, with example of good practices in implementing mitigation risk with remote sensing. ...

6. SUBMISSION OF ESSAY

The extended essay should be produced with MS-Word. **Note that if you do not submit your essay, it will not appear in the Final Scores.** Please use the following naming convention to help ease the compilation of the Volume of Essay:

```
Surname Firstname (You Student ID).doc
```

Acknowledgements: *(9pt italics)*

I thank all …

REFERENCES (in 9pt; second line indented for better distinction)

Bougeault, P., P, Binder, A. Buzzi, R. Dirks, R. Houze, J. Kuettner, R. B. Smith, R. Steinacker, and H. Volkert, 2001: the MAP Special Observing Period. *Bull. Amer. Meteorol. Soc.* **82**, 433-462.

Schwitalla, T., G. Zangl, H. S. Bauer, and V. Wulfineyer, 2007: Convective initiation in the Black Forest region in high-resolution MM5 simulations. *Proc. 29th Intern. Conf. on Alpine Meterology*, Chambery, France, 261-264.

Course title
Earth System Science Part II-Earth System Dynamics
Instructor(s)-in-charge:
Prof. JIA Gensuo
Course type:
Lecture
Course Assessment:
Homework: 3 assignments

Grading Policy:
The grading for this course will be based on:
- Participation (30% of grade)
- Assignments (40% of grade)
-Comprehensive final exam (30% of grade)

Course Prerequisites:
Preferred but not required: Ecology, environmental sciences, climate science

Catalog Description:
This course focuses on patterns and variability of the Earth system. It addresses a number of fundamental science questions. How does the Earth system operate in the absence of significant human influence? How do human-driven processes shape land surface and climate system as addition to those due to natural variability? What are the implications of global change for human well-being? How robust is the Earth System in the face of natural and anthropogenic changes? The course covers various aspects of our scientific knowledge about the nature of the Earth system and global environmental change, and includes the following sections: 1) Spatial patterns and temporal variability of the Earth system; 2) Heterogeneity and connectivity of the Earth system; 3) Human dominated changes in global environment; 4) Land surface and terrestrial ecosystem processes; 5) Interactive changes of land-use, ecosystem, and climate; 6) Disaster risks under changing climate; 7) Earth observation of global environmental change. To encourage involvement and interaction, international students will also be given opportunity to discuss ways towards a sustainable Earth system with their local, national, and regional perspectives at a well-designed science-policy forum.

Schedule of the course | Monday 1:30-4:20 pm

Section	Contents	hours
1	Spatial patterns and temporal variability of the Earth system (1)	3
2	Spatial patterns and temporal variability of the Earth system (2)	3
3	Heterogeneity and connectivity of the Earth system	3
4	Human dominated changes in global environment	3
5	Land surface and terrestrial ecosystem processes	3
6	Interactive changes of land-use, ecosystem, and climate	3
7	Disaster risks under changing climate	3
8	Earth observation of global environmental change	3

9	Science-policy forum: towards a sustainable Earth system	3
total		27

Textbook and related course material:
Steffen, W., A. Sanderson. P.D. Tyson, et al. 2004
Global Change and the Earth System
Springer. 336 pp

Shugart, H.H. and F.I. Woodward. 2011.
Global Change and the Terrestrial Biosphere: Achievements and Challenges,
Wiley-Blackwell Press, Oxford. 242 pp

Relevant science journals:
Global and Planetary Change, 0921-8181
Global Change Biology, 1354-1013
Global Ecology and Biogeography, 0960-7447
Global Environmental Change - Human and Policy Dimensions, 0959-3780

Course title

Plant Physiology and Developmental Biology

Instructor(s)-in-charge:

Prof. CHENG Youfa

Course type:

Lecture, discussions

Course Schedule:

3 hrs/week by instructors. 54 hrs. in total by Prof. Youfa CHENG; 6 hrs. in total by Prof. Jie LE

Course Assessment:

Homework: 6 assignments

Grading Policy:

Typically 50% attendance, 20% homework; 30% final presentation.

Course Prerequisites:

Botany, plant anatomy

Catalog Description:

This course is designed as an introduction course of plant physiology and developmental biology for graduate students. In this course, we will discuss plant physiology and developmental events during plant life and the underlying mechanisms controlling plant developmental processes and responses to environmental stimuli. Emphasis will be given on the molecular genetic basis of the developmental events. The entire life span will be examined, from gametocyte development to embryogenesis and post-embryonic development, such as root, leaf, flower and fruit development. Hormones and signal transduction will also be discussed.

The course is structured as a series of lectures and discussions in which individual research cases are discussed. It will cover the following topics:

Schedule of the course

Section	Content	Hours	
1	**Introduction to plant physiology and developmental biology** 1. why study plants 2. plant life cycle 3. plant structure	9	Prof. CHENG
2	**Plant gene expression and signal transduction** Plant gene expression and signal transduction	3	Prof. CHENG
3	**Plant embryogenesis** Plant embryogenesis	3	Prof. CHENG
4	**Plant cell, root and stomata development** Plant cell	6	Prof. LE
5	**Auxin and development** 1. Auxin biosynthesis and development 2. Auxin transport and development 3. Auxin signaling and development	9	Prof. CHENG
6	**Plant reproduction** 1. Gametophytes	3	Prof. CHENG

	2. Pollination 3. Seeds, and Fruits		
7	**Light signaling** 1. Improving photosynthesis and 2. Circadian regulation of sunflower 3. Light Controls Protein Localization through	3	Prof. CHENG
8	**Plant and stress** 1. Plant Stress 2. Stress-Sensing Mechanisms in Plants 3. Stress Signaling Pathways	3	Prof. CHENG
9	**Stem cell** 1. Shoot apical meristem 2. Root apical meristem	3	Prof. CHENG
10	**Plant and biotic stress** 1. Interactions between Plants and Microorganisms 2. Inducible Defense Responses to Insect Herbivores	3	Prof. CHENG
11	**Plant genomic resources** 1. Pan-genome analysis of 33 genetically diverse rice accessions 2. A Pan-Plant Protein Complex Map Reveals Deep Conservation and Novel Assemblies 3. Pan-Genome of Wild and Cultivated Soybeans	3	Prof. CHENG
12	**Plant Cell Polarity** 1. Plant cell-surface GIPC sphingolipids sense salt to trigger Ca2+influx 2. DIX Domain Polymerization Drives Assembly of Plant Cell Polarity Complexes	3	Prof. CHENG
13	**Crop improvement** 1. Major Impacts of Widespread Structural Variation on Gene Expression and Crop Improvement in Tomato 2. The Penium margaritaceum Genome Hallmarks of the Origins of Land Plants	3	Prof. CHENG
14	**Organogenesis** 1. Major Impacts of Widespread Structural Variation on Gene Expression and Crop Improvement in Tomato 2. The Penium margaritaceum Genome Hallmarks of the Origins of Land Plants	3	Prof. CHENG
15	**Embryogenesis** 1. Apical-basal polarity 2. pattern formation 3. Meristematic Tissues	3	Prof. CHENG
Total		60	

Textbook and any related course material:
Current literatures in Plant Physiology and Developmental Biology.

Course title

Plant Molecular Biology and genomics

Instructor(s)-in-charge:

Profs. Hai-Chun Jing et al.

Course type:

Lecture

Course Schedule:

3hrs/week by instructors

Course Assessment:

Homework: 15 assignments

Grading Policy:

Typically 40% homework, 20% attendance, 40% final.

Course Prerequisites:

without

Catalog Description:

This course invites lab bench-based researchers from Institute of Botany, Chinese Academy of Sciences, to share their cutting-edge knowledge of Plant Molecular Biology and Genomics. The course will explain the concept of the gene, genome and epigenome, and theories and experimental tools/platforms to explore their variations, functions, interactions and regulatory networks in the context of plant speciation and evolution, growth and development as well as adaptation to the environments. Emphasis will also be given to how to translate know-hows gained from the basic science into plant breeding. The course puts more weight into how to rationalize, design and execute scientific researches, rather than to spoon feed the attendees with jargons to memorize. We encourage actively answer-seeking rather than rote learning, do require the attendees to have ideally at least college-level education in Plant Biology and relevant fields.

Schedule of the course

Section	Content	Hours	Tutor
1	The Gene, Genome and Epigenome in Plants, Plant Sciences and *Science* 125 questions	12	Hai-Chun Jing
2	Molecular Biology and Genomics for Plant Breeding	12	Hai-Chun Jing
3	Molecular Biology of Photo-morphogenesis and Light Signalling	9	Rong-Chen Lin
4	Plant Circadian Molecular System and Epigenetic Controls	12	Lei Wang
5	Plant Genome Biology and Evolution	12	Ya-Long Guo
6	Q&A	3	Hai-Chun Jing
total		60	

Contents of the course

Section 1: The Gene, Genome and Epigenome in Plants (Hai-Chun Jing)

1. The Gene

- **The Missing Science of Heredity**
- **The Dreams of Genetists**
- **Plant Genetics**

2. The Genome

- **The Spacious Genome**
- **RNA out of the Shadows**
- **Code, Non-Code, Garbage, and Junk**

3. The Epigenome

- **The Discovery of Epigenetics**
- **DNA Methylation**
- **Histone Modifications**
- **Chromatin Remodelling**
- **Interactions between Different Epigenetic Modifcations**

Section 2:Plant Genome Biology and Evolution（Ya-Long Guo, three afternoons）

- **Genome sequencing and genomics**
- **Comparative genomics**
- **Population genomics and adaptive evolution**

Section 3: Molecular Biology of Light Signaling and Photomorphogenesis (Rong-Cheng Lin, two afternoons)

- **Light and plant development**
- **Photoreceptors: light perception**
- **Light signaling transduction**
- **Photo morphogenesis**

Section 4: Plant Circadian Molecular System and Epigenetic Controls (Lei Wang, three afternoons)

- **Plant circadian molecular system (Concept, assembly of core oscillator)**
- **Regulation of circadian clock core oscillator**
- **Circadian clock and plant development**

Section 5: Molecular Biology and Genomics for Plant Breeding (Hai-Chun Jing)

- **Crop Domestication and Plant Genetic Resources**
- **Plant Biotechnology and Moelcular Breeding**
- **Future of Plant Breeding**

Textbook and any related course material

1. Epigenetics, edited by Allis CD, Jenuwein T and Reinberg D, Caparros ML (editor-in-chief), Cold Spring Harbor Laboratory Press, New York.

2. Genes Ⅷ, Benjamin Lewin.

3. Genomics of tropical crop plants: Moore PH, Ming DR. Sringer, 2008.

4. Plant Genomics: Methods and Protocols. Daryl J. Somers DJ, PeterLangridge, J.P. Gust. Humana Press Inc.2011.

5. Plant Genomics: Methods and Protocols. Busch.Humana Press Inc. 2017.

Course title

The Frontier of Genomics and Precision Medicine

Instructor(s)-in-charge:

Prof. Zhihua Zhang (Beijing Institute of Genomics, Chinese Academy of Sciences)
Prof. Tingting Li (Peking University, School of Life Sciences)
Prof. Zhaoqi Liu (Beijing Institute of Genomics, Chinese Academy of Sciences)
Prof. Peilin Jia (Beijing Institute of Genomics, Chinese Academy of Sciences)

Course type:

Lecture

Grading Policy:

Typically 50% homework, 20% attendances; 30% final report.

Course Prerequisites:

Molecular biology, Statistics, Computer programming

Catalog Description:

Epigenome and Genome structures. This section introduces the concept of "epigenetics" and the structures of chromatins. It covers chromatin remodeling and the modifications of DNA and histones, and their roles in chromatin structure maintenance. Contemporary life sciences and medicine are moving towards the era of large data as represented by high-throughput sequencing. How to model, analyze and interpret genomic data will determine whether we can quickly and accurately discover new biological phenomena and rules, and provide accurate medical care for patients. This course will introduce common data types in genomics, such as DNA-seq, RNA-seq, and statistical analysis and graphing methods commonly used in data analysis.

Proteomics is a fast and powerful discipline aimed at the study of the whole proteome or the sum of all proteins from an organism, tissue, cell or biofluid, or a subfraction thereof, resulting in an information-rich landscape of expressed proteins and their modulations under specific conditions. In the section for proteomics, we will introduce the most common technologies and workflows used in proteomic studies. Details of this section include principles and techniques in proteomics, recent advances in proteomics and application of proteomic technology. In the section for protein phase separation, we will introduce physical basis of phase separation, biological functions of phase separation and computational screening of biological phase-separating proteins.

In the section for genetics and genomics studies, we will introduce technologies used to understand the genetic architectures underlying human complex traits, disorders, and diseases. These include genome-wide association studies, next-generation sequencing technologies, as well as the computational methods used to mine and interpret the genetics and genomics data. We will introduce approaches for basic association studies to identify disease-associated loci, including common variants, rare variants, and de novo mutations. We will also introduce approaches for advanced analyses widely used in the post-GWAS era to interpret and prioritize causal variants. These include integrative methods that rely on multi-omics data (such as transcriptome data and epigenomics data), deep learning methods to fine map

genetic variants, and statistics methods to understand the regulatory roles and functional impacts of genetic variants in disease-relevant contexts.

In the last section, we mainly talks about computational cancer biology, but with a highlight on the implication of computational analysis in solving practical problem in cancer and the development of related treatment. We will first introduce the concept of tumor intra heterogeneity which is the main reason of drug resistance to standard treatment. We will discuss computational approaches for understanding tumor intrinsic subtyping, clonal evolution as well as therapeutic implications. A big part of the course will focus on cancer transcriptomics including canonical gene expression, non-coding elements, regulatory network and mRNA splicing. We will summarize computational methods and current challenges in cancer splicing analysis. Splicing factors are recurrently mutated in human cancers, which provide genetic evidence directly linking RNA splicing dysregulation to tumorigenesis. We will particularly talk about spliceosomal mutations in human cancer and therapeutic targeting of those mutations. Lastly, we will introduce pan-cancer analysis which takes advantage of the increasing amount of genomic data and human cancer projects, and cancer pharmacogenomics studies towards a speed-up of translational medicine.:

Schedule of the course

Chapter	Hours	Lecturor	Sections	Section titles
Transcriptome	1	Zhihua Zhang	1	1 Basic principle of transcription;
			2	2 Identification of transcription regulatory factor binding sites
			3	3 Transcription regulatory factor binding sites and human disease
Epigenome	2	Zhihua Zhang	1	4 Promoter and enhancer identification methods
			2	5 DNA methylation, histone Modification and Gene expression Regulation
			3	6 Basic experimental techniques for Noncoding RNA
	3		4	7 Noncoding RNA and Human Disease
3D genome		Zhihua Zhang	1	8 Basic experimental techniques for 3D Genome
			2	9 Methods for recognition of Compartment A/B and TAD
	4		3	10 Reconstruction of the 3D genomic structure
			4	11 Chromatin loop identification methods based on multi-omics

				approach
			5	12. 3D genomics and human disease
Basic Concepts of population Genetics I	5	Zhihua Zhang	1	13 Introduction to Gene Regulatory Network
			2	14 Basic Concepts of population Genetics I
			3	15 Basic Concepts of population Genetics II.
Proteomics: technologies and their applications	3	Tingting Li	1	Proteomics: principles and techniques
			2	Recent advances in proteomics
			3	Application of proteomic technology
Biological function and computational analysis of phase separation	3	Tingting Li	4	Physical basis of phase separation
			5	Biological functions of phase separation
			6	Computational screening of biological phase-separating proteins
Genomics: introduction of GWAS and complex diseases	3	Peilin Jia	1	Principles of GWAS: common variants, rare varaints, and de novo mutations
			2	Techniques: array based and next-generation sequencing
			3	Trends in genomics data analysis
Genomics: post-GWAS analysis I	3	Peilin Jia	1	Gene-based analysis
			2	Set-based analysis
			3	Regulatory roles of genetic variants: QTL
Biobank and resource	3	Peilin Jia	1	GWAS Catalog, 1KGP, UK10K
			2	GTEx: tissue transcriptomes and eQTL
			3	Roadmap and ENCODE
Genomics: post-GWAS analysis II	3	Peilin Jia	1	Colocalization analysis of GWAS data
			2	Summary-based Mendelian

				Randomization
			3	Transcriptome-wide association study (TWAS)
Machine learning and deep learning to mine genetic variants	3	Peilin Jia	1	Regulatory elements and epigenomics
			2	Convolutional Neural Network in analysing sequence data I
			3	Convolutional Neural Network in analysing sequence data II
Tumor heterogeneity	3	Zhaoqi Liu	1	Tumor intrinsic subtyping
			2	Tumor clonal evolution
			3	Therapeutic implications of tumor heterogeneity
Cancer transcriptomics	3	Zhaoqi Liu	1	Gene expression study
			2	Non-coding RNA in cancer
			3	Regulatory network analysis
Altered splicing in cancer	3	Zhaoqi Liu	1	mRNA splicing and dysregulation in cancer
			2	Computational deciphering of splicing dysregulation
			3	Computational challenges in cancer splicing analysis
Spliceosomal mutations in cancer	3	Zhaoqi Liu	1	Spliceosomal mutations in cancer
			2	Review of cancer splicing studies
			3	Therapeutic targeting of RNA splicing
Pan-cancer analysis and pharmacogenomics	3	Zhaoqi Liu	1	Human cancer projects and cell line based drug screening systems
			2	Computational analysis reveal pan-cancer similarities and tumor-specific characteristics
			3	Pharmacogenomic studies by patient-tumor-derived short-term cultures

Course title:

Model Animals in Developmental Biology

Instructor:

Prof. YUAN Li

Course description:

The goal of this course is to introduce postgraduate students to the field of animal developmental biology, and to help them understand how the choice of model organisms matters for their research.

Topics related to growth, differentiation, morphogenesis and organogenesis in different model animals would be covered. Using genetic and molecular biological techniques, developmental biologists have moved beyond animal developmental anatomy and now study the causal mechanisms of development using a number of invertebrate and vertebrate model organisms. Thus, animal developmental Biology has a rich and fascinating history as people, events, and disciplines coalesced to form the field. It continues as one of the most rapidly expanding areas of biological research.

Course type:

Lecture, mini-seminar, discussions

Notes:

PowerPoint slides for each lecture will be sent to you in advance. During the lecture period, you will be presented with a series of discussion questions. These questions are designed to challenge you to think critically about the principles of animal developmental biology. The goal of these questions is to introduce you to the process of interpreting scientific data as well as the experimental paradigms that form the foundation of developmental biology. I will benefit from these questions by gaining feedback about your level of understanding of the presented concepts, and you can in turn use these discussion questions to gauge your own grasp of the material.

Studying developmental biology is rigorous and demanding, but the rewards can be great. I look forward to learning with you.

Grading information:

Components of Model Animals in Developmental Biology will be worth the following percentages of your total grade:

Homework assignments: 30%

Discussion questions: 20%

Attendance: 20%

Final presentation: 30%

Schedule of the course

Chapter	Content	Hours
1	Introduction to model animals in developmental biology	3
2	Studying developmental biology – tools and techniques	6
3	Introducing animal embryonic development	3

4	Cell-cell communication in development	6
5	Germ cells, fertilization and sex determination	6
6	Early *Drosophila* development and genes that pattern the *Drosophila* body plan	6
7	Early amphibian development	6
8	Early zebrafish development	3
9	Early development in chickens	3
10	Early mammalian development	3
11	Early development in *C. elegans*	3
12	Mini-seminar, discussions	3
13	Organogenesis: (1) Paraxial mesoderm: somitogenesis (2) Intermediate mesoderm: the urogenital system	6
	Open-book examination	3
Total		60

Course title

Vector and human pathogen

Instructor(s)-in-charge:

Prof. Aihua Zheng
Prof. Zhen Zou

Course type:

Lecture

Course Schedule:

39 hrs in total by Prof. Aihua Zheng; 9 hrs in total by Prof. Zhen Zou.

Course Assessment:

Exam in the last section

Grading Policy:

Exam scores

Course Prerequisites:

Without

Catalog Description:

This course will introduce the principle of molecular entomology and microbiology. In the first part, we will introduce the importance of insect transmitted diseases and their impact on human health, economy and safety. In the second part, we will discuss several kinds of important human pathogens including the bacteria, plasmodium, and particularly virus. The basic knowledge of virus isolation, virus structure, virus life cycle will be provided in this course. In the third part, we will discuss several important aspects of molecular entomology such as metabolism, endocrinology, immunity, and their relations to the transmission of pathogens. During this course, the progress and application of some of the hottest technologies including CRISPR-Cas9 and deep sequencing will also be discussed.

Schedule of the course

section	Content	Lecturer	Hours
1	Introduction to vector biology and human pathogens	Aihua Zheng	3
2	Genomes and genetics/virus life cycle	Aihua Zheng	3
3	Virus structure	Aihua Zheng	3
4	Virus receptor and entry	Aihua Zheng	3
5	Virus replication, transcription and assembly	Aihua Zheng	3
6	Tick biology and tick-borne disease	Aihua Zheng	3
7	Infection basics and acute infection	Aihua Zheng	3
8	Immunology	Aihua Zheng	3
9	Deep sequencing and genome biology	Zhen Zou	3
10	Basic of pathogenesis/HIV	Aihua Zheng	3
11	Vaccine	Aihua Zheng	3
12	Animal migration and epidemic	Aihua Zheng	3

13	Insect vectors transmitting human and plant pathogens	Zhen Zou	3
14	Interactions between insect vectors and pathogens	Zhen Zou	3
15	Emerging virus/virus evolution	Aihua Zheng	3
16	Coronavirus and COVID-19	Aihua Zheng	3
17	Exam	Xing Zhang	3

Textbook and any related course material:

David M. Knipe, Peter Howley (2013) Fields Virology， 6th edition, Lippincott Williams & Wilkins.
Michael G. Rossmann, Venigalla B. Rao (2012), Viral Molecular Machines, Springer.
Marc J. Klowden (2007) Physiological Systems in Insects. 2nd Ed. Elsevier Inc. (One annotated version permitted to publish in PRC)
Reg Chapman (1997) The Insects Structure and Function 4th Ed. University Press, Cambridge, UK.
Lawrence I. Gilbert (2012) Insect Biochemistry and Molecular Biology. Acadmeic Press, London, UK.

Course title

Organelle Biology

Instructor(s)-in-charge:

Prof. Pingsheng Liu

Course type:

Lecture

Course Schedule:

See Schedule of the course (50 hours)

Course Assessment:

Homework: 7 assignments

Grading Policy:

70% homework, 30% classroom activities.

Course Prerequisites:

Cell Biology

Catalog Description:

Organelle biology is a course of advanced cell biology. Cellular organelles are important cell structures that compartmentalize cellular processes. There are two types of organelles, membrane-bound and non-membrane-bound. The membrane-bound organelles can be categorized into three groups, including monolayer phospholipid membrane-, bilayer phospholipid membrane-, and double bilayer phospholipid membrane-bound organelles. Cellular organelles are directly linked to cellular functions and human health. Many human disorders are due to malfunctions of organelles. Therefore, this course provides: 1) fundamental knowledge of organelles, 2) relationship between organelles and human diseases, 3) detailed studies of monolayer phospholipid membrane-bound organelle, lipid droplet, 4) history of organelle studies including major contributors, and 5) current progresses of organelle studies.

Organelle Biology

1. Introduction **3 h**

Definition

History of organelle studies

Current unsolved problems

2. Macromolecules **3 h**

Functions

Regulation

Structure

3. Metabolic Syndrome **3 h**

Cardiovascular disease

None alcoholic fatty liver disease

4. Discussion 1 **3 h**

3-1 Students introduce themselves.

3-2 Introduction of discussion: Presentation includes a short talk with ppt (10 min) plus discussion (5 min)

5. Cellular Compartments **3 h**

Animal cell structures

Non-membrane-bound organelles

Membrane-bound organelles

6. Cell Membrane **3 h**

Membrane lipids

Membrane proteins

Monolayer phospholipid membrane

Bilayer phospholipid membrane

Double bilayer phospholipid membrane

7. Membrane-bound Organelles **3 h**

Endoplasmic reticulum

Golgi

Mitochondria

Lysosome

8. Discussion 2 **3 h**

Presentation includes a short talk with ppt (10 min) plus discussion (5 min)

9. Introduction of Lipid Droplets **3 h**

History

Distributions

Difference with lipoproteins and other cellular organelles

Recent progress

Uncertainty and problems

Future studies

10. Lipid Droplet Proteins **3 h**

Structural Proteins:

PLINs

Oleosins

MPL, MLDP, MLDS, LDP, CLDPs

Protein Composition:

Lipid synthetic and catalytic

Membrane trafficking

Signaling

Protein degradation

11. Origin and Life of Lipid Droplets **3 h**

Born/biogenesis/formation

Grow

Die/usage/degradation

Origin

Conserved properties

12. Discussion 3 **3 h**

Presentation includes a short talk with PPT (10 min) plus discussion (5 min)

13. Functions of Lipid Droplets **3 h**

Storage

Trafficking (movement and interaction with other cellular organelles)
Lipid synthesis
Signaling
Protein degradation
DNA protection

14. Lipid Droplets in Mammals and Other Organisms 3 h

Mammals:
Adipose tissue
Mammary gland
Liver
Macrophages
Lymphocytes
Muscle
Other mammalian cells

Plants:
Plant seeds
Chloroplasts

Genetic Model Organisms:
Drosophila
C. elegans

Microorganisms:
Yeast
Green algae
Bacteria

15. Methods and Technologies in Lipid Droplet Research

Isolation
Proteomics
In vitro assay
Imaging
Movement
Genetic screen
Artificial lipid droplets

16. Discussion 4 3 h

Presentation includes a short talk with PPT (10 min) plus discussion (5 min)

17. Course Summary 2 h

Non-membrane-bound organelles
Membrane-bound organelles
Organelle-related diseases

Course material:

All references are listed in course ppt.
You are welcome to copy the ppt.

Course title

Introduction to synthetic biology

Instructor(s)-in-charge:

Prof. Long-Jiang Yu & Prof. Lijin Tian

Course type:

Lecture

Course Schedule:

3hrs/week, 21 hrs in total by Prof. Long-Jiang Yu; 19 hrs in total by Prof. Lijin Tian.

Course Assessment:

Homework: 3 assignments

Grading Policy:

Typically attendance 20%, presentation 40%, final 40%.

Course Prerequisites:

Molecular biology, Bioinformatics, Biochemistry, Biophysics

Catalog Description:

Synthetic biology, a new interdisciplinary field of science, brings together biologist, chemist and physicist to tackle the challenge that how molecular interactions inside the cell work in concert to produce a cellular function. This course will introduce the basic concepts and principles of synthetic biology, which is loosely defined as the construction and reconstruction of biological systems, and its practical applications in research and industry. Basic principles, advanced molecular biology tools for DNA assembly, the construction of biological pathways and circuits, genome editing, strategies for transcriptional control and mathematical modelling will be examined in the course. Students enrolled in this course will be able to understand the basic concepts and the importance of synthetic biology; grasp the scientific frontier of synthetic biology; acquire the advanced molecular biology techniques that facilitate the building of biological parts and systems; understand and describe biological parts and their functions on a systems-level; understand the approaches to characterize and regulate the combinations of different biological parts and systems; learn how to design and optimize models with the aid of computer; learn how to apply synthetic biology to different fields.

Schedule of the course

section	content	hours	teacher
1	Introduction of synthetic biology	4	YU Long-Jiang
2	The principles of synthetic biology	4	YU Long-Jiang
3	Gene Circuit of Synthetic Biological System	4	YU Long-Jiang
4	Student presentation	3	YU Long-Jiang
5	Design and assembly of synthetic biological system	4	YU Long-Jiang
6	Cell-free synthetic biological system	4	TIAN Lijin
7	Mathematical modeling and synthetic biology	4	TIAN Lijin
8	Practical applications of synthetic	4	TIAN Lijin

	biology, new trends and disruptive innovations in synthetic biology		
9	Student presentation	3	TIAN Lijin
10	Lab Tour	4	TIAN Lijin
11	Exam	2	YU Long-Jiang
total		40	

Contents of the course

1. Introduction of Synthetic Biology

1.1 Origin and development of synthetic biology

1.2 Emergence process of synthetic biology

1.3 Engineering characteristics and research areas of synthetic biology

2. The Principles of Synthetic Biology

2.1 Thoughts on the analysis of synthetic biology

2.2 Standardization and quantification of blocks

2.3 Hierarchical structure of synthetic biological system

2.4 Logical structure of synthetic biological system

2.5 Quantitative research method of synthetic biological system

2.6 Design principle and simplicity of synthetic biological system

2.7 Design principle of new synthesis reaction and network

3. Gene Circuit of Synthetic Biological System

3.1 Overview of gene circuit

3.2 Regulatory elements of gene circuit

3.3 Logic gate of gene circuit

3.4 Switch of gene circuit

3.5 Regulatory mode of gene circuit

3.6 Examples of gene circuit

4. Design and assembly of synthetic biological system

4.1 Design of synthetic biological system

4.2 Assembly and construction of synthetic biological system

4.3 Optimization of synthetic biological system

4.4 Analysis and screening of synthetic biological system

4.5 Characteristic cycle of "Design-Construction-Examination-Redesign"

4.6 Interactions between bacteria in synthetic biological system

5. Cell-free synthetic biological system

5.1 Concept and design principle of cell-free synthetic biological system

5.2 Classification of cell-free synthetic biological system

5.3 Engineering modification of cell-free synthetic biological system

5.4 Engineering application of cell-free synthetic biological system

6. Mathematical modeling and synthetic biology

6.1 Introduction

6.2 Basic methods of mathematical modeling for synthetic biology system

6.3 Analysis and evaluation of mathematical models of synthetic biology

6.4 Basic mathematical models of synthetic biology

6.5 Database design and modeling in the era of big data

6.6 Applications of computer technology in synthetic biology

7. Practical applications of synthetic biology and new trends and disruptive innovations in synthetic biology

7.1 Applications in “green” chemical engineering

7.2 Applications in environmental improvements

7.3 Applications in medical science

7.4 Applications in stress resistances enhancement

7.5 Synthetic biology: global strategy and economic benefits

7.6 Risks and potential rewards of synthetic biology

Textbook and any related course material:

Synthetic Biology

Edited by Karen M. Polizzi, and Cleo Kontoravdi, Springer.

Synthetic Biology

Edited by Anton Glieder • Christian P. Kubicek • Diethard Mattanovich • Birgit Wiltschi • Michael Sauer, Springer.

Computational Methods in Synthetic Biology

Edited by Mario Andrea Marchisio, Springer.

Expected level of proficiency from students entering the course:

Biology: strong

Biochemistry: medium

Course title

International Code of Nomenclature for Algae, Fungi, and Plants (Shenzhen Code, 2018)

Instructor-in-charge:

Prof. Xiangyun Zhu

Course type:

Lecture

Course Schedule:

3hrs/week by instructor (36hrs/12weeks, 4 hrs/one week)

Course Assessment:

Homework: Look for and analyze the problemic cases in one's own research

Grading Policy:

20% attendance;30% mid. exam.;50% final exam.

Course Prerequisites (all PDF files provided):

International Code of Nomenclature for Algae, Fungi, and Plants (Shenzhen Code, 2018)

Botanical Latin (Fourth edition)

The Code Decoded (Second edition)

Catalog Description:

This course includes six sections: Opening Remarks, Brief Introduction, Key Terms, Particular Dates, Case Analysis, and Main Changes. The first section provides history, present members, procedures for amending the code, and related websites for plant taxonomy. The second section covers preamble, principles, and names with their nomenclature. The third section contains terms adopted in the code. The fourth section provides the dates from 1 May 1753 to 1 January 2019 covering all of the amendments to the code. The fifth section provides a lots of examples and make students more easily understand the accounts of the related Articles and Recommendations. The sixth section includes the changes of structure, amended Articles with Recommendations, related articles and glossary.

Schedule of the course

section	content	hours
1	Opening Remarks	3
2	Brief Introduction	6
3	Key Terms	9
4	Particular Dates	6(3 hrs for mid exam)
5	Case Analysis	9
6	Main Changes	7(4 hrs for final exam.)
total		40

Contents of the course

Section 1: Opening remarks

1. History and present nomenclatural members
2. A brief introduction to other codes
3. Procedures for amending the Code

4. Related websites for plant taxonomy

Section 2: Brief introduction

1.Preamble

14 key items

2. Principles

Six key points

3.Names and their nomenclature

History of bi-nomina and starting points

Section 3: Key terms

The most important terms including gathering, holotype, lectotype, etc.

Section 4: Particular dates

Dates upon which particular provinsion of the Code

Section 5: Case analysis

1. Where was the name *Youngia sericea* validly published? How to determine its authorship?
2. How to think of the new subclass Malvidae invalid in Melbourne Code (2012), whereas valid in Shenzhen Code (2018)?
3. How to determine the date of the valid publication of Metasequoia glaptostroboides Hu et W. C. Cheng? How to determine the date of its lectotype?
4. An illegitimate name used for a long time！ Cathaya argyrophylla Chun & Kuang
5. Was the genus *Acidosasa* (desciptio-generico-specific) validly published? Why?
6. What is the date for valid publication of *Paeonia rockii* and *P. rockii* subsp. *lingyangshanii* ?
7. Is the species *Carex henryi* a new taxon or new combination?
8. How to cite the names of editor-in-chief, vice editors-in-chief, editor, and authors of Flora Yunnannica?
9. Is the subspecies new to science or not?
10. How to determine the authorship of a taxon?
11. How to determine and cite various kinds of types?

……

Section 6: Main changes

1.Structure of the code

2.New articles and recommendations or amended ones

3.Related articles connected to each other

4.Glossary

Textbook and any related course material:

1. *International Code of Nomenclature for Algae, Fungi, and Plants (Shenzhen Code, 2018) By Nicholas J. Turland et al., 2018, Koeltz Botanical Books.* Printed version. *https://www.iapt-taxon.org/nomen/main.php online.*
2. *International Code of Nomenclature for Algae, Fungi, and Plants (Shenzhen Code, 2018)* https://naturalhistory2.si.edu/botany/codes-proposals/ *Cite this website as: Wiersema, J.H., Turland, N.J., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F. (eds.) 2018+ [continuously updated]: International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical*

Congress Shenzhen, China, July 2017: Appendices I–VII. Online at < https://naturalhistory2.si.edu/botany/codes-proposals/> [accessed 25 May 2020].

3. Botanical Latin by William T. Stearn, 1998, Timber Press.

4. The Code decoded（Second edition）by Nicholas J. Turland, 2019, Pensoft Publisher.

Expected level of proficiency from students entering the course:

Botany: strong

Plant taxonomy: strong

Botanical Latin: normal

Course title

Urban Ecology: Pattern, Process, Planning, and Sustainability

Instructor(s)-in-charge:

Prof. ZHOU Weiqi

Course Schedule:

3hrs/week by instructor. 3 hrs/week by teaching assistant.

Course Assessment:

Homework: 4-6 assignments

Grading:

Homework and quizzes: 40%； course project presentations: 40%; final exam: 20%.

Course Prerequisites:

Some background on Ecology, Environmental Sciences, Geography, or Urban Planning

Course Goals

This is an introductory course to urban ecology. The focus of this course is the ***theory, methodology and application of urban ecology****. This course will introduce the general history, theories, conceptual frameworks and approaches of urban ecology, and will organize four field trips, including two field trips to the Beijing Urban Ecosystem Research Station (BUERS), and two trips to the urban parks to observe the application of ecology on urban planning and urban design. The class will ultimately lead the students to use scientific methods and strategies of urban ecology for planning and management, achieving urban sustainability.*

Course Description:

This course includes three sections:1) foundations of urban ecology research, 2) pattern, process, effect and service of urban ecosystem and 3) using urban ecology for planning and sustainability. The first section provides the latest progress of urban ecology research and urban long-term ecological research methodology. It covers concept, history and focus of urban ecology, monitoring methods and data application strategies for long-term ecological research. For the second part, pattern, process, effect and service of urban ecosystem will be introduced. This section includes the spatial pattern quantification, typical ecological process and environment effect study, including urban heat island effect, air quality and contamination control, and urban water cycle and pollutant, urban biodiversity and ecosystem service evaluation. The third focus the application of urban ecology for planning, management and sustainability. It provides the challenges of urban planning and management, how to use the urban ecology knowledge for urban planning and management, achieving urban sustainability. In each section, we will organize field trips to enhance students' understanding of the theories, methods, and

applications of urban ecology.

Schedule of the course

section	contents	hours
1	Introduction of urban ecology	3
2	Urban long-term ecological research: approaches, data, and applications	6
3	Structure of urban ecosystems: understanding the socio-ecological hybrid heterogeneity in space	3
4	First field trip: *BUERS* site -Beijing Teaching Botanical Garden	4
5	Ecological processes: Fluxes of energy and materials in urban areas	3
6	Course project presentation	3
7	Second field trip: *BUERS* site-Mangshan National Forest Park	6
8	Environmental pollution and public health	3
9	Urban biodiversity	6
10	Third field trip: Olympic Forest Park	4
11	Urban greenspace and ecosystem services	3
12	Linking urban ecological research to urban planning and management: Examples and challenges	3
13	Fourth field trip: Small city parks	4
14	Urban sustainability and Ecocity	6
15	Course project presentation	3
total		60

Contents of the course

Section 1: Foundations of urban ecology research

75. Introduction of urban ecology
    21. Global urbanization and trends
    22. Concept, history and focus of urban ecology
    23. Paradigm of urban ecological study: ecology in-, of-, and for city
    24. The latest progress and trend of urban ecological research

76. Urban long-term ecological research: theory, monitor, data issues and strategies
    (1) Urban ecosystem research: scientific question, concept, theory and method

(2) Long-term ecological research network: from natural ecosystem to urban ecosystem
(3) Monitoring method and system of urban ecosystem
   a) Monitoring contents and elements
   b) Monitoring methods and data application strategies: field survey, plot observation, remote sensing monitoring and socio-economic survey
(4) Comparisons of urban ecosystem study station between the U.S. and China

77. First field trip: Beijing Teaching Botanical Garden
(1) The History of the Beijing Urban Ecosystem Research Station
(2) Urban Monitoring Instruments: Vegetation, Soil, Atmosphere
(3) Understanding plant's growth conditions and ecological functions in urban environments

Section 2: Pattern, process, effect and service of urban ecosystem

78. Spatial patterns and quantification
(4) Spatial heterogeneity in urban ecosystem: scale and patterns
(5) Spatial models for understanding patterns: urban-rural gradient, patch-corridor-matrix and other models
(6) Neighborhood mosaics and their linkages
(7) Theory, data and methods for spatial patterns quantification

79. Typical ecological process and environment effect in urban area
(1) Urban heat environment characteristics, mechanism and effects of urban heat island
(2) Air quality evaluation, influence mode of air pollution and contamination control
(3) Urban water system: flows in water cycle, water quality evaluation, stormwater and pollutants control

80. Second field trip: Mangshan National Forest Park
(1) Basic principles and methods of forest management
(2) Long-term forest ecological monitoring methods
(3) Vegetation structure, species composition, and ecological functions within the forest

81. Urban biodiversity
(1) Characteristics of urban habitat, plants and animals
   a) Urban plants, vegetation and habitat
   b) Composition and value of urban greenspace
   c) Species type and movement of urban wildlife
   d) Changing urban wildlife and adaptation
(2) Urban biodiversity protection and education
(3) Urban biodiversity and human health study

82. Urban ecosystem service and ecological assets assessment
    (1) Principle and evaluation of urban ecosystem service
    (2) Ecological infrastructure and its service
    (3) Urban ecological assets evaluation and management

83. Third field trip: Olympic Forest Park
    (1) Identifying and recording different types of plants and animals
    (2) Observe the various technical facilities at Olympic Forest Park
    (3) Exploring the different ecosystem services that Olympic Forest Park provides to urban residents

Section 3: Using urban ecology for planning and sustainability

84. Application of urban ecology for urban planning and management
    (1) Principle and method for ecological planning and urban planning
    (2) Challenges of urban planning and management
    (3) Application of urban ecology: urban growth boundary, urban ecological security pattern, urban spatial pattern optimizes etc.
    (4) Application cases: eco-city, low-carbon city and spongy city etc.

85. Fourth field trip: Small city parks
    (1) Typical features of small city parks
    (2) Different purposes of small parks in urban planning

86. Urban sustainability
    (1) Framework and research tendency of urban sustainability study
    (2) Key question, content, evaluation system and method of urban sustainability

Textbook and any related course material:

1. Richard Forman, 2014, Urban Ecology, Science of Cities, Cambridge University Press

2. Kevin Gaston, 2010, Urban Ecology, Cambridge University Press

3. Morgan Grove, 2015, The Baltimore School of Urban Ecology: Space, Scale, and Time for the Studies of Cities. Yale University Press

Course title

Soil Ecology-Water and Nutrients Cycling and Management

Instructor(s)-in-charge:

Prof. Xiying Zhang & Prof. Chunsheng Hu

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 20 hrs each for Prof. Xiying Zhang and Prof. Chunsheng Hu

Course Assessment:

Homework, presentations and open book examination

Grading Policy:

40% homework, 20% attendance, 40% final.

Course Prerequisites:

Some basic knowledge in soil and plant sciences.

Catalog Description:

Soil Ecology focus on the interactions among soil organisms, and between biotic and abiotic aspects of the soil environment, particularly concerned with soil structure and stability, macro-ecology and functions, the cycling of soil water and nutrients, above- and below-ground biological interactions. Mastery of those knowledge will help to addresses the impacts of human activities on soil function, and improve the sustainability and productivity of soil ecosystems. The course includes the following sections: Basics to soil ecology, soil nutrient and water cycling, soil macro-ecology, human activities impact on soil ecology, soil ecosystem management. The course is structured as a series of lectures and mini-seminars. It will cover the following topics:

Schedule of the course

Sections	Contents	Hours	Instructor
1	**Introduction of Soil Ecology** Soil formation; Soil physical environment; Soil chemical environment; Soil functions.	4	Prof. X Zhang
2	**Soil water cycling** Soil water dynamics; Plant roots and soil water use; Soil evaporation and plant transpiration; Soil water balance.	6	Prof. X Zhang
3	**Soil water management** Increasing soil water availability; Regulating soil water use; Reducing evaporation loss; Improving soil water productivity.	6	Prof. X Zhang
4	**Soil nutrient cycling** C\N\P\K cycling;	6	Prof. C Hu

	Soil micro-nutrients; Soil nutrient dynamics; Roots and nutrient acquisition.		
5	**Soil nutrient management** Soil health improvement; Soil nutrient balance; Four Rs in managing fertilizers; Examples for different types of soils and crops.	6	Prof. C Hu
6	**Human impacts on soil ecology** Soil pollution and degradation; Agricultural practices; Invasive species; Land-use transformation.	4	Prof. C Hu
7	**Climate changes on soil ecology** Soil carbon sequestration; Greenhouse gas emissions from soils; Atmospheric nitrogen deposition; Interactions between climate and soils.	4	Prof. C Hu
8	**Management to improve soil ecology** Sustainability and productivity of soil ecosystems; Soil biotic and abiotic interactions; Soil type, quality and management at diverse scales; Integrated soil water and fertility/health management.	4	Prof. X Zhang
total		40	

Contents of the course:

Section 1: Basics to soil ecology

1. **Introduction to soil ecology**
2. **Soil formation**
   (1) Parent material
   (2) Climate
   (3) Topography
   (4) Time
   (5) Human influence
3. **Soil physical environment**
   (1) Soil texture, structure and color
   (2) Soil horizons, bulk density and soil pores
   (3) Soil water
   (4) Soil atmosphere
4. **Soil chemical environment**
   (1) Structure and function of clay minerals
   (2) Soil organic matter
   (3) Cation exchange reactions and base saturation
   (4) Soil acidity and buffer capacity
5. **Soil functions**

(1) Nutrient cycling
(2) Water dynamics
(3) Filtering and buffering,
(4) Physical stability
(5) Biodiversity and habitat.

Section 2: Soil water cycling and management

1. Soil water cycling

(1) Sources of water input
(2) Sources of water output
(3) Plant roots and soil water use;
(4) Soil evaporation and plant transpiration;
(5) Soil water balance.

2. Soil water management

(1) Increasing soil water availability;
(2) Regulating soil water use;
(3) Soil water conservation;
(4) Improving soil water productivity.

Section 3: Soil nutrient cycling and management

1. Soil nutrient cycling

(1) Soil carbon cycling
(2) Soil macro-nutrients cycling
(3) Soil micro-nutrient cycling
(4) Roots and nutrient acquisition

2. Soil nutrient management

(1) Soil health improvement;
(2) Soil nutrient balance;
(3) Four Rs (right timing, right location, right amount and right method) in managing fertilizers;
(4) Examples for different types of soils and crops in nutrient management.

Section 4: Impacts of human activities and climate Change on soil ecology

1. Human impacts on soil ecology

(1) Soil pollution and degradation;
(2) Influences of agricultural practices on soil quality;
(3) Invasive species;
(4) Land-use transformation.

2. Climate changes on soil ecology

(1) Soil carbon sequestration;
(2) Greenhouse gas emissions from soils;
(3) Atmospheric nitrogen deposition;
(4) Interactions between climate and soils.

Section 5: Management to improve soil quality

(1) Sustainability and productivity of soil ecosystems
(2) Using soil biotic and abiotic interactions to improve the functions of soil ecosystems
(3) Soil type, quality and management at diverse scales for improving ecosystem production and resource use efficiency
(4) Integrated soil water and fertility/health management for the sustainability of soil ecosystem

Textbook and any related course material:

1. *Essentials of Ecology, 4th Edition by Michael Begon, Robert W. Howarth, Colin R., Wiley.*
2. *Soil Physics, by W Jury and R Horton, Wiley.*
3. *Soil Nutrients, by M Miransari*
4. *Soil Water Dynamics, by A.W. Warrick, Oxford University Press*

Expected level of proficiency from students entering the course:

Some knowledge in soil and plant sciences.

Course title

Data Mining

Credits: 3

Instructor(s)-in-charge:

Prof. Ying Liu

Course type:

Lecture

Course Schedule:

Course Assessment:

Homework: 3 assignments, 1 project

Grading Policy:

homework, 40%, project, 50%, attendance, 10%.

Course Prerequisites:

data structure, computer algorithms, programming, database

Catalog Description:

The goal of the course is to provide the students with knowledge and hands-on experience in developing data mining algorithms and applications. Firstly, the course will introduce the motivation of data mining techniques. Then, present the principles and major classic algorithms in data mining. Next, the course will introduce some successful applications to the students. Finally, big data and the most recent techniques will be introduced as well.

Schedule of the course

section	content	hours
1	Introduction	4
2	Data Warehouse	4
3	Data Preprocessing	4
4	Classification	6
5	Association Rules Mining	6
6	Clustering	6
7	Recommendation System	2
8	Applications	6
9	Big Data Mining	12
10	Project Discussion & Demo	8
11	Review	2
total		60

Contents of the course

Section 1: Introduction

Motivation, major issues, major applications, characteristics

Section 2: Data warehouse

Model, architecture, operations

Section 3: Data pre-processing

Data cleaning, data transformation, data reduction

Section 4: Classification

Decision tree, Bayesian Classifier, Classification by backpropagation, KNN classifier, statistical prediction models, major applications

Section 5: Association rules

Apriori, FP-Growth, Partition, DIC, DHP, multi-level association rules, quantitative association rules, major applications

Section 6: Clustering

Partitioning methods, hierarchical methods, density-based methods, grid-based methods, major applications

Section 7: Recommendation System

Content-based recommendation, Collaborative Filtering

Section 8: Applications

Credit scoring, oil exploration, customer relationship management, cosmological simulation

Section 9: Big data mining

Big data, big data characteristics, big data mining techniques including high performance mining, deep learning, stream mining, text mining, cloud mining, etc.

Section 10: Project Discussion & Demo

Students and the instructor discuss the course projects in class, and students present their work and make demonstrations.

Textbook and any related course material:

Data Mining, Concepts and Techniques. Jiawei Han and Micheline Kamber, Morgan Kaufmann, 2012.

Research papers: to be announced in class

Course title

Fluid-Structure Interactions in Engineering

Instructor(s)-in-charge:

Prof. Weimin Chen

Course type:

Lecture

Course Schedule:

3hrs/week.

Course Assessment:

Homework: 3-4 assignments

Grading Policy:

Typically 50% homework, 20% attendances; 30% final presentation.

Course Prerequisites:

Mechanical Engineering, or Mathematics and Physics

Catalog Description:

There are many fluid-structure coupling problems in practice, such as vibration and unstability of precise instrument, civil building/bridge, power line, flight vehicle and ocean pipeline. Because these structures often serve in air or water, they might interact strongly with the amid fluid. This course, fluid-structure interactions in engineering, is a typical and leading-edge inter-discipline. The class will introduce the fundamental concepts, theories and solution approaches, along with applications in aero-space, ocean, earth and civil industries.

It mainly includes three parts. 1) Fundamental theory. The fundamental theory covers essential dimensional analysis, structural vibration and its dynamics, fluid dynamics and solution techniques of a coupling system. 2) The fluid-solid coupling problems in air. It will introduce flutter and divergence, in terms of modelling, solution and its characteristics; 3) The fluid-solid coupling problems in water, e.g. vortex-induced vibration, stability of fluid-conveying pipeline; some challenging issues including active control, status monitoring and safety assessment of these coupling systems.

Through attending this class, students could have deeper understanding of the basic concepts, fundamental formulations of typical coupling problems in engineering.

Schedule of the course

Section	Content	Hours	Notes
1	**Introduction**	**4**	
	1.1 Categories and Main Characters of Structural-Fluid Interaction Problems	2	
	1.2 Some Important Concepts and Analysis Methods of Structural-Fluid Interactions	2	
2	**Dimensional Analysis and Fundamental Theory**	**14**	
	2.1 Dimensional Analysis Introduction of dimensional analysis; Some useful non-dimensional variables	4	
	2.2 Structural Vibration and Its dynamics	3	

	Vibrations of typical solid bodies such as string vibration and its wave problem; Tensional bar/rod and beam bending dynamics.		
	2.3 Fluid Dynamics Introductions of fundamentals of potential flow; Basic concept and methods of added mass and fluid coupling.	3	
	2.4 Numerical Solution Techniques Some popular methods, e.g. direct integration method and mode superposition method; Comparisons of different mothods, in terms of application conditions and stability behaviors.	4	
3	**Fluid-Solid Coupling Problems in Air**	**14**	
	3.1 Static Aeroelasticity Including equilibrium equations, torsional divergence and air-load distribution.	3	
	3.2 Aeroelastic Flutter Including stability characteristics introduction, aeroelasticity analysis of typical section and classical flutter analysis.	4	
	3.3 Solution Approaches Engineering solutions such as the k method and the p-k method. Unsteady aerodynamics and flutter prediction approach.	4	
	3.4 Active Control of Coupling System. State-space equations; Control law design	3	
4	**Fluid-Solid Coupling Problems in Water**	**13**	
	4.1 Vortex-Induced Vibration Including phenomenon and main factor, analysis of VIV problems, VIV response of ocean risers/pipelines	4	
	4.2 Vibration and Stability Problems of Flow-Conveying Pipe Examples of simply-supported pipeline and cantilever pipeline. Effects of boundary conditions on stability	4	
	4.3 Parametric Excitation The modelling (Mathieu equation); Its solution and applications	2	
	4.4 Some leading-edge Problems of Fluid-Structure Interactions	3	
5	**Review and Discussions**	**3**	

	Summary, Review and Discussions of this course		
6	**Students Final Presentations** The students may give their presentations, they can choose any topic in coupling problems. Then all students and instructor would have discussions on their understanding, thoughts and comments.	**2**	
Total		**50**	

Contents of the course

Section 1: Introduction of Immunology and Innate Immunity

1. Categories and Main Characters of Structural-Fluid Interaction Problems

2. Some Important Concepts and Analysis methods of Structural-Fluid Interactions

Section 2: Dimensional Analysis and Fundamental Theory

1. Dimensional Analysis: Introduction of dimensional analysis; Some useful non-dimensional variables, such as reduced velocity, dimensionless amplitude, mass ratio, damping factors.

2. Structural Vibration and its dynamics: Vibrations of typical solid bodies such as string vibration and its wave problem; Tensional bar/rod and beam bending dynamics.

3. Fluid Dynamics: Introductions of fundamentals of potential flow; Basic concept and methods of added mass and fluid coupling.

Section 3: Fluid-Solid Coupling Problems in Air

1. Static aeroelasticity: Including equilibrium equations, torsional divergence and air-load distribution.

2.Aeroelastic Flutter: Including stability characteristics introduction, aeroelasticity analysis of a typical wing section; classical flutter analysis of 1) One-DOF flutter; and 2)Two-DOF flutter.

3. Solution Approaches: Engineering solutions such as the k method and the p-k method; Unsteady aerodynamics; Flutter prediction approach and boundary characteristics .

4. Active Control of Coupling System: State-space equations; Control law design

Section 4: Fluid-Solid Coupling Problems in Water

1. Vortex-induced vibration: Including phenomenon and main factor, analysis of VIV problems, VIV response of ocean risers/pipelines.

2. Vibration and Stability Problems of Flow-Conveying Pipe: Examples of simply-supported pipeline and cantilever pipeline. Effects of boundary conditions on stability

3. Parametric Excitation: The modelling (Mathieu equation); Its solution and applications

4. Some leading-edge Problems of Fluid-Structure Interactions

Section 4: Review and Discussions

Summary, Review and Discussions of this course

Section 5: Students Final Presentation

The students may give their presentations, they can choose any topic in coupling problems. Then all students and instructor would have discussions on their understanding, thoughts and comments.

Textbook and any related course material:

1. *Rao SS. Mechanical Vibrations. NJ: Prentice Hall，2016*
2. *Robert D. Blevins, Flow-Induced Vibration. Van Nostrand Reinhold Com., 1977.*
3. *Dewey H. Introduction to Structural Dynamics and Aeroelasticity, Aerospace Series. Cambridge University Press, 2002*
4. *Self-design teaching materials given by the instructor*

Expected level of proficiency from students entering the course:

Through attending this class and implementing the assignments, hopefully, students could understand the basic concepts, fundamental formulations of various kinds of coupling problems. What's more, they would be able to know how to develop appropriate math and numerical models, and their ability of figuring out the solutions of coupling problems would get a progress after taking this course.

Course title

Mechanics of MEMS/NEMS and Micro/Nano Sensors

Instructor(s)-in-charge:

Prof. ZHANG, Yin

Course type:

Lecture

Course Schedule:

3hrs/week by instructor.

Course Assessment:

Homework: 12 assignments

Grading Policy:

Typically 40% homework, 20% attendances, 10% project, 30% final exam.

Course Prerequisites:

Mechanics, Physics, Mathematics

Catalog Description:

After several decades' development, Micro/Nano-Electro-Mechanical Systems (MEMS/NEMS) have reached a level of maturity. Many MEMS/NEMS devices have been widely used in our every-day life, ranging from accelerometers and pressure sensors in cars, micro-mirrors in plasma TVs, radio frequency (RF) switches and microphones in cell phones, and inertia sensors in video games. Even with the maturity of fabrication and commercialization, MEMS/NEMS is still one of the hottest evolving areas in science and engineering. The growing demands on the MEMS/NEMS technology give rise to great challenges. Designers are now aiming to achieve complicated objectives while meeting a long list of specifications related to sensitivity, fabrication, system integrity, packaging and reliability. These challenges have created a motivation to seek new solutions and ideas, which can also be of a great boost to the development of various sensors. The major application of MEMS/NEMS is sensor and actuator. Therefore, we will discuss the working principles of various sensors and actuators including physical, chemical and biological ones. Mechanics is the best approach to understand those working principles. The concept of sensor is also broaden in this course. For example, the working mechanisms of some important scientific instruments, such as atomic force microscope (AFM), seismometer and gyroscope etc, will also be discussed.

This course has two main goals: The first is to provide the students a comprehensive view on the working principles of various sensors and actuators. The students are expected to have an overall idea on the applicability range and limit, pros and cons of various sensing/measurement mechanisms.The second goal is to prepare the students for their future research by presenting the in-depth analysis for the most common and important sensing/measurement mechanisms. And the related literatures are thus provided for their further studies.

Schedule of the course

section	content	hours
1	**Introduction to MEMS/NEMS and sensors**	3

	History of MEMS/NEMS History of sensor Definitions of sensor and actuator Various applications Size effect An overview on various sensing mechanisms	
2	**Vibration of the Discrete System** Vibration of one DOF system Sensing mechanisms of accelerometer, seismometer and gyroscope Drop/shock test Vibration of two DOF system MEMS band-pass filter	5
3	**Sensing and Actuation Mechanisms** Static sensing mechanisms Strain gauge Conductor path Mechanical/Thermal/Electrical/Capacitive mechanisms Piezoelectric mechanism Optical mechanism Micropump Microvalve Thermal actuator Pressure sensor Flow sensor Inertial sensor Mass resonator sensor	15
4	**Microbeams and Atomic Force Microscopes (AFM)** Euler-Bernoulli beam theory Vibration of beam Modal analysis Scaling laws and size effect Working principle of AFM Lennard-Jones force	15
5	**Nonlinear Mechanics of MEMS/NEMS and sensor** Dynamics of MEMS/NEMS under the electrostatic force driving Pull-in instability of MEMS/NEMS Adhesion Capillaries	20

	Primary resonance and subharmonic Resonance Bifurcation	
6	Final Exam	2
total		60

Contents of the course

Section 1. Introduction: MEMS, Their Features, and Modeling Challenges (3 hr)

1.1 What Are MEMS and Why They Are Attractive?

1.2 History and Definitions of Sensor and Actuators

1.3 Challenges of MEMS Modeling and Simulations

1.4 Coupled-Field MEMS Phenomena

1.5 Fabrication of MEMS/NEMS

1.6 The State-of-the-Art of MEMS Modeling and Simulations

Section 2. Vibrations of Lumped-Parameter Systems (5 hr)

2.1 Free Vibration of Single-Degree-of-Freedom (SDOF) Systems

2.1.1 Undamped Vibration

2.1.2 Damped Vibration

2.2 Forced Harmonic Excitation of SDOF Systems

2.3 Vibrating MEMS Gyroscopes

2.4 Base Excitations of SDOF Systems and Accelerometers Principles

2.5 Response of SDOF Systems to Arbitrary Excitation

2.6 Vibrations of Two-Degree-of-Freedom Systems

2.6.1 Undamped Free Vibration and Eigenvalue Problem

2.6.2 Modal Analysis

2.6.3 Resonances in 2-DOF Systems

2.7 MEMS Band-Pass Filters

Section 3. Sensing and Actuation in MEMS (15 hr)

3.1 Electrothermal Actuation

3.1.1 U-Shaped Actuator

3.1.2 V-Beam Actuator

3.1.3 Bimorph Actuator

3.2 Piezoelectric Actuation and Detection

3.3 Electromagnetic and Magnetic Actuation

3.4 Piezoresistive Detection

3.5 Electrostatic Actuation and Detection

3.6 Resonant Sensors

3.7 Energy Harvesters (from Magrab's Textbook)

Section 4. Microbeams and Atomic Force Microscopes (15 hr)

4.1 The Linear Equation of Motion

4.1.1 Boundary Conditions

4.1.2 Beams Made of Different Material Layers

4.2 The Static Response

4.3 Residual Stresses and Nonideal Supports of Cantilever Microbeams

4.4 Natural Frequencies and Mode Shapes

4.4.1 Nondimensionalization
4.4.2 Flexible (Nonideal) Supports
4.4.3 Cantilever Beam with a Lumped Mass at the Tip
4.5 The Effect of Axial Load on the Natural Frequency and the Buckling Limit
4.6 The Orthogonality of Mode Shapes
4.7 Forced Vibrations and Modal Analysis
4.7.1 Undamped Response with no Axial Load
4.7.2 Adding Axial Force
4.7.3 Adding Damping
4.8 A Nonlinear Model of Beams with Midplane Stretching
4.9 Other Nonlinear Models of Beams
4.10 The Galerkin Discretization and Reduced-Order Modeling
4.10.1 The Galerkin Method
4.10.2 Beams with Midplane Stretching
4.11 Reduced-Order Model of Beams Under Electrostatic Force
4.12 The Static Behavior of Beams Under Electrostatic Force
4.12.1 Cantilever Microbeams
4.12.2 Clamped–Clamped Microbeams
4.13 The Natural Frequencies Under Electrostatic Force
4.14 Pull-in Time of RF Switches
4.15 Resonators Under AC + DC Excitation
4.16 Atomic Force Microscopes
4.16.1 Introduction
4.16.2 Interaction Forces
4.16.3 AFM Models
4.16.4 AFM Under Lennard–Jones Force
4.16.5 Contact Mechanics (Hertz, JKR, DMT and MD models)
4.17 Beams Under Capillary Forces and Stiction Failure
4.18 Coupled-Field Damping of Beams
4.18.1 Squeeze-Film Damping
4.18.2 Thermoelastic Damping

Section 5. Nonlinear Dynamics of MEMS/NEMS (20 hr)

5.1 Nondimensionalization
5.2 Fixed Points and Linearization
5.3 Bifurcations of Fixed Points
5.3.1 Saddle-Node Bifurcation
5.3.2 Transcritical Bifurcation
5.3.3 Pitchfork Bifurcation
5.3.4 Hopf Bifurcation
5.4 Phase Portraits
5.5 Primary Resonance and Subharmonic Resonance
5.6 Basin of Attraction Analysis
5.7 Remarks on Resonant Dynamic Pull-in
5.8 Mass Detection Application

Section 6. Final Examination (2 hr)

Textbook and any related course material:

Course text:

M. I. Younis, ***MEMS Linear and Nonlinear Statics and Dynamics.*** Springer, New York, 2011.

Related texts:

A.N. Cleland, ***Foundation of Nanomechanics: From Solid-State Theory to Device Applications***. Springer, Berlin, 2003.

E. B. Magrab, ***Vibrations of Elastic Systems With Applications to MEMS and NEMS.*** Springer, Dordrecht, 2012.

N. Lobontiu and E. Garcia, ***Mechanics of Microelectromechanical Systems***. Kluwer Academic Publishers, New York, 2005.

S. Schmid, L.G. Villanueva and M.L. Roukes, ***Fundamentals of Nanomechanical Resonators***, Springer, Berlin, 2016.

A. Erturk and D.J. Inman, ***Piezoelectric Energy Harvesting.*** Wiley, 2011

Expected level of proficiency from students entering the course:

Mathematics: basic

Physics: basic

Mechanics: strong

Course title

Functional Nanostructures: Syntheses, Characterization and Device Application

Instructor(s)-in-charge:

Prof. Xiangnan Sun, Prof. Jianqi Zhang & Assoc Prof. Feng Wang

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 15 hrs in total by Prof. Xiangnan Sun; 15 hrs in total by Prof. Jianqi Zhang; 21 hrs in total by Assoc Prof. Feng Wang.

Course Assessment:

Homework: 6 assignments

Grading Policy:

Typically 50% homework, 20% attendances; 30% final presentation.

Course Prerequisites:

None

Catalog Description:

This course includes three sections: inorganic semiconductor nanostructures, organics functional nanostructure and application of functional nanomaterials. The first section provides atoms-to-device introduction to the latest semiconductor quantum heterostructures. It covers nanostructures growth, characterization, their electronic, optical, and transport properties, their role in exploring new physical phenomena, and their utilization in devices. For the second part, student will know principles of organic electronics, understand how to use various strategies to produce organic functional nanomaterials, get the ideas how to construct organic electronic and optoelectronic devices. The third provides the various application areas of functional nanostructures, including water splitting, photodetection, light-emitting diode, field-effect transistors, spintronic devices, thermoelectric devices and photovoltaic devices. It will cover the following topics:

Schedule of the course

Chapter	Chapter Name	Chapter hours	Section Name	Section hours	Instructor
1	Introduction of Nanoscience and Technology	3	Introduction of Nanoscience and Technology	3	Feng Wang
2	Physics Basics	3	Physics Basics	3	Feng Wang
3	Typical Nanostructures	3	Typical Nanostructures	3	Feng Wang
4	Growth Methods	3	Growth Methods	3	Feng Wang
5	Applications of Nanostructures: Water splitting and photodetection	6	Water splitting	3	Feng Wang
			Photodetection	3	Feng Wang
6	Characterizations of	6	Spectroscopic	3	Jianqi Zhang

	Nanostructures		Characterization		
			Electron Microscopic	3	Jianqi Zhang
7	Organic electronics	3	Organic electronics	3	Xiangnan Sun
8	Applications of Nanostructures: Light-emitting diode and field-effect transistors	6	Light-emitting diode	3	Xiangnan Sun
			Field-effect transistors	3	Xiangnan Sun
9	Applications of Nanostructures: Spintronics and thermoelectrics	6	Spintronic devices	3	Xiangnan Sun
			Thermoelectric devices	3	Xiangnan Sun
10	Applications of Nanostructures: Photovoltaics	6	Organic photovoltaics	3	Jianqi Zhang
			Perovskite photovoltaics	3	Jianqi Zhang
11	Student Presentation and Discussion	6	Student Presentation and Discussion	3	Jianqi Zhang
			Student Presentation and Discussion	3	Feng Wang

Contents of the course

Chapter 1: Introduction of Nanoscience and Technology
Chapter 2: Physics Basics
Chapter 3: Typical Nanostructures
Chapter 4: Growth Methods
Chapter 5: Applications of Nanostructures: Water splitting and photodetection
Chapter 6: Characterizations of Nanostructures
Including Spectroscopic characterization and electron microscopic
Chapter 7: Organic electronics
Chapter 8: Applications of Nanostructures: Light-emitting diode and field-effect transistors
Chapter 9: Applications of Nanostructures: Spintronics and thermoelectrics
Including Spintronic devices and thermoelectric devices
Chapter 10: Applications of Nanostructures: Photovoltaics
Chapter 11: Student Presentation and Discussion

Textbook and any related course material:

Low dimensional semiconductor structures: fundamental and device applications. Edited by Keith Barnham and Dimitri Vvedensky,
Organic Electronics, Materials, Processing, Electronics, and Apllications. Edited by Franky So,
Characterization of Materials, edited by Elton N. Kaufmann (editor-in-chief), Wiley-Interscience.

Expected level of proficiency from students entering the course:

Inorganic semiconductor nanostructures: basic

Organics functional nanostructure: basic
Application of functional nanomaterials: basic

Course title

Materials Production and Environmental Sciences

Instructor(s)-in-charge:

Prof. Hao Du

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 60 hrs in total by Prof. Hao Du.

Course Assessment:

Homework: 8 assignments, will be given after each class, extensive literature reading is expected.

Grading Policy:

Assignments 40%, Final 20%, Presentation 20%, Attendance 20%.

Course Prerequisites:

College Chemistry, College Mathematics, English.

Catalog Description:

This course includes two sections. First, the introduction of different processes to recover some of the more important industrial materials; Second, introduction of the environmental issues involved in different metal recovery processes, and the methods for the pollution control. Emphasis will also be given to the clean production related to industry application.

It is expected that after taking this course, students will be familiar with most common metallic materials production processes and environmental issues related.

Schedule of the course

section	content	hours	
1	**Overview** Metallurgy Metallurgy and Environment Pollution Control	3	Prof. Hao Du
2	**Steel production** Iron and Steel Materials and Preparation Iron and Steel Making Environmental Issues	3	Prof. Hao Du
3	**Chromium production** Chromium Production of Chromium Environmental Issues and Control	3	Prof. Hao Du
4	**Manganese production** Manganese Production of Manganese Environmental Issues and Control	3	Prof. Hao Du

5	**Aluminum production** Introduction Metallurgical Processes Environmental Issues and Control	3	Prof. Hao Du
6	**Titanium production** Introduction Metallurgical Processes Environmental Issues and Control	3	Prof. Hao Du
7	**Vanadium production** Vanadium Production of Vanadium Environmental Issues and Control	3	Prof. Hao Du
8	**Copper production** Copper Production of Copper Environmental Issues and Control	3	Prof. Hao Du
9	**Zinc production** Zinc Prodcution of Zinc Environmental Issues and Control	3	Prof. Hao Du
10	**Lead production** Lead Production of Lead Environmental Issues and Control	3	Prof. Hao Du
11	**Nickle and Cobalt** Nickel Production of Nickel Cobalt Production of Cobalt	3	Prof. Hao Du
12	**Gold production** Gold Production of Gold Environmental Issues and Control	3	Prof. Hao Du
13	**Rare earth metals production** Rare Earth Elements Production of Rare Earth Elements Environmental Impact and Control	3	Prof. Hao Du
14	**Lithium production** Lithium Production of Lithium Lithium Battery	3	Prof. Hao Du
15	**Potassium and Phosphorus production** Phosphorus	3	Prof. Hao Du

	Production of Phosphorous Environmental Impact and Control Potassium Production of Potassium Environmental Impact and Control		
16	**Wasted battery recovery** Introduction Recycling of Wasted Batteries Challenges	3	Prof. Hao Du
17	**Student presentation** 8-10 minutes per student, the student can choose one metal of their interest and discuss how this metal can be extracted from resources (Include: resources, major processes, major reactions, major equipment).	8	Prof. Hao Du
18	**Study tour** Take a visit to Shougang Park and mount the 40-meter platform of the third blast furnace, which is a typical production line in the smelting system and is Shougang's first modern large blast furnace with a furnace capacity of more than 25,000 cubic meters. During the visit, Prof. Du will take you to learn about the industrial production facilities and feel the spirit of Shougang.	4	Prof. Hao Du
total		60	

Contents of the course

Section 1: Introduction of the material

Section 2: Production of the material

Section 3: Environmental Issues and Control

Textbook and any related course material:

No textbook, and electronic course reading materials will be provided one week before each class.

Expected level of proficiency from students entering the course:

College Chemistry: basic

Course title

Fundamentals and Frontier of Materials Science

Instructor(s)-in-charge:

Prof. Guangjin Zhang , Prof. Jun Yang, Prof. Yongshen Han

Course type:

Lecture

Course Schedule:

4hrs/week by instructors. 20 hrs in total by Prof. Guangjin Zhang; 20 hrs in total by Prof. Jun Yang，20 hrs in total by Prof. Yongshen Han. .

Course Assessment:

Homework: literature presentations

Grading Policy:

Typically 60% final examination, 10% attendances; 30% presentations.

Course Prerequisites:

Chemistry, Materteral science, Chemical Engineering

Catalog Description:

Materials science is the fastest-growing subject in recent years. It is closely related to our daily life and work. The understanding of the basics and frontiers of materials science needs to be comprehensively in-depth. The establishment of this English course is based on this purpose. Students understand some key factors in the development of materials science, expand their knowledge in the field of materials science, and understand the current international research hotspots and difficulties in the field of materials science through teachers' lectures, self-inquiry of literature, classroom exchanges, etc.

Schedule of the course

section	content	hours	
1	**Introduction of Materials Science** Introduction to Materials; Conception of Materials, History of Materials development:anicient materials History of Materials development:modern materials	4	Prof. Guangjin Zhang
2	**Materials Chemistry and Physics** Concept of materials physics and chemistry, Characterization technologies for Materials, Typical development of new technologies for Materials	4	Prof. Guangjin Zhang
3	**Structure materials** Concept of structure materials, Typical structure materials, discussion and reports	4	Prof. Guangjin Zhang
4	**Functional Materials** Concept of Functional materials, Development of	4	Prof. Guangjin Zhang

	Functional materials		
5	**Atomic Structure and Bonding** Atomic structure; Atomic bonding;	4	Prof. Jun Yang
6	**Fundamentals of Crystallography** Space lattice; Crystal system & lattice types; Crystal structure and complex lattice; Indices of crystal planes and directions;	4	Prof. Jun Yang
7	**Inorganic Nanomaterials for Sustainability** What is nanoscale science/technology? Why nanomaterials? What kind of nanoparticles can we make? What properties of nanostructures are dependent on size? Synthesis of nanomaterials; Phase transfer for the synthesis of nanomaterials; Tools for characterizations; Nanomaterials for sustainability;	4	Prof. Jun Yang
8	**Inorganic Nanomaterials for Energy Conversion and Environmental Remediation** Fuel cells; The need for better electrocatalysts; Nanostructured electrocatalysts; Nanostructured catalysts for environmental remediation;	4	Prof. Jun Yang
9	**Inorganic Heterogeneous Nanostructures and Nanocomposites: Preparation and Applications** Heterogeneous nanostructures; Heterogeneous nanocomposites; Scientific issues derived from semiconductor-noble metal nanocomposites; The road ahead;	4	Prof. Jun Yang
10			
11	**General introduction of crystals** Definition; Classification; Preparation； Application	4	Prof. Yongsheng Han
12	**To control the formation of crystals by thermodynamics**	4	Prof. Yongsheng Han

	Thermodynamics; Interface thermodynamics; Role of thermodynamics in crystallization;		
13	**To control the formation of crystals by kinetics** Driving force of crystallization; Interface concentration; Chemical diffusion; Heat transfer; How reaction and diffusion manipulate crystallization; Interface gradient;	4	Prof. Yongsheng Han
14	**In-situ technology for dynamic structures** In-situ electron microscopy; In-situ spectroscopy; Synchrotron radiation technique; Computer simulation;	4	Prof. Yongsheng Han
15	**Advances in Crystallization** Mesoscience; Reaction-diffusion; Rational synthesis by reaction and diffusion control; Scale-up synthesis of catalysts; Batteries reaction and diffusion;	4	Prof. Yongsheng Han
total		60	

Contents of the course

Section 1: Introduction of Materials Science

1. Introduction of Materials Science: overview;
2. Materials Chemistry and Physics: developments and technologies;
3. Structural Materials
4. Functional Materials;

Section 2: Fundamentals of Materials Science

1. **Atomic Structure and Bonding:** Atomic structure; Atomic bonding;
2. **Fundamentals of Crystallography,** Space lattice; Crystal system & lattice types; Crystal structure and complex lattice;

Section 3: Inorganic nanomaterials

1. **Inorganic Nanomaterials for Sustainability,** What is nanoscale science/technology? Why nanomaterials? What kind of nanoparticles can we make? What properties of nanostructures are dependent on size? Synthesis of nanomaterials; Phase transfer for the synthesis of nanomaterials; Tools for characterizations; Nanomaterials for sustainability; Indices of crystal planes and directions;
2. **Inorganic Nanomaterials for Energy Conversion and Environmental Remediation,**

Fuel cells; The need for better electrocatalysts; Nanostructured electrocatalysts; Nanostructured catalysts for environmental remediation;

3. **Inorganic Heterogeneous Nanostructures and Nanocomposites: Preparation and Applications,** Heterogeneous nanostructures; Heterogeneous nanocomposites; Scientific issues derived from semiconductor-noble metal nanocomposites; The road ahead;

Section 4: Thermodynamics and kinetics of Materials science

Textbook and any related course material:

Expected level of proficiency from students entering the course:

Chemistry: strong,

Physics: basic

Course title

Synchrotron Radiation for Materials Science Applications

Instructor(s)-in-charge:

Dr. Yi Zhang

Course type:

Lecture

Course Schedule:

3hrs/week by instructor. 0 hr/week by teaching assistant.

Course Assessment:

Homework: 10 assignments

Grading Policy:

Typically 30% homework, 20% Student Presentation, 50% final thesis.

Course Prerequisites:

Material Science, Collage Physics.

Catalog Description:

This course is a specialized core course for graduate students majoring in material science and engineering. It introduces the theory and applications of synchrotron techniques in material characterization and research. The main contents include: the first part will be the introduction to synchrotron, neutron and XFEL sources; the second part will describe various experimental techniques based on the modern synchrotron facilities, which including X-ray scattering, diffraction, absorption, fluorescence, microscopy and coherent imaging etc.

The third part will focus on the applications of synchrotron techniques in materials science. Student will have chance to visit and carry on experiments at two synchrotron facilities in Beijing.

Schedule of the course

section	content	hours	
1	Introduction to Synchrotron and other Accelerator-based Light Sources	12	Assoc Prof. Zhe Duan
2	Visiting the High Energy Photon Source	3	Assoc Prof. Zhe Duan
3	Synchrotron Radiation Experimental Techniques	24	Assoc Prof. Yi Zhang
4	Student Presentation	3	Assoc Prof. Yi Zhang
5	Applications of Synchrotron techniques in materials science	15	Assoc Prof. Yi Zhang
6	Experiment at Beijing Synchrotron Facility	5	Assoc Prof. Yi Zhang
total		60	

Contents of the course

Chapter 1 Introduction to Synchrotron and other Accelerator-based Light Sources 错误！未定义书签。

§1.1 Synchrotron Light Sources

§1.2 X-ray Free Electron Lasers

§1.3 Spallation Neutron Sources

§1.4 Beamlines in Modern Synchrotron Sources

Chapter 2 Synchrotron Radiation Experimental Techniques

§2.1 X-ray Diffraction and Kinetic Diffraction Theory

§2.2 Small - angle X - ray scattering (SAXS) and grazing incident SAXS (GISAXS)

§2.3 X-ray Reflectivity

§2.4 X-ray Fluorescence Spectroscopy

§2.5 X - ray Absorption Fine Structure (XAFS)

§2.6 X - ray Absorption Near Edge Structure (XANES)

§2.7 Other X - ray Spectroscopy Methods

§2.8 X - ray Absorption and Phase imaging

§2.9 X - ray Coherent Diffraction Imaging

§2.10 Ptychography

§2.11 X-ray Photon Correlation Spectroscopy (XPCS)

Chapter 3 ***Applications of Synchrotron techniques in materials science***

§3.1 Photon - In Photon - Out Spectroscopic Techniques for Materials Dynamic Analysis

§3.2 X-ray Nanoprobe for High Resolution 3D structural and functional imaging of Nano Materials

§3.3 In Situ Catalytic Studies Using Synchrotron techniques

§3.4 Investigating Strain and Nanostructures of Semiconductor Materials by Coherent X - ray Diffraction

§3.5 Multiscale Imaging of Engineering Material Using Synchrotron and Neutron Sources

§3.6 X - ray Absorption Spectroscopy Study of Carbon and Silicon Nanostructures for Energy Applications

§3.7 Study of multiscale structural and mechanical properties of biomaterials

using combined SAXS/WAXD methods

§3.8 X‐ray Microscopy for Nanoscale 3D Imaging of Biological Cells and Tissues

Textbook and any related course material:

Elements of Modern X-ray Physics, Jens Als-Nielsen and Des McMorrow, (Wiley, New York, 2001).

Synchrotron Radiation in Materials Science: Light Sources, Techniques, and Applications, Volume 1, Chunhai Fan, Zhentang Zhao, (Wiley, Verlag GmbH & Co. KGaA, 2018).

An introduction to synchrotron radiation: techniques and applications, Phil. Willmott (John Wiley & Sons, 2019)

1. *Elements of X-ray Diffraction, (3rd edition), B.D. Cullity, S.R. Stock, (Springer, 2001)*
2. *X-Ray Spectroscopy, (2nd edition), Bipin K. Agarwal, (Prentice Hall, 1991)*
3. *X-ray Microscopy, Chris Jacobsen, (Cambridge University Press 2019)*

Expected level of proficiency from students entering the course:

Mathematics: Medium
Physics: Medium
Material Science: Medium

Course title

Intelligent Software Engineering

Instructor(s)-in-charge:

Prof. Tiejian Luo

Course type:

Lecture

Course Schedule:

3hrs/week by instructor. 60hrs in total.

Course Assessment:

Homework: 2 assignments and 1 project

Grading Policy:

Typically 60% homework, 40% project.

Course Prerequisites:

Data Structure, Database, Software Engineering

Catalog Description:

This course is a basic course for graduate students in computer science and technology. This course focuses on the new issues facing software engineering today and the development of new technologies to address these issues, including requirements engineering, software design, software processes, and software quality. Through this course, students will be able to fully understand the latest developments in software engineering today and enhance the ability to design actual systems.

Schedule of the course

section	content	hours
1	Software Engineering Foundation	2
2	Software Process	6
3	Software Project Management	6
4	Software Requirements Engineering	6
5	Software Design Fundamentals	6
6	Software Development Technology	6
7	Software Testing	6
8	Software Evolution	6
9	Software Reliability Technology	6
10	Project Presentation	10
total		60

Contents of the course

Chapter 1 Software Engineering Foundation (Introduce the concept and development process of software engineering concepts, analyze the nature of software development, and introduce the organizational content structure of this course around the nature of software development);

Chapter 2 Software Process (The concept of software process model, software life cycle model, such as waterfall model, spiral model, agile development model, etc.);

Chapter 3 Software Project Management (software project management basic concepts, project personnel and organization, product quality assurance, project

management process and content, familiar with the project management process and related tools through curriculum practice, create curriculum practice projects);
Chapter 4 Software Requirements Engineering (Basic Concepts of Software Requirements, Software Requirements Engineering Processes and Methods, Software Requirements Models and Requirements Specification);
Chapter 5: Software Design Fundamentals (Basic Concepts and Principles of Software Design, Software Structure and Behavior Models, Software Architecture Concepts and Models, Software Architecture Design, Object-Oriented Design Methods, and UML);
Chapter 6 Software Development Technology (Agile Software Development Method, Software Reuse, Design Pattern, Application Framework, Component-Based Software Development Method);
Chapter 7 Software Testing (Software Verification and Validation, Software Testing Basics, Software Testing Types, Software Testing Activities, Software Testing Automation, Software Reliability Verification and Protection);
Chapter 8 Software Evolution (the goal and type of software maintenance, software maintenance process, legacy system evolution technology);
Chapter 9 Software Reliability Technology (Introduction to Formal Methods, Formal Language, Software Reliability Concepts and Challenges, Software Fault Tolerance Techniques)

Textbook and any related course material:

Armando Fox, and David Patternson, Engineering software as a service, 1st edition, Strawberry Canyon LLC

Course title

Data Science

Instructor(s)-in-charge:

Prof. Tiejian Luo

Course type:

Lecture, Seminar

Course Schedule:

3hrs/week by instructor. 60hrs in total.

Course Assessment:

Homework: 3 assignments and 1 project

Grading Policy:

Typically 60% homework, 40% project.

Course Prerequisites:

Discrete Mathematics

Catalog Description:

This course is a professional seminar for graduate students in computer software and theory. Its purpose is to enable students to master the basic content of network science and understand its application fields. This course focuses on the common models of network science. The requirements for students are follows: Master the basic methods of network science including common models and algorithms; Master the main ideas of network modeling and network behavior analysis. This course enables computer graduate students to deeply grasp the scientific research trends in the direction of network science, the latest technology, and have a preliminary understanding of the application of different fields of network science. It is supposed to cultivate the research learning ability of graduate students, broaden their horizons, and lay a solid foundation for future research and application.

Schedule of the course

section	content	hours
1	Introduction to Network Science	6
2	Basic concepts of network science	6
3	Main Issues in Network Science	6
4	Discussion on the research direction of network science	6
5	Network Communication Model in Network Science	6
6	Exercise Class	6
7	Project Presentation	6
8	Project Presentation	6
9	Project Presentation	6
10	Project Presentation	6
total		60

Contents of the course

Topic 1: Introduction to Network Science
Basic concepts, development history, role and impact of network science
Topic 2: Basic concepts of network science
Graph representation of the network, computer representation of the graph, path and connectivity, spanning tree and minimum spanning tree, bipartite graph and matching problem network topology properties (node degree, average path length, clustering coefficient, degree distribution, power law distribution)
Topic 3: Main Issues in Network Science
Network science focuses on the scientific understanding of the quantitative and qualitative characteristics of complex networks. (1) structural complexity, (2) node complexity, (3) interaction between structure and nodes, and (4) interaction between networks.
Topic 4: Discussion on the research direction of network science
Reveal and describe the topological properties of network systems and the appropriate methods to measure these properties; establish network models to help people understand the meaning and mechanism of these statistical properties; predict network behavior based on the nature of individual nodes and the structural nature of the entire network; Effective methods to improve existing network performance and design new networks is proposed.
Topic 5: Network Communication Model in Network Science
Contagion model, propagation threshold analysis, communication impact analysis, complex network immunization strategies, etc.

Textbook and any related course material:

Hongsong, Chen. Networks, Crowds, and Markets: Reasoning about a Highly Connected World ,Easley, D. and Kleinberg, J., 2010

Stanford University：Analysis of Networks MINING AND LEARNING WITH GRAPHS, Stanford

Cornell University：The Structure of Information Networks, Jon Kleinberg

University of Southern California：Structure and Dynamics of Networked Information, David Kempe

University of Helsinki：Information Networks, Panayiotis Tsaparas

Course title

MATLAB with Applications to Mathematics, Science, Engineering, and Finance

Instructor(s)-in-charge:

Prof. LUO CUI CUI

Course type:

Lecture

Course Schedule:

3hrs/week by instructor.

Course Assessment:

Homework: 2 assignments,1 Midterm, 1 final project

Grading Policy:

Attendance: 15%, Homework: 40%, Midterm: 20% Project: 20%, Final presentation:5%

Course Prerequisites:

Calculus, Linear Algebra, Probability and Statistics

Catalog Description:

This course studies the design, implementation and use of computer programs to solve practical mathematical problems of relevance to health, biology, finance and risk management. This course will help develop your quantitative skills and ability to reason logically and mathematically and apply these skills to problems of relevance to social sciences. It emphasizes the importance of understanding the underlying mathematics, computational techniques and problems solving skills.

Schedule of the course

Section	Content	Hours
1	Introduction to MATLAB	3
2	Introduction to programming in MATLAB	6
3	MATLAB Programing	9
4	Plotting with MATLAB	6
5	Simulations and optimization	6
6	MATLAB applications	12
8	Student presentation	3
total		45

Contents of the course

Section 1: Introduction to MATLAB

1. Introduction to MATLAB
2. Variables and constants, operators and simple calculations
3. Vectors and matrices
4. Expressions

Section 2: Introduction to programming in MATLAB

1. Algorithms and structures
2. MATLAB scripts
3. Control structures

Section 3: MATLAB Programing

1. Personalized functions

2. Debugging techniques
3. Toolbox structure
4. Input–Output statements

Section 4: Plotting with MATLAB

1. Data import and export
2. Data visualization in both 2D and 3D

Section 5: Simulations and optimization

1. Numerical simulations
2. Simple optimization problems

Section 6: MATLAB applications in Statistics, Finance, Machine learning

1. Application in Statistics
2. Application in Finance
3. Machine learning

Textbook and any related course material:

MATLAB help, https://www.mathworks.com/help/

Expected level of proficiency from students entering the course:

Mathematics: moderate

Statisticss: moderate

Course title

Digital Image Processing

Instructor(s)-in-charge:

Prof. WANG Weiqiang

Course type:

Lecture

Course Schedule:

4hrs/week by instructor. 1 hr/week by teaching assistant.

Course Assessment:

Homework: 10 assignments

Grading Policy:

Typically 60% homework, 10% attendances; 30% final Open-book exam.

Course Prerequisites:

advanced mathematics, linear algebra，probability theory and statistics

Catalog Description:

This course is for graduate students majoring in computer science, Automatic control and electronic engineering. This course teaches classical methods of image processing and analysis, including the main concepts, algorithm ideas and classical image processing and analysis techniques. The main contents include image model, image spatial and frequency processing technology, image restoration, color image processing, wavelet analysis and multi-resolution analysis technology, morphological processing, image coding, edge detection and shape description, etc.

Through learning this course, students are expected to understand the basic concept of image processing and classic algorithms, so that they can lay a solid foundation for further learning machine vision and image understanding. The practice of the Matlab language can validate the learned content, deepen their understanding and flexible application of knowledge, improve students good hands-on practice and research ability.

Schedule of the course

section	content	hours
1	Introduction and Matlab tutorial	
2	image spatial processing technology	
3	image frequency processing technology	
4	image restoration	
5	color image processing	
6	wavelet analysis and multi-resolution analysis technology	
7	morphological processing	
8	image coding	
9	edge detection and shape description	
total		40

Contents of the course

Chapter 1 introduction

1.1 course introduction: course objectives, examination and assessment

methods, course assignment requirements, etc

1.2 teaching content and schedule

Chapter 2 MATLAB language and image processing toolkit quick tutorial

2.1 the Matlab language

2.2 basic correlation function of image processing-related toolbox,

(the teaching of the following chapters will be accompanied by the realization of matlab while teaching theoretical knowledge.)

Chapter 3 image spatial processing - image enhancement.

3.1 brightness transformation (power transformation, piecewise linear change, logarithmic transformation, etc.)

3.2 histogram equalization and histogram matching

3.3 analysis and understanding of convolution and correlation calculation, convolution and linear shift-invariant system

3.4 smooth linear filter

3.5 statistical sorting filter

3.6 sharpening filter (Laplace filter enhanced, gradient method enhanced).

Chapter 4 Fourier transform and frequency processing technology

4.1 Fourier positive and negative transformation and its origin

4.2 properties of Fourier transform

4.3 the relationship between spatial filtering and frequency filtering,

4.4 some problems in engineering implementation (filling, numerical type, error of inverse transformation)

4.5 low-pass smoothing filter (ideal, butterworth, gauss)

4.6 sharpening smoothing filter (ideal, butterworth, gauss)

4.7 homomorphic filter.

Chapter 5 image noise modeling and image recovery technology.

5.1 image degradation and recovery process model

5.2 noise model (several noise models with independent and identical distribution, periodic noise)

5.3 construction and implementation of general random noise generator

5.4 estimation of noise parameters

5.5 restoration of spatial filtering in the presence of noise (mean value filter, statistical sorting filter, adaptive filter)

5.6 frequency-domain filters for periodic noise (band-stop filter, band-pass filter, notch filter, notch filter)

5.7 estimation of degenerate functions (observational method, experimental method, model method)

5.8 the inverse filtering

5.9 wiener filtering

5.10 constrained least squares filter

5.11 geometric mean filtering

5.12 geometric transformation (spatial variation, grayscale interpolation).

Chapter 6 color space and color image processing

6.1 what is color

6.2 color expression and measurement experiments

6.3 common color space (RGB, CMY, YCbCr, YUV,HIS,HSV, Lab,Luv)

6.4 full-color image processing (histogram processing, smoothing and sharpening of color images, color segmentation).

Chapter 7 perfect reconstruction filter, multi-resolution analysis and wavelet transform

7.1 image pyramids

7.2 perfect reconstruction filter

7.3 haar transformation

7.4 multi-resolution analysis theory (sequence expansion, scaling function, wavelet function)

7.5 one-dimensional wavelet transform (sequence expansion, discrete wavelet transform, continuous wavelet transform)

7.6 fast wavelet transform

7.7 two-dimensional wavelet transform (sequence expansion, discrete wavelet transform)

7.8 wavelet packet

Chapter 8 overview of information theory and image compression

8.1 basic principles and concepts of image compression

8.2 source coding and channel coding

8.3 basic knowledge of information theory (information quantity, entropy, conditional entropy, mutual information, channel capacity)

8.4 DCT transformation and other image transformation.

Chapter 9 morphological image processing

9.1. Background knowledge

9.2 expansion and corrosion

9.3 open and closed operations

9.4 hit and miss transform

9.5 some basic morphological algorithms

Chapter 10 image segmentation and edge detection (3 periods)

10.1 filter with point and line detection

10.2 Canny edge detection algorithm

10.3 corner detection algorithm

10.4 Hough transform

10.5 watershed segmentation algorithm

10.6 shape representation (Fourier descriptor, invariant moment descriptor)

Textbook and any related course material:

Text books*:*

1. Rafael C.Gonzalez, Richard E. Woods, digital image processing (3rd Ed.), electronic industry press, 2017.

2. Rafael c. nelson, Richard e. Wilson, Steven l. nelson, digital image processing (MATLAB) (version 1/2), electronics industry press, April 2013.

Related referencess:

1. David a. Forsyth, Jean Ponce, computer vision - A modern approach (2nd Ed.),

electronic industry press, June 2017
2. Some papers.
Expected level of proficiency from students entering the course:
advanced mathematics: basic
linear algebra: basic
probability theory and statistics: basic

Course title

Multiphase Reactor Theory and Analysis

Instructor(s)-in-charge:

Prof. Xiaoxing Liu & Prof. Bona Lu

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 27 hrs in total by Prof. Xiaoxing Liu; 27 hrs in total by Prof. Bona Lu.

Course Assessment:

Homework: 4~6 assignments

Grading Policy:

Typically 40% homework, 30% attendances; 30% final presentation.

Course Prerequisites:

Be familiar with the basic knowledge of multi-phase (gas, liquid, solid) system and transport phenomena. Be interested in the handling and applications of gas-solid system.

Catalog Description:

Reactors involving multiphase flow (gas-liquid, gas-solid, liquid-solid, gas-liquid-solid) are commonly encountered in a variety of chemical engineering processes. For the proper design, operation and optimization of chemical reactors handling multiphase flows, it is critical to get a basic understanding of the hydrodynamic, mass- and thermal transfer, and reaction characteristics of multi-phase systems. This course will be started with basic knowledge of chemical reaction theory, followed by a general introduction of the characterization and classifications of multi-phase flow phenomena. The heaviest parts of this course will be contributed to the introduction of the hydrodynamic, mixing and heat transfer phenomena occurred in the gas-solid fluidized bed reactors, the related measurement techniques and instrumentation, and typical applications of fluidized bed reactors. Technologies of numerical modelling of multiphase reactors will also be addressed and discussed. The course is structured as a series of lectures and mini-seminars in which individual research cases are discussed with faculty tutors. It will cover the following topics:

Schedule of the course

section	content	hours	
1	**Mole Balances—part 1** General introduction of Multiphase reactors; Reaction kinetics; Definition and characterization of reaction rate;	3	Prof. Xiaoxing Liu
2	**Mole Balances – part 2** Derivation of conservation equations; Applications of mole balance equations to typical ideal reactors.	3	Prof. Xiaoxing Liu
3	**Conversion Rate and Reactor Sizing**	3	Prof. Xiaoxing

	Design equations for typical ideal reactors; Reactor sizing; Arrangement optimization of multi-reactors		Liu
4	**Residence Time Distributions of Chemical Reactors** Functionality of residence time; Measurements of RTD; RTD of typical ideal reactors; Diagnostics and Troubleshooting through RTD	3	Prof. Xiaoxing Liu
5	**Diffusion and Reaction** Derivation of Mass balance equation; Fluid-particle Inter-phase mass transfer; Applications in fixed bed reactor	3	Prof. Xiaoxing Liu
6	**Fluidized Bed — A General Review, part 1** Principle of fluidization; Typical applications of fluidization technology; Components of fluidized bed Fundamentals of fluidization	3	Prof. Xiaoxing Liu
7	**Fluidized Bed — A General Review, part 2** General review of the flow regimes of fluidization and their characteristics: from bubbling to fast fluidization	3	Prof. Xiaoxing Liu
8	**Fluidized Bed: Powders and Grains part 1** Geldart particle classification; Particle characterization: size and density	3	Prof. Xiaoxing Liu
9	**Fluidized Bed: Powders and Grains part 2** Definitions and Measurements of particle size; Forces experienced by particles in multi-phase systems	3	Prof. Xiaoxing Liu
10	**Dense Fluidization—01** Definition of dense fluidization, introduction of typical fluidization flow regimes, like bubbling fluidization. Introduction of use of distributor in dense fluidization.	3	Prof. Bona Lu
11	**Dense Fluidization—02** Introduce the features of bubbling fluidization, related models, the normal Features of bubbling fluidization, bubble size models, abnormal state and the special	3	Prof. Bona Lu

	type of fluidized bed reactor.		
12	**Dense Fluidization—03** Introduce another dense fluidized bed -turbulent fluidized bed, the difference in entrainment and elutriation, how to relate the fluidization features and reactor design, and typical applications of dense fluidized bed.	3	Prof. Bona Lu
13	**Dilute Fluidization** Introduce the circulating fluidized bed (CFB), the fast fluidization and related modeling	3	Prof. Bona Lu
14	**Heat Transfer** Introduce different modes of heat transfer and related models	3	Prof. Bona Lu
15	**Mass Transfer** Introduce different modes of mass transfer (e.g., diffusion, convection), and related models of mass transfer in fluidization	3	Prof. Bona Lu
16	**Other types of multiphase reactors** Introduce other types of widely used multiphase reactors, like trickle bed reactors, micro fluidized bed	3	Prof. Bona Lu
17	**Design Criteria and Simulation tools** Introduce different considerations of reactor design criteria, simulation approaches and related analysis for reactor design.	3	Prof. Bona Lu
total		51	

Contents of the course

Section 1: Mole Balances—part 1

1. General introduction of Multiphase reactors;
2. Reaction kinetics;
3. Definition and characterization of reaction rate;

Section 2: Mole Balances – part 2

1. Derivation of conservation equations;
2. Applications of mole balance equations to typical ideal reactors.

Section 3: Conversion Rate and Reactor Sizing

1. Design equations for typical ideal reactors;
2. Reactor sizing;
3. Arrangement optimization of multi-reactors

Section 4: Residence Time Distributions of Chemical Reactors

1. Functionality of residence time;
2. Measurements of RTD;
3. RTD of typical ideal reactors;
4. Diagnostics and Troubleshooting through RTD

Section 5: Diffusion and Reaction

1. Derivation of Mass balance equation for heterogeneous system;
2. Fluid-particle Inter-phase mass transfer;
3. Applications in fixed bed reactor

Section 6: Fluidized Bed — A General Review, part 1

1. Principle of fluidization;
2. Typical applications of fluidization technology;
3. Components of fluidized bed
4. Fundamentals of fluidization

Section 7: Fluidized Bed — A General Review, part 2

General review of the flow regimes of fluidization and their characteristics: from bubbling to fast fluidization

Section 8: Fluidized Bed: Powders and Grains part 1

1. Geldart particle classification;
2. Particle characterization: size and density

Section 9: Fluidized Bed: Powders and Grains part 2

1. Definitions and Measurements of particle size;
2. Forces experienced by particles in multi-phase systems

Section 10: Dense Fluidization-part 01

1. General introduction
2. Homogeneous fluidization
3. Bubbling fluidization
4. Introduction of distributor

Section 11: Dense Fluidization-part 02

1. Features of bubbling fluidization, bubble size models
2. Slugging
3. Spouted bed

Section 12: Dense Fluidization-part 03

1. Turbulent fluidized bed
2. Entrainment and Elutriation
3. Application of dense fluidized bed

Section 13: Dilute Fluidization

1. Circulating fluidized bed (CFB)
2. Modeling of Fast fluidization: steady state
3. Modeling of fast fluidization: interphase drag
4. Application of fast fluidization

Section 14: Heat Transfer

1. Modes of heat transfer
2. Models of heat transfer

Section 15: Mass Transfer

1. Diffusion
2. Mass transfer in fluidization

Section 16: Other types of multiphase reactors

1. Micro fluidized bed
2. Trickle bed reactors

Section 17: Design Criteria and Simulation tools

1. Design considerations
2. Simulation approaches and related analysis

Textbook and any related course material:

1. *Fogler H. Scott, Elements of chemical reaction engineering, 2016*
2. *Principles of gas-solid flows. Fan Liang-Shi, Zhu Chao. Cambridge University Press. 1998*
3. *Octave Levenspiel. Tracer Technology. Springer, 2012*
4. *Yang, W.-C., Handbook of Fluidization and Fluid-Particle Systems. Marcel-Dekker, 2003.*
5. *Crowe CT. Multiphase Flow Handbook. CRC Press, 2006.*

Expected level of proficiency from students entering the course:

Be familiar with the basic knowledge of multi-phase (gas, liquid, solid) system and transport phenomena.

Course title

Chemical Process Safety

Instructor(s)-in-charge:
Prof. Ning Yang, Associate Prof. Xiaoping Guan
Course type:
Lecture
Course Schedule:
3hrs/week by instructors. 40 hrs in total by Prof. Ning Yang; 20 hrs in total by Assoc Prof. Xiaoping Guan.
Course Assessment:
Homework: ~3 assignments
Grading Policy:
Typically 30% attendances,30% homework, 40% final exam
Course Prerequisites:
general chemistry, chemical reaction engineering
Catalog Description:
The primary objective of this course is to present the important technical fundamentals and case studies of chemical process safety, and help students to understand the concepts and apply them accordingly. The application requires a significant quantity of fundamental knowledge and technology, integrating different aspects of knowledge on chemistry, chemical engineering and fluid mechanics. This course then aims to provide the base by integrating and applying these various aspects of knowledge in chemical process safety.
Schedule of the course

section	content	hrs	
1	**Introduction to Chemical Process Safety**	4	*Prof. Ning Yang*
2	**Toxicology**	3	*Prof. Ning Yang*
3	**Industrial Hygiene**	3	*Prof. Ning Yang*
4	**Exercises** about the fatal accident rate, toxicology, industrial hygiene.	3	Assoc Prof. *Xiaoping Guan*
5	**Source models**	5	*Prof. Ning Yang*
6	**Toxic Release and Dispersion Models**	5	*Prof. Ning Yang*
7	**Exercises** about the source models, toxic release and dispersion models.	3	*Assoc Prof. Xiaoping Guan*
8	**Fires and Explosions**	5	*Prof. Ning Yang*
9	**Concepts to Prevent Fires and Explosions**	5	*Prof. Ning Yang*
10	**Exercises** about fires and explosions, the concepts to prevent fires and explosions.	3	*Assoc Prof. Xiaoping Guan*
11	**Chemical Reactivity**	5	*Prof. Ning Yang*
12	**Exercises** about chemical reactivity.	3	*Assoc Prof. Xiaoping Guan*
13	**Introduction to Reliefs**	3	*Assoc Prof. Xiaoping Guan*

14	**Relief Sizing**	4	*Prof. Ning Yang*
15	**Exercises** about reliefs and relief sizing; Final exam instructions.	3	*Assoc Prof. Xiaoping Guan*
16	**Exam** Open-book exam	3	*Prof. Ning Yang* *Assoc Prof. Xiaoping Guan*
Total		60	

Contents of the course

Section 1: Introduction to Chemical Process Safety

1. Safety Programs, Engineering Ethics, Public Perceptions
2. Accident, Loss Statistics, Acceptable Risk and Seven Significant Disaster

Section 2: Toxicology

1. Effects of Toxicants on Biological Organisms
2. Models for Dose and Response Curves
3. Relative Toxicity and Threshold Limit Values
4. Toxic Effect Criteria and Release Mitigation

Section 3: Industrial Hygiene

1. Government Regulations
2. Industrial Hygiene: Anticipation and Identification
3. Industrial Hygiene: Evaluation
4. Industrial Hygiene: Control

Section 4: Source Models

1. Introduction to Source Models
2. Flow of Liquid through Holes and pipes
3. Flow of Gases or Vapors through Holes and Pipes
4. Flashing Liquids
5. Liquid Pool Evaporation or Boiling
6. Conservative Analysis

Section 5: Toxic Release and Dispersion Models

1. Parameters Affecting Dispersion
2. Neutrally Buoyant Dispersion Models
3. Dense Gas Dispersion
4. Dense Gas Transition to Neutrally Buoyant Gas
5. Toxic Effect Criteria
6. Release Mitigation

Section 6: Fires and Explosions

1. Definitions, Concepts and Distinction between Fires and Explosions
2. The Fire Triangle, Autoignition, Auto-Oxidation, Adiabatic Compression
3. Flammability Characteristics of Liquids and Vapors
4. Limiting Oxygen Concentration and Inerting
5. Explosions

Section 7: Concepts to Prevent Fires and Explosions

1. Inerting
2. Static Electricity
3. Controlling Static Electricity
4. Explosion-Proof Equipment and Instruments
5. Ventilation

Section 8: Chemical Reactivity

1. Background Understanding
2. Commitment, Awareness, Identification and Control of Reactive Chemical Hazards
3. Characterization of Reactive Chemical Hazards Using Calorimeters
4. Controlling Reactive Hazards

Section 9: Introduction to Reliefs

1. Concepts, Definitions, Types and Characteristics of Reliefs
2. Relief Scenarios
3. Data for Sizing Reliefs
4. Relief Systems

Section 10: Relief Sizing

1. Conventional Spring-Operated Reliefs
2. Rupture Disc Reliefs
3. Two-Phase Flow during Runaway Reaction Relief
4. Pilot-Operated and Bucking-Pin Reliefs
5. Venting for Fires External to Process Vessels
6. Reliefs for Thermal Expansion of Process Fluids

Textbook and any related course material:

Daneil A. Crowl, Chemical Process Safety: Fundamentals and Applications, 2011, Prentice Hall

Roy E. Sanders, Chemical Process Safety: Learning from Case Histories, 2005, Elsevier Butterworth–Heinemann.

Expected level of proficiency from students entering the course:

Mathematics: intermediate

Chemistry: intermediate

Course title

Environmental and Natural Resource Economics

Instructor(s)-in-charge:

Prof. DENG Xiangzheng, Prof. LIU Yuexian, Dr. LI Zhihui, Dr. Zhang Fan

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 1 hr/week by teaching assistant.

Catalog Description:

The Environmental and Natural Resource Economics course is designed for research postgraduates in Environmental Sciences field. The class will give students a general view of environmental and natural resource economics and some detailed development in certain selected areas. As a course for research students, a mini-seminar series are incorporated into the course to provide examples for researches carried out in respective fields. This course covers the components of the environmental economics and natural resource utilization analysis and research, their key definitions and research approaches, economics of natural science based environmental changes and assessment, natural resources categories and their scientific issues, issue-oriented analysis and discussion of environmental justice and sustainable development, etc. The course is structured as a series of lectures and mini-seminars, in which individual research cases are discussed with faculty tutors. It will cover the following topics:

Schedule of the course

Section	Content
1	**The Economic Approach** 1.1 The Human–Environment Relationship: -the role of economics; -studying human behavior in a laboratory; -the environment as an asset. 1.2 Environmental Problems and Economic Efficiency: -property rights and efficient market allocation; -improperly designed property rights systems; -the pursuit of efficiency. 1.3 Externalities as a Source of Market Failure: -public goods; -imperfect market structures; -government failure; -an efficient role for government.
2	**Evaluating Trade-Offs** 2.1 Normative Criteria for Decision Making: -pollution control; -preservation *versus* development; -issues in benefit estimation. 2.2 Approaches to Cost Estimation: -the Treatment of Risk; -distribution of benefits and costs; -choosing the discount rate; -divergence of social and private discount rates; -cost-effectiveness analysis; -impact analysis.

	2.3 Valuing the Environment: -identification of types of values of environment; -classification of valuation methods; -preference based models (stated preference, revealed preference, travel cost, hedonic property and wage, averting expenditure). 2.4 GIS based modeling works: -examples and practices.
3	**Dynamic Efficiency and Sustainable Development** 3.1 Efficiency vs Equality: -a two-period model; -defining intertemporal fairness; -efficient allocations and sustainability criterion. 3.2 Sustainable Development: -market allocations; -efficiency and sustainability; -trade and environment. 3.3 Environmental Policy for Sustainable Development: -implications for environmental policy; -depletable resource allocation; -efficient intertemporal allocation; -market allocation of depletable resource.
4	Student presentations and discussions
5	**Replenishable but Depletable Resources: Water** 5.1 The Potential for Water Scarcity: -the efficient allocation of scarce water; -water transfers; -water markets; -water prices; -GIS and water resource. 5.2 Watershed based efficiency and cost-effectiveness: -nature of water pollution problem; -water pollution control. 5.3 Mini-seminars: -group discussions
6	**A Locationally Fixed, Multipurpose Resource: Land** 6.1 The Economics of Land Allocation: -land use; -land use conversion; -examples and practices. 6.2 Efficiency of land use: -sources of inefficient use and conversion; -innovative market-based policy remedies; -establishing property rights; -transferable development rights. 6.3 Mini-seminars: -group discussion.
7	**Reproducible Private Property Resource: Agriculture and Food Security** 7.1 Global Scarcity and food security: -outlook for the future; -the role of agricultural policies; -distribution of food resource. 7.2 Climate changes and food security: -feast and famine cycles; -examples and summary,

	7.3 Mini-seminars: -group discussion.
8	Student presentations and discussions
9	**Land Storable, Renewable Resources: Forests** 9.1 Sources of Inefficiency: -perverse incentives for the landowner and nations; -poverty and debt; -sustainable forestry. 9.2 Public Policy: -carbon sequestration credits; -REDD. 9.3 Mini-seminars: -group discussion.
10	**Economics of Pollution Control** 10.1 The Efficient Allocation of pollution: -a pollutant taxonomy; -market allocation of pollution; -efficient policy responses. 10.2 Policy Analysis: -cost-effective policies for uniformly mixed fund pollutants: -cost-effective policies for nonuniformly mixed surface pollutants: -responses to changes in the regulatory environment; -price volatility; -instrument choice under uncertainty; -product charges as an indirect form of environmental taxation. 10.3 Air Pollutions: -conventional pollutants; -cost-effectiveness of the command-and-control approach; -innovative approaches; -regional pollutants. 10.4 Mini-seminars: -group discussion.
11	Student presentations and discussions
12	**Course conclusion and discussion**
13	**Final Exam**
Total	

Course title

Environmental Chemistry

Instructor(s)-in-charge:

Prof. Zhen-Yu Tian

Teaching objectives, requirements:

This course introduces chemical principles and concepts and applies them to relevant environmental situations and problems. The course includes an introduction to environmental science, technology and chemistry, basic chemical concepts; atmospheric chemistry and its pollution; toxicological chemistry of chemical substances; water chemistry; geosphere and geochemistry; soil environmental chemistry; and principles of industrial ecology. Through this course, students will become familiar with the basic chemical principles of environmental science, technology and chemistry.

Course Prerequisites:

College Chemistry, College Mathematics

Target group:

Masters and PhD students

Course type:

Lectures, discussions

Schedule of the course

section	Chapter name	Chapter Hours	sub-sections	Subsection name	Section hours
1	What is environmental science	1	1	Definition environmental chemistry	0.5
			2	The mission of environmental chemist	0.5
2	Some basic chemical concepts	4	1	Phase of matter	0.5
			2	Structure of matter	0.5
			3	Periodic table	1
			4	Gas Laws	1
			5	Thermal properties	1
3	Atmospheric pollution	4	1	Gases oxides	1
			2	Hydrocarbons	1
			3	Photochemical smog	1
			4	Greenhouse effect	1
4	Structure and composition	4	1		4
5	Circles, radicals and ozone	4	1		4
6	Oxidation and reduction	4	1		4

section	Chapter name	Chapter Hours	sub-sections	Subsection name	Section hours
7	Phase interactions	3	1		3
8	Aquatic microbial biochemistry	3	1		3
9	Water pollution	3	1		3
10	Water treatment	3	1		3
11	The atmosphere and atmospheric chemistry	3	1		3
12	Particles in the atmosphere	4	1		4
13	Gaseous inorganic air pollutants	4	1		4
14	Organic air pollutants	5	1		5
15	Photochemical smog	5	1		5
16	The geosphere and geochemistry	3	1		3
17	Soil environmental chemistry	3	1		3

Assessment methods:

Open-book examinations

Textbooks:

None

Reference books:

None

List of book writing members:

Course title

Advanced Diagnostic Technologies of Chemical Reactions and Its Application

Instructor(s)-in-charge:

Prof. Zhen-Yu Tian

Teaching objectives, requirements:

This course focuses on the advanced diagnostic principles of homogeneous and non-homogeneous chemical reactions, with particular reference to the application of these diagnostic methods in the chemical and environmental fields. The course will provide a detailed introduction to spectrophotometry, electrochemical analysis, chromatography and mass spectrometry, and their applications to gas, liquid and surface reactions. In addition, theoretical calculations and kinetic modelling will be presented to further improve understanding of homogeneous and non-homogeneous reactions.

Course Prerequisites:

College Chemistry

Target group:

Masters and PhD students

Course type:

Lectures, discussions

Schedule of the course

section	Chapter name	Chapter Hours	sub-sections	Subsection name	Section hours
1	Overview	7	1	Introduction	1
			2	Main works of advanced diagnostics	1
			3	Classification	1
			4	Invasive techniques	2
			5	Noninvasive techniques	2
2	Gas Chromatography/Mass Spectrometry	6	1	Introduction	1
			2	Theory	1
			3	Literature review	1
			4	Recent applications of GC/MS	2
			5	Outlook	1
3	Combustion Characteristics of Fossil Fuels by Thermal Analysis Methods	9	1	Introduction	1
			2	Classificatoini of Thermal analysis	1
			3	Important terminologies used in thermal analysis	1
			4	Thermogravimetry	1
			5	Differential thermal	1

section	Chapter name	Chapter Hours	sub-sections	Subsection name	Section hours
				analysis (DTA)	
			6	Differential scanning calorimetric (DSC)	1
			7	Simulataneous Technique	1
			8	Applications	2
4	Gas Potentiometry	6	1	Introduction	1
			2	Theoretical foundations of gas potentiometry	1
			3	GOP materials, design, and systems	1
			4	Analysis and characterization of gaseous and liquid fuel combustion	1
			5	Analysis and characterization of solid fuel conversion	1
			6	Applications with potential for development	1
5	Raman Scattering Diagnostics	7	1	Introduction	1
			2	Theory of SRS signal estimation	1
			3	Current status in multiscalar diagnostics	1
			4	Excitation system	1
			5	Spectroscopy system	1
			6	Data reduction	1
			7	Flow controller system design	1
6	CARS Spectroscopy	13	1	Introduction	1
			2	Theory	1
			3	Interpretation of CARS spectra	1
			4	Principle of CARS	1
			5	Molecular Parameters	1
			6	Instrumentation	1
			7	Experimental setup	1

section	Chapter name	Chapter Hours	sub-sections	Subsection name	Section hours
			8	Commonly used CARS microspectroscopy schemes	1
			9	Phase matching	1
			10	Fast CARS	1
			11	Typical examples	1
			12	General applications	1
			13	Advantages and disadvantages of CARS	1
7	Laser-Induced Fluorescence	12	1	Introduction	1
			2	Theory	1
			3	LIF applications	1
			4	LIF of reaction species	1
			5	Metal salts	1
			6	Inorganic molecules	1
			7	Organic molecules	1
			8	Aliphatic molecules	1
			9	High-speed LIF	1
			10	Combined LIF techniques	1
			11	Excitation sources	1
			12	Detection strategies	1

Assessment methods:

Open-book examinations

Textbooks:

None

Reference books:

None

List of book writing members:

Course title

Advanced Physical/Chemical Water Treatment

Instructor(s)-in-charge:

Prof. Chao LIU, Prof. Huiyu DONG, & Prof. Mengkai LI

Course type:

Lecture

Course Schedule:

6 h/week by instructor.

Course Assessment:

Homework: 5 assignments

Grading Policy:

Typically 25% homework, 25% presentation, 50% final.

Course Prerequisites:

General Chemistry,

Catalog Description:

Environmental engineering helps improve people's way of life and the world as a whole. Essentially, it improves processes in the environment that are very fundamental to life. One area of focus is advanced water treatment processes, which help streamline how water is obtained and used. The Advanced Physical/Chemical Water Treatment course aims to equip participants with the necessary competencies and skills in advanced technologies. Participants will have a better understanding of water quality testing and monitoring with respect to emerging chemical and biological contaminants, water and used water treatment technologies. Participants will also acquire knowledge on how to evaluate performance of the current plants and works, identify potential problems and take corrective actions.

Schedule of the course

Section	Content	Hours
1	Introduction	3
2	Part 1: Water Quality	6
3	Part 2: Water treatment principle	9
4	Part 3: Physical Separation	12
5	Part 4: Physical/Chemical Treatment	15
6	Part 5: Disinfection products, distribution, and management	12
7	Presentation	3
Total		60

Contents of the course

Part 1: Water Quality

1. Physical and chemical quality of water
2. Microbiological quality of water
3. Water quality management strategy

Part 2: Water Treatment Principles

- Principles of Chemical Reactions
- Principles of Reactor Analysis and Mixing

- Principles of Mass Transfer
- Chemical Oxidation and Reduction

Part 3: Physical Separation

- Coagulation and floccuation
- Gravity Separation
- Granular Filtration/Biofiltration
- Membrane Filtration

Part 4: Physical/Chemical Treatment

- Adsorption
- Ion Exchange
- Air Stripping and Aeration
- Advanced Oxidation
- Disinfection

Part 5: Disinfection products, distribution, and management

- Disinfection/Oxidation By-products
- Removal of Selected Constituents
- Residuals Management
- Internal Corrosion of Water Conduits
- Synthesis of Treatment Trains

Textbook and any related course material:
MWH's Water Treatment: Principles and Design, Third Edition. John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe and George Tchobanoglous

Expected level of proficiency from students entering the course:
Mathematics: strong
Chemistry: strong

Course title

Water Chemistry

Instructor(s)-in-charge:

Prof. Chao LIU, Prof. Huiyu DONG, & Prof. Mengkai LI

Course type:

Lecture

Course Schedule:

6 h/week by instructor.

Course Assessment:

Homework: 5 assignments

Grading Policy:

Typically, 25% homework, 25% presentation, 50% final.

Course Prerequisites:

General Chemistry, Physical Chemistry

Catalog Description:

Advanced Water Chemistry is a core course in the Environmental Science and Engineering program. It provides a thorough understanding of the fundamentals of water chemistry to our incoming cohorts of students. This course details the quantitative treatment of chemical processes in aquatic systems such as lakes, oceans, rivers, estuaries, groundwaters, and wastewaters. It includes a brief review of chemical thermodynamics that is followed by discussion of acid-base, precipitation-dissolution, coordination, and reduction-oxidation reactions. Emphasis is on equilibrium calculations as a tool for understanding the variables that govern the chemical composition of aquatic systems and the fate of inorganic pollutants.

Schedule of the course

Section	Content	Hours
1	Basics of Water Chemistry	3
2	Part 1: Chemical Reactivity, Reactions, and Equilibrium	6
3	Part 2: Reaction Kinetics and the Kinetics-based Interpretation of Equilibrium	6
4	Part 3: Acid-base Chemistry	9
5	Part 4: Titrations and Buffers	3
6	Part 5: Gas/liquid Equilibrium	3
7	Part 6: Complexation, Precipitation, and Dissolution	9
8	Part 7: Redox Chemistry	9
9	Part 8: Adsorption Reactions	3
10	Part 9: Photo Chemistry	6
11	Presentation	3
Total		60

Contents of the course

Part 1: Chemical Reactivity, Reactions, and Equilibrium

1. Overview
2. Characterizing Chemical Reactivity
3. Predicting Activity Coefficients from Knowledge of the Solution Composition
4. The Activity as an Intensive Property; The Activity of Solids Dispersed in Water
5. Models of Chemical Equilibrium
6. Effect of Temperature on the Equilibrium Constant

Part 2: Reaction Kinetics and the Kinetics-based Interpretation of Equilibrium

1. A Molecular-level picture of an elementary reaction and factors that affect its rate
2. Effect of temperature on reaction rate constants
3. The kinetics of some important categories of environmental chemical reactions
4. Kinetics of elementary chemical reactions
5. Reaction reversibility and the definition of the equilibrium constant
6. Effect of temperature on the equilibrium
7. Combining chemical reactions: Kinetics and equilibrium constants of nonelementary reactions
8. Experimental evaluation of reaction kinetics
9. Rate-limiting steps and some classical, model reaction pathways
10. Heterogeneous (phase-transfer) reactions

Part 3: Acid-base Chemistry

1. Stability Diagrams
2. Use of Log C-pH Diagrams and the TOTH Equation

Part 4: Titrations and Buffers

1. Reactions Occurring During a Titration: Qualitative considerations
2. Quantitative Interpretation of Titration Data
3. Titrations with Weak Acids or Bases
4. The Effect of the Acidity of Water Titration Curves
5. Titration of Solutions Containing Unknown Acids and Bases
6. Titration Equivalence Points
7. Alkalinity and Acidity
8. Acid/Base Titrations of Natural Organic Matter
9. Buffers

Part 5: Gas/liquid Equilibrium

1. Basic concepts and terminology for gas/liquid equilibrium
2. Effect of gas/liquid equilibration on gas-phase composition
3. Factors affecting volatility and henry's constant
4. Henry's law and aqueous-phase speciation
5. CO2 dissolution, alkalinity, and acidity

Part 6: Complexation, Precipitation, and Dissolution

1. Complexation
2. Precipitation
3. Dissolution

Part 7: Redox Chemistry

1. Determining oxidation numbers
2. Balancing redox reactions
3. Redox half-reactions
4. The activity of free electrons; equilibrium constants for redox half-reactions
5. Definition of e° and pe°
6. Computing pe from species activities: the Nernst equation
7. Combining redox reactions
8. Redox speciation and logC-pe diagrams
9. Similarities between acid/base and redox systems
10. Redox reactions involving exchange of both electrons and protons
11. Computing equilibrium speciation in redox systems
12. Oxidation and reduction of water
13. Energy changes accompanying redox reactions
14. Redox titrations and the geochemical redox sequence
15. pe-pH predominance area diagrams
16. Redox reactions and electrochemistry

Part 8: Adsorption Reactions

1. Introduction of Adsorption Reactions
2. Two views of the interface and adsorption equilibrium
3. Quantitative representations of adsorption equilibrium: the adsorption isotherm
4. Adsorption of ions in the presence of a surface electrical potential
5. Surface precipitation
6. Activated carbon adsorption

Part 9: Photochemistry

1. Introduction
2. Light fundamentals
3. Measurement of light
4. Photoreactions
5. Photoreactants
6. Photochemical reactions in atmospheric Waters
7. Heterogeneous photochemistry
8. Photochemistry in water treatment

Textbook and any related course material:

Mark Benjamin, Water Chemistry, Second Edition, Waveland Press, Inc.; 2nd edition (September 25, 2014), ISBN-10 : 147862308X

Stumm, Werner, and James J. Morgan. Aquatic Chemistry. New York, NY: Wiley-Interscience, 1996. ISBN: 0471511854.

Anderson, G. W. Thermodyanmics of Natural Systems. New York, NY: Wiley-Interscience, 2005. ISBN: 0521847729.

Expected level of proficiency from students entering the course:
Mathematics: strong
Chemistry: strong

Course title:

Global Environment Outlook

Instructor(s)-in-charge:

Prof. JIA Gensuo & Prof. XU Xiyan

Course type:

Lecture

Course Schedule:

3hrs/week by instructors. 20 hrs in total by Prof. JIA Gensuo; 20 hrs in total by Prof. XU Xiyan.

Course Assessment:

Homework: 3 assignments

Grading Policy:

Typically 50% homework, 20% attendances; 30% final presentation.

Course Prerequisites:

Environmental Science

Catalog Description:

The state of the global environment is the results of geodynamics, biological, physical, and chemical changes driven by the interaction between human activities and natural processes. The rapid environmental changes have brought many negative effects and posed threat to human well-being. The global policymakers and environmental governance institutions have made great efforts in formulating and implementing sustainable socio-economic development strategies as well as environmental protection policies. This course introduces latest assessment of UNEP Global Environment Outlook (GEO), and focuses on the state, drivers, trends and outlook of the global environment. It also covers policy options for global environmental protection and governance, as well as future outlook. Students are expected to better understand the state and trends of the global and regional environment, and learn the latest progresses in environmental sciences and policies.

Course contents and arrangement:

No.	Section	Contents	hrs	Lecturer
1	Introduction to Global Environment Outlook	Objectives and outlines, key environmental issues, UNEP assessment of global environment – drivers, status, policy, and outlook.	3	JIA Gensuo
2	State of the environment	**Terrestrial environment**: Global land resources and status, land use and management, degradation.	3	XU Xiyan
		Fresh water: Global water quality and water security, water management policies and outlook.	3	XU Xiyan
		Marine and coastal environment: Environmental state and pressures of global oceans and offshore as well as policy response.	3	JIA Gensuo

		Atmospheric environment: Introduce the problems, factors, and policies of global atmospheric environment.	3	XU Xiyan
		Biodiversity: Patterns and dynamics of global biological diversity, protection, challenges, and policies.	3	JIA Gensuo
4	Cross-cutting environmental issues	Focus on key cross-cutting issues in GEO-6, e.g., urbanization, climate change, human well-being, polar and alpine regions.	6	XU Xiyan
5	Mega-trends and emerging environmental issues	Major global and regional trends that shape future environment, and issues emerging to be major environmental concerns.	6	JIA Gensuo
6	Field practice	Beijing urban-wildland interface	4	JIA Gensuo XU Xiyan
		CAS big Earth data facilities	3	JIA Gensuo
Science-policy forum		Students present and discuss environmental issues, science-policy interface, SDGs.	3	XU Xiyan

Course schedule arrangement:

Three hours a week on Tuesday 8:30-11:20 | Start on October 10th, 2023

Course materials:

1. The sixth Global Environment Outlook (GEO-6), 2019, Cambridge University Press. https://doi.org/10.1017/9781108627146.
2. GEO-6: Global Environment Outlook: Regional Assessment for Africa, Asia and the Pacific, Latin America and the Caribbean, North America, West Asia, the Pan-European Region. 2016. https://www.unep.org/resources/global-environment-outlook-6-regional-assessments.
3. UNEP Frontiers reports series (2016, 2017, 2018/19, 2022) | https://www.unep.org/resources/frontiers.
4. IPCC Special Report on climate change and land, 2022, Cambridge University Press. https://www.ipcc.ch/srccl/ | https://doi.org/10.1017/9781009157988

Expected level of proficiency from students entering the course:

Environmental science: basic

Earth system science: basic

Course title

Introduction to Soil Carbon and Nitrogen Cycling

Instructor(s)-in-charge:

Prof. Xu XingKai

Course type:

Lecture

Course Schedule:

6hrs/week, Monday and Friday afternoon (3hs each), on the 7th and 9th week, and from 12th to 19th week

Course Assessment:

Homework for discussion: three assignments

Grading Policy:

50% homework, 20% class attendance, and 30% final examination

Course Prerequisites:

Basic knowledge in soil and/or ecology sciences

Catalog Description:

This course is designed for research postgraduates in soil science and related fields. It will give students a general view of soil carbon and nitrogen cycling, with particular attention to production and consumption of greenhouse gases (e.g., carbon dioxide, methane, and nitrous oxide) in soils and their responses to climate changes and human activities. Some advances and research methods in the field of soil carbon and nitrogen cycling are also introduced. A series of seminar with students are incorporated into lectures according to several major research topics proposed within the contents of the course. The presentation of students will be followed by discussion during which other students in class are encouraged to give questions or comments. Students are expected to attend class regularly, which will be incorporated into a final score of this course. Each student should be expected to give a report at the end of the course. This course can provide students a nice understanding of concepts, theories, research methods, and advances in the field of soil carbon and nitrogen cycling.

Schedule of the course

section	content	hours
1	Brief introduction to global soil organic and inorganic carbon and nitrogen stocks in terrestrial ecosystems; Importance and uncertainty of carbon and nitrogen dynamics in soils	3
2	Carbon input, forms, transformations, and stabilization in soils	6
3	Components and properties of soil organic matter, and its application in related studies	3
4	Soil respiration and its components and their responses to climate changes and human activities	6
5	Production and consumption of methane and other gaseous hydrocarbon in soils and influencing factors	3
6	Responses of soil methane and other gaseous hydrocarbon fluxes to climate changes and human	3

	activities	
7	Suitable management practices for enhancing organic carbon sequestration in soils and reducing soil carbon loss and/or methane flux	3
8	Outline of soil nitrogen cycling, soil nitrogen forms, and stabilization	3
9	Transformations and leaching of organic and inorganic nitrogen in soils and their influencing factors	3
10	Production and consumption of nitrous oxide and other gaseous nitrogen compounds in soils and influencing factors	3
11	Responses of soil nitrous oxide and other gaseous nitrogen emissions to climate changes and human activities	3
12	Suitable management practices for improving fertilizer-nitrogen utilization efficiency and reducing nitrogen losses in soils	3
13	Brief introduction to several major measurement methods	3
14	Case studies using stable isotope technology and modern biology methods to characterize the specific processes of carbon and nitrogen cycling in soils	3
15	Brief introduction to the application of long-term positioning experiments, remote sensing methods, and biogeochemical models in the measurements of soil carbon and nitrogen cycling	3
16	Brief review of meta-analysis in the field of soil carbon and nitrogen cycling	3
17	Experimental design and data analysis of relevant factors and dose-effect experiments in the field of soil carbon and nitrogen cycling	3
18	Summary and review questions	3
Total		60

Contents of the course

Section 1: Background of soil carbon and nitrogen cycling

1) Brief introduction to global soil organic and inorganic carbon and nitrogen stocks in terrestrial ecosystems
2) Importance and uncertainty of carbon and nitrogen dynamics in soils

Section 2: Soil carbon cycling and its influencing factors

1) Carbon input, forms, transformations, and stabilization in soils
2) Components and properties of soil organic matter (SOM) including dissolved organic matter and its role in influencing soil function (e.g., sources and biodegradation of dissolved organic matter, indicators of SOM dynamic and soil quality, impact of SOM on soil properties, and responses of SOM dynamic to

environmental changes)

3) Soil respiration and its components and their responses to climate changes and human activities
4) Production and consumption of methane and other gaseous hydrocarbon in soils and influencing factors
5) Responses of soil methane and other gaseous hydrocarbon fluxes to climate changes and human activities
6) Suitable management practices for enhancing organic carbon sequestration in soils and reducing soil carbon loss and/or methane flux (e.g., farmland management, usage of biochar, forest management, and land use changes)

Section 3: Soil nitrogen cycling and its influencing factors

1) Outline of soil nitrogen cycle, soil nitrogen forms, and stabilization
2) Transformations and leaching of organic and inorganic nitrogen in soils and their influencing factors
3) Production and consumption of nitrous oxide and other gaseous nitrogen compounds in soils and influencing factors
4) Responses of soil nitrous oxide and other gaseous nitrogen emissions to climate changes and human activities
5) Suitable management practices for improving fertilizer-nitrogen utilization efficiency and reducing nitrogen losses in soils (e.g., farmland management, usage of biochar, and achievements of long-term field experiments)

Section 4: Methods for studying carbon and nitrogen cycling in soils

1) Brief introduction to several measurement methods
2) Case studies using stable isotope technology and modern biology methods to characterize the specific processes of carbon and nitrogen cycling in soils (e.g., the decomposition of soil organic carbon, soil heterotrophic and autotrophic respiration, the sources of nitrous oxide emission, indicators of N saturation in forest ecosystems, and production and consumption of methane)
3) Brief introduction to the application of long-term positioning experiments, remote sensing methods and biogeochemical models in the measurements of soil carbon and nitrogen cycling.
4) Brief review of meta-analysis in the field of soil carbon and nitrogen cycling
5) Experimental design and data analysis of relevant factors and dose-effect experiments in the field of soil carbon and nitrogen cycling

Textbook and any related course material:

1) Nieder R. and D.K. Benbi (2008) Carbon and Nitrogen in the Terrestrial Environment. Berlin: Springer-Verlag.
2) Data R., Meena R.S., Pathan S.I. and M.T. Ceccherini (2019) Carbon and Nitrogen Cycling in Soil. Singapore: Springer Nature.
3) Hartemink A.E. and K. McSweeney (2014) Soil Carbon. Switzerland: Springer International Publishing.
4) Alef K and P. Nannipieri (1995) Methods in Applied Soil Microbiology and Biochemistry. New York: Academic Press.

5) Paul E.A. and F.E. Clark (1989) Soil Microbiology and Biochemistry. London: Academic Press.
6) Schulze E.D. (2013) Carbon and Nitrogen Cycling in European Forest Ecosystems. Berlin: Springer-Verlag.
7) Gasche R, Papen H and H. Rennenberg (2013) Trace Gas Exchange in Forest Ecosystems. Netherlands: Kluwer Academic Publishers.

Expected level of proficiency from students entering the course:

1) Familiar with basic knowledge in soil and/or ecology sciences

Good ability to learn knowledge based on scientific literature

Course title

Input-output Analysis and Its Application in Environmental Management

Instructor(s)-in-charge:

Prof. Xiuli Liu

Course type:

Lecture, discussions

Course Schedule:

3hrs/week by instructor.

Course Assessment:

Assignment and informative speeches made by students

Grading Policy:

25% Attendance, 20% assignments, 20% informative speech, 35% final research report.

Course Prerequisites:

Basic knowledge in macroeconomics and linear algebra.

Catalog Description:

Input–output analysis is one of the most widely applied methods in economics. This course introduces the framework set forth by Leontief who won the Nobel Prize in Economic Science in 1973 and many extensions especially in environmental management that have been developed over the last nearly a century. Input–Output Analysis is an ideal introduction to the subject for advanced undergraduate and graduate students in a wide variety of fields, including economics, regional science, regional economics, city, regional and urban planning, environmental planning, public policy analysis, and public management. The course aims to enhance students' macro-economic analysis, modelling and policy simulation skills and proficiency in environmental management techniques through case study experiences.

Contents of the course

Session 1. The History and Development of Input-Output Analysis: Introduction; What is input-output (IO) analysis; The Development of IO; The Application of IO; Some Examples; Academic Organizations of IO; Outline for This Text; Internet Website and Real Datasets

Session 2. GDP: Measuring Total Production and Income: Gross Domestic Product (GDP) Measures Total Production and Income; Real GDP versus Nominal GDP; Does GDP measure what we want it to measure?

Session 3. Foundations of Input-Output Analysis: The fundamental structure of the input–output model; The assumptions behind it; Technical coefficient; Shortcomings of IO model

Session 4. Calculations with IO Model: Leontief Inverse Matrix; Open Models and Closed Models; Closing a Model with respect to Households; Numerical Examples

Session 5. The Price Model and Regional IO Model: The Price Model Overview; The Price Model based on Monetary Data; The Price Model based on Physical Data; Input-Output Models at the Regional Level; Single-Region Models; Regional Coefficients; Numerical Examples

Session 6. Input-Output Models at Regional Level: Single-Region Models; Many-Region Models; The Interregional Approach; Interregional IO Models; Assumptions and Dimensionality; The Multiregional Approach; The Regional Tables; The Interregional Tables; Advantage and disadvantages of Regional IO Models

Session 7. Multipliers in Input-Output Model: Simple Output Multipliers; Total Output Multipliers; Income/Employment Multipliers; Value-Added Multipliers; Which Multiplier to Use? The role of the multiplier; Numerical Examples

Session 8. Regional Multipliers: Interregional Input-Output Multipliers; Intraregional Effects; Interregional Effects; National Effects; Sectoral Effects; More Than Two Regions; Multiregional Input-Output Multipliers

Session 9. Non-survey and Partial-Survey Methods: Fundamentals: The Question of Stability of Input-Output Data; Stability of National Coefficients; Comparisons of Direct-Input Coefficients; Comparisons of Leontief Inverse Matrices; Other Summary Measures; Data for the China and US Economy; Constant versus Current Prices; Stability of Regional Coefficients; Updating and Projecting Coefficients; The RAS Approach and Hybrid Methods; An Economic Interpretation of the RAS Procedure; Numerical Example

Session 10. Energy Input-Output Analysis: Approaches to Energy Input-Output Analysis; The Basic Formulation; The Total Energy Requirements Matrix; The Hybrid Units Formulation and Energy Conservation Conditions; Energy Input-Output and Econometrics; Numerical Examples

Session 11. Environmental Input-Output Analysis and Case Study in GHG Emissions Reduction: Ecological Commodities; The Pollution-generation Coefficients; Pollution Elimination; Generalized Input-Output Analysis Model; Pollution-Activity-Augmented Leontief Model; Economic-Ecologic Model; Limitation of Economic–Ecologic Models; Case Study in GHG Emissions Reduction

Session 12. Exam- final research report

Textbooks and Reference Books

Ronald E. Miller and Peter D. Blair, Input–Output Analysis-Foundations and Extensions, 2009, Cambridge University Press

Xiuli Liu, Some Advance of Input-Output Analysis-Theory and Practice in China, 2009, VDM published

Course title

Savoring Chinese Culture through Drama

Instructor(s)-in-charge:

Dr. Wu Hai Yan

Course type:

Lecture

Course Schedule:

3 *hrs/week by instructors*

Pre-requisites and Co-requisites:

None

Credits:

1

Catalog Description:

This drama program combines dramatic skills with traditional Chinese culture. It aims to introduce the fundamentals of drama and to develop students' ability to appreciate Chinese dramatic works and to improve their acting skills. In this program, students will be led through an exploration of the famous Chinese legend The Butterfly Lovers and be guided to work out a theatrical production of their own.

The major conventions of DIE will be introduced all through this course. Drama in Education (DIE) focuses on collaborative play, imaginative exploration, and role play to engage learners in the imagined world of the story. It is a student-centered approach to learning, as students' ideas, questions and creative work move the story forward lesson by lesson, deepening their understanding and investment in its themes. Students are encouraged to use their imagination and creative thinking skills to work together as an ensemble as they use dramatic conventions to explore and create the story together.

This course is a public elective course designed for all those who are interested in drama and there are no special requirements for previous acting experience.

Contents of the course:

1 Self-consciousness and creation

1) Discover ourselves

2) Develop ourselves

3) Enter the world of drama and theatre

2 Stage direction

1) Settings

2) Characters' appearances and personalities

3) Characters' gestures and emotions

4) Acts and scenes

3 Dialogue

1) Cooperative principle

2) Soliloquy and aside

3) Chinese play:

A Foolish Old Man Who Moved Mountains

4 Character

1) Characterization
2) Seven elements of your voice
3) Flat and round characters
4) Narrator character
5) Four roles of Sheng, Dan, Jing and Chou in Peking Opera
5 Action
1) The exposition
2) The complication
3) The climax
4) The denouement
5) Chinese play: Hua Mulan
6 Tragedy
1) Tragic hero
2) Tragic action
3) Catharsis
4) Chinese tragedy: The Orphan of Zhao
7 Comedy
1) Comic characters
2) Coincidences in the action
3) Funny Chinese Stories:
Learning Walk in Handan
A Man from the States of Zheng Bought Shoes
8 History play
1)The Shakespearean history play
2) Contemporary history play
3 ）Chinese Classic Plays
9 Peking Opera:
1) Intriguing facial makeup
2) Chinese Music and the orchestra
3) Traditional costumes
10 Exploring the Chinese legend: The Butterfly Lovers
1) Storytelling
2) Generating ideas
3)Planning for performance
11 Producing preliminary work for performance
1) Role and relationship
2) Time and place
3) Tension
4) Focus and emphasis
12 Revising and refining the performance
1) Costume design
2) Stage setting and props
3) Full Run with feedback

13 Putting it on the stage

1) Production role

2) Dress rehearsal

3) Final performance

14. Visiting China National Peking Opera Company

Textbook and any related course material

1.Structuring Drama Work Jonothan Neelands and Tony Goode 2015 年 1 月 Cambridge University Press

2.Insights into Chinese Culture Ye Lang and Zhu Liangzhi 2008 年 6 月 Foreign Language Teaching and Research Press

3.Peking Opera Xu Chengbei 2003 年 12 月 China Intercontinental Press

Course title

Public Speaking

Instructor(s)-in-charge:

Associate Prof. Meng Yanli

Course type:

Lecture and seminar combined

Course Schedule:

3hrs/week by instructor

Course Assessment:

Assignment and public speeches made by students

Grading Policy:

10% Attendence, 20% assignment, 10% introductory speech, 30% informative speech, 30% persuasive speech.

Course Prerequisites:

no

Catalog Description:

The purpose of this course is to improve your skills of writing and presenting effective public speeches, with special emphasis on informative and persuasive discourse. The principles you learn in this class will benefit you not only in subsequent courses, but also in your career and in your life as a citizen in a global age. The course will introduce major principles and strategies in speech-making, including choosing a topic, audience analysis, supporting your idea, orgazing the main points, beginning and ending your speech, using visual aids, language rhetorics, and so on. The charm of the class includes the use of a large amount of excellent speeches as samples for analysis and the encouragement for student practice and participation.

Schedule of the course

Session	Content	Hours	Date
1	Introduction to public speaking	3	9.29
2	Delivering the speech Preparing for your first speech	3	10.6
3	Introductory speech presentation Comments and discussion	3	10.13
4	Selecting a topic and a purpose	3	10.20
5	Analyzing the audience	3	10.27
6	Supporting your ideas	3	11.3
7	Outlining the speech Organizing the body of the speech	3	11.10
8	Beginning and ending the speech	3	11.17
9	Using language	3	11.24
10	Using visual aids, Speaking to inform	3	12.1
11	Presentation of informative speeches	3	12.8
12	Speaking to persuade	3	12.15
13	Presentation of persuasive speeches	4	12.22

total		40	13 weeks

Contents of the course

Session 1: Overview of public speaking

1. Course overview
2. Icebreaker activity
3. Basic principles of public speaking
4. Speaking confidently and ethically

Session 2: Delivering the speech

1. Principles of effective speech delivery
2. Sample analysis and practice students' delivery skills

Session 3: Introductory speech presentation

1. Students' presentation of introductory speeches
2. Comments and discussion

Session 4: Selecting a topic and a purpose

1. Selecting a topic
2. Determine general purpose, specific purpose
3. Phrase the central idea

Session 5: Analyzing the audience

1. What is audience-centredness?
2. Factors in audience analysis
3. Exercise and sample analysis

Session 6: Supporting your ideas

1. Types of supporting materials
2. Tips in using supporting materials in a speech
3. Exercise and sample analysis

Session 7: Outlining the speech, Organizing the body of the speech

1. Outlining the speech
   1.1 Drafting a speech outline for your manuscript
   1.2 Drafting a speaking outline for your delivery
   1.3 Exercise and sample analysis
2. Organizing the body of the speech
   2.1 The concept of strategic structure
   2.2 Methods of organization
   2.3 Use of connectives to smooth the progression of ideas
   2.4 Exercise and sample analysis

Session 8: Beginning and ending the speech

1 The four objectives of an effective speech introduction
2 Tips for creating an effective speech introduction
3 The two objectives of an effective speech conclusion
4 Tips for creating an effective speech conclusion
5 Exercise and sample analysis

Session 9: Using language

1 Criteria of using English in public speaking

2 Rhetorical devices and exercises

3 Sample analysis

Session 10 Using visual aids, Speaking to inform

1. Using visual aids

1.1 Types of visual aids

1.2 Tips of creating and presenting visual aids

1.3 Exercise and sample analysis

2. Speaking to inform

2.1. Types of informative speeches

2.2 Tips for informatie speaking

2.3 Exercise and sample analysis

Session 11: Presentation of informative speeches

1. Students' presentation of informative speeches
2. Comments and discussion

Session 12: Speaking to persuade

1. Methods of persuasion
2. Tips for persuasive speaking
3. Exercise and sample analysis

Session 13: Presentation of persuasive speeches

1. Students' presentation of persuasive speeches
2. Comments and discussion

Textbook and any related course material:

Stephen E. Lucas. 2011. *The Art of Public Speaking.* Beijing: Foreign Language Teaching and Research Press

Expected level of proficiency from students entering the course:

English language: strong

Course title

Scientific Writing

Objectives

For graduate students, writing academic papers in English not only means a fundamental skill in their academic study, but also symbolizes their professional development and achievement. Grounded on the common difficulties and challenges that science students may encounter in their academic writing, the aim of this course is to help them understand academic papers' style, guidelines, and writing methods, improve their language accuracy in academic contexts, and therefore, improve their confidence and capacity in academic English writing.

Main Contents

This course is designed as a series of 4-hour lectures, 12 lectures in total for the present course syllabus. The topics of these lectures range from stylistic features of academic papers to abstract writing, to approaches of integrating outside sources, to visual information, to cohesive devices, and to how to make academic presentation.

Teaching Approaches

Class instruction

Textbooks and Reference Books

1. Grace Canseco. Inside Academic Writing: Understanding Audience and Becoming Part of an Academic Community, Ann Arbor University of Michigan Press, 2010.
2. Robert A. Day and Barbara Gastel. How to Write and Publish a Scientific Paper (Sixth Edition), Peking University Press, 2012.
3. John M. Swales and Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills (3rd Edition), University of Michigan Press, 2012.

Course title

Research Ethics, Bioethics,& Survival Skills for a Research Career

Instructor(s)-in-charge:

Changqing Zeng

Course type:

Lecture

Course Schedule:

3hrs/week by instructor.

Course Prerequisites:

none

Catalog Description:

This curriculum will deliver general introduction of scientific integrity and misconduct, bio-ethics, and survival skills for a research career. After these three parts is the class discussion. Each participant will present or submit a PPT regarding a topic on the discussion list. To pass the class requires attendance and PPT submission.

Contents of the course

大纲章次	*章名称*	*章学时*	*大纲小节次*	*小节名称*
1	*Scientific integrity and misconduct*	*9*	*1*	*Types of major research misconduct*
			2	*Case analysis of fraud*
			3	*Data selection in presentation*
			4	*Other ethical issues in research activities (A)*
			5	*Other ethical issues in research activities (B)*
			6	*Be aware of unethical deeds in research*
			7	*System efforts on keeping scientific integrity (A)*
			8	*System efforts on keeping scientific integrity (B)*
			9	*Research ethic issues in China*
2	*Bio-ethics*	*6*	*1*	*Bioethics: Rising moral challenges*
			2	*Institutional Review Board [IRB]*
			3	*Resources of bioethical regulations*
			4	*Example 1: Cloning and stem cell research*
			5	*Example 2: DNA sample*

				collection
			6	*Ethical issues in precision medicine*
3	*Survival skills for a research career*	*9*	*1*	*Being a successful trainee*
			2	*Surviving in busy lab work*
			3	*Attending an academic meeting*
			4	*Making your presentation effective (A)*
			5	*Making your presentation effective (B)*
			6	*Collaboration in research*
			7	*Sharpening your communication and writing skills*
			8	*Paper writing and publication (A)*
			9	*Paper writing and publication (B) Application for funding*
4	*Class Discussion*	*6*	*1-6*	*Individual presentations Summary*

Textbook and any related course material:

On Being a Scientist: A Guide to Responsible Conduct in Research National Academy of Sciences, National Academy of Engineering (US) and Institute of Medicine (US) Committee on Science, Engineering, and Public Policy National Academies Press (US)

Course title

Characters and Chinese Stories

Instructor(s)-in-charge:

Chu Guofei

Course type:

Lecture

Course Schedule:

3hrs/week by instructor.

Course Prerequisites:

none

Catalog Description:

By explaining the details of the "picture"(Chinese characters), and introducing some Chinese idioms, Chinese sayings, and the hot news, the course focus on sharing Chinese history, culture, tradition, as well as the stories going on in today's China.

Contents of the course

1 General introduction The Transformation of Chinese Characters
Some Basic Chracters and Stories behind

2 On Food Related Characters, Idioms, Sayings and Hot Words
The Development of Ancient Chinese Agriculture
China's Food Security

3 On Road Related Characters, Idioms, Sayings and Hot Words
The Ancient Silk Road and the BRI
Chinese Bullet Trains

4 On Biodiversity Related Characters, Idioms, Sayings and Hot Words
Biodiversity: Building a Shared Future
Trip of Wandering Wild Asian Elepants
National Parks in China

5 On Environment Related Characters, Idioms, Sayings and Hot Words
Climate Change and China's Efforts
China "Zipping" the desert

6 On Festivals and Space Explorations Related Characters, Idioms, Sayings and Hot Words
Chinese Traditional Festivals
China's Space Explorations

7 On Poverty Alleviation Related Characters, Idioms, Sayings and Hot Words
Poverty Alleviation: China's Experience and Contribution
Yan'an and Minning Town

8 On Education Related Characters, Idioms, Sayings and Hot Words
Confucius: The Great Teacher
The Development of Chinese Education

9 Summary & Review Summary & Review

10 Final examination Discussions on the papers