



VIETNAM ACADEMY OF SCIENCE AND TECHNOLOGY
UNIVERSITY OF SCIENCE AND TECHNOLOGY OF HANOI

DOCTORAL SCHOOL

Ph.D. Training Program Curriculum

Hanoi, March 2024

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Preface

University of Science and Technology of Hanoi (USTH) - Vietnam France University is an advanced-model international public university established under Decision No. 2067/QĐ-TTg dated December 9th, 2009 of the Prime Minister based on the Intergovernmental Agreement between Vietnam and France signed on November 12th, 2009.

USTH was granted institutional accreditation by The High Council for Evaluation of Research and Higher Education (HCERES) complying with French and European standards for educational institutions on October 26, 2023.

USTH follows the European Bologna Process with **LMD** system: Bachelor (3 years, 180 ECTS), Master (2 years, 120 ECTS), PhD (3 years, 180 ECTS). The doctoral program at USTH was built with the philosophy that the scientist is the essential part of the society. The PhD student will be able to do the research and create new values serving for the development of the society and the scientific community.

The doctoral program was developed by Vietnamese and French scientists based on the demand of society and prioritized research fields at USTH, which allows PhD students to study in an international environment and to prepare for their future careers. Upon graduation, the PhD students are awarded the doctoral degree which is recognized by international institutions.

The documentation is prepared with the strong cooperation with all academic departments. The Doctoral School would like to express sincere thanks to Rector board, Academic Department, Assoc. Nguyen Viet Dung, former Director of Doctoral School, and all colleagues for their contribution to this documentation.

Hanoi, March 15, 2024

Director of Doctoral School

An Overview of the Training Program

The USTH-Doctoral School offers full-time doctoral training at USTH laboratories and/or at laboratories cooperating with USTH. The training period is 3 years (36 months) for Ph.D. students holding a Master diploma and 4 years (48 months) for Ph.D. students holding a Bachelor diploma.

The training program consists of 180 ECTS, including general and thematic essays, common courses, doctoral courses, and a Ph.D. thesis. The annual Doctoral Day is a part of the training program. Ph.D. students are also encouraged to attend doctoral training courses organized by other institutions, relevant regular (master) course units during their training period, to attend and present at scientific seminars and conferences.

Program Structure

No.	Content	Form	Description
1	Essays	04 ECTS (02 ECTS/Essay)	01 General essay. 01 Doctoral thematic essays. Presented in annual Doctoral Day.
2	Common Courses	04 ECTS (02 ECTS/course)	02 common courses on management science or transferable skills (problem-solving, decision making, critical thinking, scientific integrity, communication skill, CV or resume writing, and interviews attending ...)
3	Doctoral Courses	12 ECTS (03 ECTS/course)	Doctoral courses are developed by the Academic departments. A Ph.D. student can valid up to 2 doctoral courses through other academic activities: oral presentation at national and international conferences, participating in training courses.
4	PhD thesis	160 ETCS	
5	Publications	compulsory	To submit her/his PhD thesis, a PhD student must be the main author of at least 02 research papers from the Ph.D. research work in peer-reviewed scientific journals. Among them, at least 01 paper must have been published or accepted for publication in journals, proceedings within the Web of Science/Scopus
6	Doctoral Day	annually	Oral or poster presentation

7	Progress Report	annually	Written report with approval of supervisor(s)
8	Midterm Evaluation	compulsory	Oral presentation in front of a committee
9	Conferences	optional	PhD students are encouraged to participate
10	Thesis Defense	mandatory	Internal Jury Thesis Examination Jury
11	Other Academic Activities	optional	Some other academic activities can help Ph.D. students accumulate credits required by the training program.

The Common Courses

The common courses aim to provide Ph.D. students with a broadening list of transferable skills such as communication skills, Research & Valorisation, Scientific Integrity, Career management, etc. Common courses on transferable skills are compulsory for Ph.D. students of all academic departments. The Doctoral School will coordinate organizing these courses.

The doctoral courses are designed by Academic Departments. The list of doctoral courses of each Academic Department can be found in this document.

The Ph.D. thesis

The most important part of the Ph.D. training program at the USTH Doctoral School is the Ph.D. thesis.

During the training program, depending on the progress of the research project, supervisor(s) and Ph.D. students decide appropriate period(s) to conduct research at USTH research laboratory, a USTH associated laboratory, a USTH consortium laboratory and/or at a laboratory that has signed MOU with USTH provided that at least half of total research period should be at USTH research laboratory and/or USTH associated laboratory in Vietnam.

Part 1. Common Course

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	CC6.01	How to Write and Publish a Scientific Paper	2	Dr. Nguyen Thi Van Anh Other lectures
2	CC6.02	Research Methodology	2	Assoc. Prof. Nguyen Thi Kieu Oanh Other lectures
3	CC6.03	Article Seminar and Analytical Skills	2	Assoc. Prof. Nguyen Thi Kieu Oanh Other lectures
4	CC6.04	Scientific Project Management	2	Assoc. Prof. Dong Van Quyen Other lectures

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Detailed Course

1. Course name: How to Write and Publish a Scientific Paper

Course code: CC6.01

2. Credits points (ECTS): 2

3. Lecturer in charge: Dr. Nguyen Thi Van Anh and other lectures from academic departments

Teaching time	24	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24
	Practice	
	Discussion	
	Total	24
Prerequisites		
Recommended background knowledge		
Course description:	This course aims to give a classic guide offering practical advice on preparing and publishing journal articles as well as succeeding in other communication-related aspects of a scientific career.	
Objectives & Outcome	Passing this course, the students will achieve the techniques and procedure to write and publish a scientific paper.	
Assessment/Evaluation	Assignments	
Required Textbooks and Other Course Materials:		

COURSE CONTENTS & SCHEDULE

Class	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	Provides practical, easy-to-read, and immediately applicable guidance on preparing each part of a scientific paper: from the title and abstract, through each section of the main text, to the acknowledgments and references.	5				
2	Explains step by step how to decide to which journal to submit a paper, what happens to a paper after submission, and how to work effectively with a journal throughout the publication process.	5				
3	Includes key advice on other communication important to success in scientific careers, such as giving presentations and writing proposals	5				
4	Presents an insightful insider's view of how journals actually work—and describes how best to work with them	5				
5	Assignment	4				
	Total	24				

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Detailed Course

1. Course name: Research Methodology

Course code: CC6.02

2. Credits points (ECTS): 2

3. Lecturer in charge: Dr. Nguyen Thi Kieu Oanh and other lectures from academic departments

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	21
	Practice	3
	Discussion	
	Total	24
Prerequisites		
Recommended background knowledge		
Course description:	This course provides students with a fundamental knowledge of philosophy of science. Students will learn how to implement a research pipeline including have an idea, research survey and documentation, experimental design, data analysis, publication. This course also provide guidelines of writing a proposal and information of available funding in Vietnam that a future scientist may interest.	
Objectives & Outcome	This course provides students different components of research approach from the beginning of their scientific career. ELOs: At the end of this course, student should be able to: • Define the basic concepts in science and research methodology • List the prerequisites of “good research” • Effectively write a research proposal	

Assessment/ Evaluation	Assignments
Required Textbooks and Other Course Materials:	1. Shanti Bhushan Mishra and Shashi Alok (2017). Handbook of Research Methodology. Educreation Publishing

COURSE CONTENTS & SCHEDULE

Class	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	History of science Meaning and objective of research Type of research Defining research problem Research process and steps involved in research process Research proposal	3				
2	Literature survey and documentation Methods of literature survey Importance of documentation Documentation techniques Use of computer programs/packages in literature survey and documentation	3	1			
3	Data collection, analysis and hypothesis Classification of data Methods of data collection Data processing and graphical representation of data Hypothesis: Type of hypothesis, hypothesis testing, types of errors and their control	3				
4	Research ethics, plagiarism and impact of research Research ethics, responsibility and accountability of the researchers, ethical consideration during animal experimentation including CPCSEA guidelines Plagiarism and use of plagiarism detection softwares.	3				
5	Technical writing and reporting of research Types of research report: Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report etc. Structure and organization of research reports: Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgement, references, footnotes, tables and illustrations	3	1			

	Use of reference managing softwares (such as-MENDELEY, ENDNOTE). Impact factor, rating, indexing and citation of journals.					
6	Project cost management Cost analysis of the project, cost incurred on raw materials, procedure, instrumentation and biological testing.	3				
7	Funding agencies and research grants Introduction to various research funding agencies along with their functions in Vietnam Writing a research project and procurement of research grant.	3	1			
	Total	21	3			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Article Seminar and Analytical Skills

Course code: CC6.03

2. Credits points (ECTS): 2

3. Lecturer in charge: Assoc. Prof. Dong Van Quyen and other lectures from academic departments

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24
	Practice	
	Discussion	
	Total	24
Prerequisites		
Recommended background knowledge		
Course description:	This course provides students: 1. Methods to find information in articles and scientific communication, 2. Provide a theoretical foundation for the scientific field, 3. Build a thorough foundation for scientific reasoning, 4. Develop the ability for independent reasoning in a scientific context and develop writing skills. 5. How to organise and present scientific knowledge and are able to critically evaluate methodological approaches within the scientific field.	
Objectives & Outcome	This course provides students different components of article seminar and analytical skills ELOs: At the end of this course, student should be able to: - Find information in a scientific paper - Make a literature review	
Assessment/ Evaluation	Assignments	

Required Textbooks and Other Course Materials:	
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COURSE CONTENTS & SCHEDULE

Class	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect	Prc.	Dis.		
1	Methods to find information in articles and scientific communication	5				
2	Methods to research a theoretical foundation for the scientific field	5				
3	Data collection, analysis and hypothesis	5				
4	Write a literature review	5				
5	Organise and present scientific knowledge and are able to critically evaluate methodological approaches within the scientific field	4				
	Total	24				

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Detailed Course

1. Course name: Scientific Project Management

Course code: CC6.04

2. Credits points (ECTS): 2

3. Lecturer in charge: Assoc. Prof. Dong Van Quyen and other lectures from Academic departments

Teaching time	30	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24
	Practice	0
	Discussion	
	Total	24
Prerequisites		
Recommended background knowledge		
Course description:	In the framework of this course, students will work collectively and individually through key topics of how to design and manage a successful research project, laying a strong foundation for their theses and research careers.	
Objectives & Outcome	This course provides students different components of scientific project management ELOs: At the end of this course, student should be able to know design and manage a successful research project.	
Assessment/ Evaluation	Assignments	
Required Textbooks and Other Course Materials:		

COURSE CONTENTS & SCHEDULE

Class	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	How to formulate research questions that are specific, answerable, and relevant	2				
2	How to critically evaluate and synthesise material from different sources	2				
3	How to assess the strengths and weaknesses of research methods	2				
4	How to understand the importance of ethics and integrity in research	2				
5	How to understand the importance of the wellbeing of the research participants and the researcher	3				
6	How to communicate research processes and outcomes to various academic and non-academic audiences	3				
7	How to apply the principles and good practices of research project management to their own work	3				
8	How to develop the research skills needed to plan and conduct research	3				
9	How to write a research proposal and disseminate research findings to stakeholders and the international research community	4				
	Total	24				

Part 2. Doctoral Courses for PhD Program on Pharmacological, Medical, and Agronomical Biotechnology

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	PMAB6.01	Biosafety and Infection Control	3	Dr. Nguyen Quang Huy, Assoc. Prof. Dong Van Quyen
2	PMAB6.02	Recent Trends in Life Sciences	3	Dr. Nguyen Thi Kieu Oanh Dr. Tran Tuan Anh Dr. Nguyen Van Phuong
3	PMAB6.03	Processing and Analysing Experimental Data	3	Dr. Tran Thi Thanh Tam Dr. Nguyen Cam Linh
4	PMAB6.04	Advanced Drug Delivery System	3	Dr. Nguyen Hong Van
5	PMAB6.05	From genomic to system biology	3	Dr. Tran Thi Thanh Tam Dr. Nguyen Cam Linh
6	PMAB6.06	Genetic, Cellular and Molecular Mechanisms of Human Diseases	3	Dr. Nguyen Thy Ngoc
7	PMAB6.07	Molecular Biology of Emerging Viruses and Other Pathogens	3	Dr. Tran Thi Thu Phuong
8	PMAB6.08	Advanced Phytopathology: Physiological and Molecular Mechanisms of Plant Responses to Pathogens	3	Dr. Nguyen Van Phuong
9	PMAB6.09	Recombinant Proteins for Medical Use	3	Assoc. Prof. Dong Van Quyen TS. Le Thị Thu Hang.
10	PMAB6.10	Analytical Platform for Small Molecules	3	Dr. Nguyen Thi Kieu Oanh Dr. Le Hong Luyen

Hanoi, March 15, 2024

Detailed Course

1. Course name: Biosafety and Infection Control

Course code: PMAB6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Quang Huy, Assoc. Prof. Dong Van Quyen

Teaching time	August - October	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	21 h
	Practice	15 h
	Discussion	
	Total	36 h
Prerequisites	No	
Recommended background knowledge	Medical Microbiology	
Course description:	This course is designed to provide basic concepts in biological safety for working with pathogenic biological agents in laboratories and to analyze the real-world problems of biosafety and infection issues.	
Objectives & Outcome	The first objective of this course is to help students manage biosafety laboratories and assess risk factors. The second objective is to help students implement good microbiological practice and procedure and apply methods of decontamination and waste management. At the end of the course, students will be able to: • list the routes of exposure for a pathogen to a human being • demonstrate and assess the proper use of personal protective equipment, best practices, biological containment, and be prepared to safely conduct research • identify the role of the Biosafety Professional in Biomedical Research Laboratories	

Assessment/ Evaluation	essay, thematic report and oral exam
Required Textbooks and Other Course Materials:	1. Biosafety in Microbiological and Biomedical Laboratories. 6th Edition. U.S Department of Health and Human Services Public Health Service Centers 2. World Health Organization, Laboratory biosafety manual, 4th Edition, 2020 3. Mayhall's Hospital Epidemiology and Infection Prevention 5th edition (2020). David Weber, Tom Talbot. Lippincott Williams & Wilkins (LWW) ISBN: 978-1-97-512458-8

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	- Main content 1: Introduction to biosafety in microbiological and biomedical laboratories + Content 1.1. Microbiological risk assessment + Content 1.2. Basic laboratories – Biosafety Levels 1 and 2 + Content 1.3. The containment laboratory – Biosafety Level 3 + Content 1.4. The maximum containment laboratory – Biosafety Level 4 + Content 1.5. Laboratory animal facilities	3			Chapter 1	
2	- Main content 2: Laboratory biosecurity and equipment + Content 2.1. Laboratory biosecurity concepts + Content 2.2. Biological safety cabinets + Content 2.3. Safety equipment	4	3		Chapter 2	
3	- Main content 3: Good microbiological techniques + Content 3.1. Laboratory techniques + Content 3.2. Contingency plans and emergency procedures + Content 3.3. Disinfection and sterilization + Content 3.4. Introduction to the transport of infectious substances	4	3		Chapter 3	
4	- Main content 4: Introduction to biotechnology • Biosafety and recombinant DNA technology • Biosafety considerations for	4	3		Chapter 4	1

	biological expression systems • Biosafety considerations for expression vectors • Viral vectors for gene transfer • Transgenic and “knock-out” animals • Transgenic plants • Risk assessments for genetically modified organisms • Further considerations					
5	- Main content 5: Chemical, fire and electrical safety • Hazardous chemicals • Additional laboratory hazards	3			Chapter 5	
6	- Main content 6: Infection control • Preventing and Controlling Infections: Routine Practices & Additional Precautions • Surveillance	3	6		Chapter 6	1
	Total	21	15			

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Detailed Course

1. Course name: Recent Trends in Life Sciences

Course code: PMAB6.02

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Thi Kieu Oanh, Dr. Tran Tuan Anh, Dr. Nguyen Van Phuong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	36
	Practice	
	Discussion	
	Total	36
Prerequisites		
Recommended background knowledge		
Course description:	This course carries 3 ECTS focusing on the introduction of systemic techniques such as metabolomics, metagenomics, genome editing and their application in drug development, biomedicine and plant biotechnology fields.	
Objectives & Outcome	This course provides students the recent trends in life sciences: (i) Omics techniques: metagenomics and metabolomics, (ii) Genome editing, genome mining and their applications in plant biotechnology, drug development and biomedicine Upon completing the course students will be able to • Define what is omics techniques especially metabolomics and metagenomics and what is genome mining, genome editing approaches • Present the different stages in metabolomics, metagenomics and genome editing approaches	

	• Analysis the applications of these above-mentioned approaches in drug development, biomedicine and plant biotechnology. Investigate drug discovery pipelines to pinpoint limitations of traditional approaches as well as related research in Vietnam. • Get along with modern techniques and approaches towards drug discovery • Acknowledge fundamentals of genome mining in natural product discovery and application of Biotechnology in this field
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.
Required Textbooks and Other Course Materials:	1. Hu, H., Scheben, A., Edwards, D., 2018. Advances in integrating genomics and bioinformatics in the plant breeding pipeline. Agric. 8. https://doi.org/10.3390/agriculture8060075 2. Jamil, I.N., Remali, J., Azizan, K.A., Nor Muhammad, N.A., Arita, M., Goh, H.H., Aizat, W.M., 2020. Systematic Multi-Omics Integration (MOI) Approach in Plant Systems Biology. Front. Plant Sci. 11. https://doi.org/10.3389/fpls.2020.00944 3. Kotra, A., Jabalia, N., Chaudhary, N., 2016. Significant Role of Genomics in Crop Breeding: An Overview. Int. J. Basic Appl. Biol. 3, 50–54. 4. Kumar, R., Bohra, A., Pandey, A.K., Pandey, M.K., Kumar, A., 2017. Metabolomics for plant improvement: Status and prospects. Front. Plant Sci. 8, 1–27. https://doi.org/10.3389/fpls.2017.01302 5. Kumar, R., Sharma, V., Suresh, S., Ramrao, D.P., Veershetty, A., Kumar, S., Priscilla, K., Hangargi, B.S., Narasanna, R., Pandey, M.K., Naik, G.R., Thomas, S., Kumar, A., 2021. Understanding Omics Driven Plant Improvement and de novo Crop Domestication: Some Examples. Front. Genet. 12, 1–25. https://doi.org/10.3389/fgene.2021.637141

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	Introduction to metabolomics and application in drug discovery, biomedicine and drug development	5				
2	Pipeline for plant metabolomics and case studies	5				
3	Pipeline for human metabolomics and case studies	5				
4	Genome mining and genome editing for drug discovery	6				
5	Metagenomics analysis and case studies	6				
6	Some trends in plant biotechnology research	9				
	Total	36				

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Detailed Course

1. Course name: Processing and Analysing Experimental Data

Course code: PMAB6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Tran Thi Thanh Tam & Dr. Nguyen Cam Linh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	36 s
	Practice	0
	Discussion	0
	Total	36 h
Prerequisites		
Recommended background knowledge	Basic knowledge about biology and statistics	
Course description:	This course provides students with a fundamental knowledge in experiment design and experimental data analysis using R – an open source statistical programming language. The knowledge covered in the course includes basic concepts of experiment designs, experimental data manipulation and visualization, questions/hypothesis generation and analysis of experimental results by different statistical methods. Students will learn how to conduct ecological experiments, how to clean, organize, analyze, visualize, and report data in new and more powerful ways with R. Students will also be introduced to a variety of statistical methods, as well as the interpretation of statistical and graphic results by working through real-world examples of experiments from the biological field.	
Objectives & Outcome	At the end of this course, student should be able to: 1. Understanding the basic concepts in experimental design 2. Understand the syntax and data structures in R programming	

	3. Effectively manipulate and visualise experimental data with R Comprehend a collection of statistical analysing methods and confidently apply them into specific problems.
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.
Required Textbooks and Other Course Materials:	[1] Joseph Adler (2012). R in a Nutshell: A Desktop Quick Reference. Shroff/O'Reilly. [2] John Pezzullo (2013). Biostatistics For Dummies. Wiley Publishing, Inc. [3] Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani (2013). An Introduction to Statistical Learning : with Applications in R. New York :Springer. [4] Gerry P. Quinn and Michael J. Keough (2002). Experimental Design and Data Analysis for Biologists. Cambridge University Press

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	Introduction to R R overview and history Installing R & Getting started with Rstudio	2				
2	Data structure in R Commands, Assignments and Objects Operations Different data types of R: vectors, lists, arrays, matrices, data frames and factors R syntax and how to write good code	4				
3	Programming with R Loops Conditional statements Writing simple functions	4				
4	Data manipulation in R Indexing and Subsetting Sorting and locating observation Combining data frames and matrices Counts, Data aggregation and group operations, data cleaning, reshaping data	4				
5	Introduction to Experimental Design Experimental Principles Hypothesis Testing Power and Sample Size Determination	4				
6	Exploratory data analysis Summarizing & describing a collection	4				

	of data Mean, median and standard deviation Percentages, Ratios, and Histograms Identifying randomness and uncertainty in data Statistical tests for normality					
7	Fitting Linear Models to Raw Data Correlation and regression Simple linear regression Multiple linear regression	4				
8	Statistical Testing How to choose the right statistical test? Parametric Tests Nonparametric Tests Interpretation of statistical results	4				
9	Distance, clustering, and classification Distance and clustering Classification	3				
10	Introduction to data visualisation with ggplot2	3				

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Detailed Course

1. Course name: Advanced Drug Delivery System

Course code: PMAB6.04

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Hong Van

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	9 h
	Discussion	3 h
	Total	36 h
Prerequisites	Pharmaceutics and Pharmacokinetics	
Recommended background knowledge	Drug development, Pharmacy	
Course description:	This course emphasizes control release drug dosage form, site –specific drug delivery system as well as nanocarriers in pharmaceutical formulation, preparation and evaluation processes	
Objectives & Out-come	At the end of this course, student should be able to: 1. Understand the basic knowledge of modern drug delivery systems: advantages, disadvantages, formulation, preparation, evaluation criteria of control release drug dosage form, site –specific drug delivery system nano ingredients, intermediate ingredients for diagnosis and treatment of diseases 2. Describe the content, theory of various control release drug dosage form, site –specific drug delivery system and nano techniques in pharmaceutics 3. Propose the solution for improvement of drug effectiveness by application of modern techniques, including nanotechnology	

Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.
Required Textbooks and Other Course Materials:	Perrie, Yvonne, and Thomas Rades. FASTtrack pharmaceuticals: drug delivery and targeting. Pharmaceutical press, 2012, 256pp.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	Introduction to conventional dosage forms and bioavailability control	3				
2	Introduction to advanced drug delivery system	3		3		
3	Control release drug dosage forms	3				
4	Site-specific drug dosage forms	3				
5	Nanocarrier: advantages, disadvantages, and application in diagnosis and treatment for healthcare	3				
6	Nanoemulsion and nanosuspension	3	6			
7	Nanopolymers and nanocrystals	3	3			
8	Nanovesicles: liposomes	3				
	Total	24	9	3		

Hanoi, March 15, 2024

Detailed Course

1. Course name: From Genomic to System Biology

Course code: PMAB6.05

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Tran Thi Thanh Tam, Dr. Nguyen Cam Linh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	36 h
	Practice	
	Discussion	
	Total	36 h
Prerequisites		
Recommended background knowledge	Molecular Biology, Genetics, Statistics	
Course description:	This course will provide the basic conceptual approach to the understanding of different omic- levels, including the genome, transcriptome, epigenome, etc. The course also introduces and sets up different concepts and procedures for interpreting high-throughput data, in connection with bioinformatics.	
Objectives & Outcome	Passing this course, the students will achieve the following knowledge: - Knowledge of conceptual approaches to large-scale study of genome, transcriptome, epigenome and so on. - Knowledge of various computational techniques used in studying the high-throughput omic data.	
Assessment/ Evaluation	Assignments	
Required Textbooks and Other Course Materials:	1. E.A. Milward, A. Shahandeh, M. Heidari, D.M. Johnstone, N. Daneshi, H. Hondermarck. Transcriptomics. Editor(s): Ralph A. Bradshaw, Philip D. Stahl, Encyclopedia of Cell Biology, Academic Press, 2016, p160-	

	165. 2 Preeti Arivaradarajan, Gauri Misra. Omics Approaches, Technologies and Applications: Integrative Approaches For Understanding OMICS Data. Springer Singapore 2018, 148pp.
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COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	Genomics 1.1. Introduction to the genome 1.2. Genomic profiling techniques 1.3. DNA Sequencing data analysis	6				
2	Transcriptomics 2.1. Introduction to the transcriptome 2.2. Transcriptomic profiling techniques 2.3. RNA-Sequencing data analysis 2.4. Differential Expression analysis	6				
3	Epigenome 3.1. Introduction to the epigenome 3.2. Epigenomic profiling techniques	6				
4	Statistical methods in omics-studies: Regression, Classification and Clustering	6				
5	Pathway analysis	6				
6	Applications of omics profiling and analysis	6				
	Total	36				

Hanoi, March 15, 2024

Detailed Course

1. Course name: Genetic, Cellular and Molecular Mechanisms of Human Diseases

Course code: PMAB6.06

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Thy Ngoc

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	36 h
	Practice	
	Discussion	
	Total	36 h
Prerequisites		
Recommended background knowledge	Molecular Biology, Genetics, Statistics	
Course description:	This course presents the physical basis of inheritance, the mechanics of inheritance, probability, sex chromosomal abnormalities, autosomal anomalies, gene structure and function, molecular genetics, behavioral genetics, twinning and contemporary issues in human genetics. The main topics include the study of genes, inheritance, genetic variation, and the impact of genetics on human health and disease..	
Objectives & Outcome	Passing this course, the students will achieve the following knowledge: - Explain fundamental concepts in heredity, human genetics and genomic medicine using specific disease examples and appreciate the duties, responsibilities and challenges facing the professionals who perform these analyses - Explain how variation in the coding and non-coding components of the human genome that can result in genetic disease - Discuss how the latest advances in genomic technologies	

	and how they can be applied to disease gene identification and precision medicine - Identify and navigate relevant literature, specialised web sites and databases used for research into human genetics and use these sources to develop and test hypotheses in the field of human genetics - Evaluate, synthesise and critically review literature describing recent research into human genetics - Predict the causative genetic mutations that realted to a disorder.
Assessment/ Evaluation	Assignments
Required Textbooks and Other Course Materials:	1. Michael Goldberg, Janice Fischer, Leroy Hood, Leland Hartwell, Charles (Chip) Aquadro, Lee Silver and Ann E. Reynolds. Genetics: From Genes to Genomes (6th Edition) 2017 Mc Graw Hill Education, 848pp. 2. Griffiths et al. Introduction to genetic analysis (9th Edition) 2008 W.H.Freeman and Company, 838pp. 3. Tom Strachan and Andrew Read. Human Molecular Genetics (4th Edition) 2011 New York: Garland Science/Taylor & Francis Group, 781pp.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	Basic genetics principles: Students will learn about the fundamental principles of genetics, including gene structure and function, genetic variation, inheritance patterns, and genetic disorders.	6				
2	Molecular genetics: This section of the course focuses on the molecular basis of genetics, including DNA structure, replication, transcription, and translation related to human physical features and disorders.	6				
3	Human genome: Students will learn about the structure and function of the human genome, including the different types of DNA sequences and their roles in gene expression.	6				
4	Genetic variations mutations and polymorphisms	6				
5	Genetic counseling: Students will learn about the role of genetic counseling in patient care, including how to interpret genetic test results, the ethical and social implications of genetic testing, and how to communicate genetic information to patients and their families.	6				
6	Personal genomics: This section of the course focuses on the use of genetic information in personalized medicine, including the development of targeted therapies and the use of genetic testing to predict disease risk.	6				
	Total	36				

Hanoi, March 15, 2024

Detailed Course

1. Course name: Molecular Biology of Emerging Viruses and Other Pathogens

Course code: PMAB6.07

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Tran Thi Thu Phuong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	30 h
	Seminar/ presentation	6 h
	Discussion	
	Total	36 h
Prerequisites	English reading and comprehension	
Recommended background knowledge	Basic Molecular Biology; Basic Virus; and Basic immunology	
Course description:	This teaching module is focused on the emerging bacterial, fungal, parasitic, and viral infectious diseases. An understanding of basic concepts in Microbiology is crucial for this course, as we will detail the genetic mechanisms involved in the emergence of new infectious diseases such as horizontal gene transfer. We will also discuss the extrinsic factors favoring these emergence events such as human activities (intensive agricultural practices, urbanization, and industrialization, etc..) in the selection of new emerging pathogens. We will also demonstrate that multidisciplinary approaches are fundamental to having a global view of infectious systems. A second objective is to provide students with general knowledge in molecular biology in the field of infectious diseases. The courses will be illustrated by concrete examples on viruses, bacteria, or parasite diseases. We will show how genetics can help to better understand infectious systems. This will include the evolution of resistance and	

	virulence, identification of transmission routes, three fundamental aspects in public health.
Objectives & Outcome	- Knowledge in emerging infectious diseases and the factors of emergence - Knowledge in genetic mechanisms involved in emergence events. Overview of the molecular biology techniques used in infectious diseases
Assessment/ Evaluation	Seminar/Presentation and oral exam
Required Textbooks and Other Course Materials:	[1] Basic Immunology: Function and disorders of the immune system; Abul K. Abbas & Andrew H. Lichtman, Shiv Pillai, Saunders/Elsevier, 2019. [2] Kuby Immunology. Eighth edition. Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A Owen, W. H.. Freeman and Company, 2018 [3] Viruses 1st Edition - August 10, 2017 Author: Susan Payne [4] Bloodborne Pathogen Fifth Edition, 2007 Author: Jones and Bartlett Publishers [5] Textbook of SARS-CoV-2 and COVID-19. Author Suramani Mani and Jorn-Hendrik Weikamp

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment (s)
		Lect.	Prc.	Dis.		
1	Main content 1: Brief introduction on Emerging and re-emerging disease Evolution and infectious diseases + 1.1. Definitions + 1.2. Virus + 1.3. Immune response to virus + 1.4. Immune system	6			[1] [2] [3]	
2	- Main content 2: Zoonotic infection and diseases + 2.1. Zoonotic born epidemiology + 2.2. Zoonotic pathogen and transmission + 2.3. How to prevent and control zoonotic disease + 2.4. Influenza	6			[3]	
3	Main content 3: Foodborne infection and disease + 3.1. Food borne epidemiology and pathogen. + 3.2. Antibiotic resistance and foodborne pathogen + 3.3. Foodborn pathogen detection + 3.4. Prevent and control foodborne disease.	6			[3]	
4	Main content 4: Bloodborne infection and disease + 4.1. Blood born epidemiology and pathogen. + 4.2. HIV infection + 4.3. HCV infection	6			[3] [4]	
5	Main content 5: Coronavirus- SARS-CoV-2 + 5.1. SARS-CoV-2 characteristic + 5.2. SARS-CoV-2 Detection + 5.3. SARS-CoV-2 Vaccination	6		6	[3] [5]	
	Total	36		6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Phytopathology: Physiological and Molecular Mechanisms of Plant Responses to Pathogens

Course code: PMAB6.08

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Van Phuong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	25 h
	Practice/Exercises	6 h
	Discussion	5 h
	Total	36 h
Prerequisites	Plant Physiology, Microbiology, Plant Genetics	
Recommended background knowledge	Plant-Microorganism Interaction	
Course description:	Based on the fundamental and basic knowledge on plant physiology, plant• microorganism interaction and plant response to stresses, the course will present physiological and molecular mechanisms of plant responses to pathogens	
Objectives & Outcome	Passing this course, the students will achieve the following skills: - Conceptual overview of interaction between plants and microbes Understanding the physiological and molecular mechanisms of plant response to pathogens Detection and diagnosis of plant pathogens and the diseases they cause Protection and control of disease process caused by pathogens, improving the beneficial microbes for plants	
Assessment/ Evaluation	exercises, Midterm test and final thematic group presentation.	

Required Textbooks and Other Course Materials:	1. Richard N. Strange (2003) Introduction to Plant pathology. John Wiley & Sons Ltd. 255pp. 2. B.M.Cooke, D. Gareth Jones and B. Kaye (2006) The epidemiology of plant diseases (2nd edition) Springer 551pp 3. Online materials
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COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment (s)
		Lect.	Prc.	Dis.		
1	- Introduction	4				
2	- Plant-Pathogen interactions + Definitions + PTI-ETS-ETI + Gene-for-gene concept	5	1	1		
3	- Reconnaissance and Specificity: a molecular dialog + PAMPs: Genetic determinants: avirulent genes, resistant genes + Other signals: toxins, DAMPs	4	1	1		
4	- Plant responses to infection + Reinforcement on the cell wall + Induction of defense genes, the PR- proteins + Phytoalexins + Hypersensitive reaction and programmed cell death + Systemic resistances: acquired and induced	7	2	2		
5	- Systemic resistances: acquired and induced + Ions fluxes, calcium and calmodulin + Reactive oxygen species + Proteins phosphorylations, MAP-Kinases + Other signals: salicylic acid, jasmonate, ethylene	5	2	1		
	Total	25	6	5		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Recombinant Proteins for Medical Use

Course code: PMAB6.09

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Dong Van Quyen, TS. Le Thị Thu Hang.

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	30 h
	Practice	6 h
	Discussion	
	Total	36
Prerequisites		
Recommended background knowledge	Molecular Biology, Biochemistry	
Course description:	This course is designed to provide students with a critical understanding of the various ways in which large scale protein expression can be carried out in recombinant systems for medical applications. The students will be introduced the various applications of recombinant proteins, including in pharmaceutical, human and animal health. Also, the students will know how recombinant is used in clinic such as recombinant hormones, interferons, interleukins, growth factors, drugs, and enzymes for treating major diseases such as diabetes, and cancers therapies.	
Objectives & Outcome	The objective of this course is to introduce to the students the available recombinant protein expression systems, with their advantages and limitations Also, high-throughput protein expression, expression in different expression systems will be discussed. The course will focus on strategy design to optimize protein expression and purification and how to address quality assurance of the purified proteins. In	

	addition, the course will guide the students through the key points to consider when one wants to produce and purify high quantities of functional proteins such as antibodies for non-clinical experimental use or as biotherapeutics.
Assessment/ Evaluation	exercise, essay, practice, thematic report
Required Textbooks and Other Course Materials:	1. Protein Engineering: Tools and Applications. Editor(s): Huimin Zhao, Sang Yup Lee, Jens Nielsen, Gregory Stephanopoulos. First published:6 August 2021. Print ISBN:9783527344703 !Online ISBN:9783527815128 001:10.1002/9783527815128 2. A Practical Guide to Protein Engineering Tuck Seng Wong, Kang Lan Tee. Springer Nature Switzerland AG 2020. DOI: https://doi.org/10.1007/978-3-030-56898-6

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Chapter 1: Introduction to recombinant protein technologies + Content 1.1. Introduction to the current methodologies used to express and purify proteins of biotechnological significance in recombinant systems + Content 1.2. Evaluate the use of different recombinant systems and purification mechanisms.	3	3			
2	- Chapter 2: Describe techniques that are commonly used to express proteins in recombinant systems.	4				
3	- Chapter 3: Analyze the results from experimental data	3	3			
4	- Chapter 4: Define & distinguish between different types of recombinant protein expression	2				
5	- Chapter 5: Explain essential DNA elements & their functions in an expression vector	3				
6	- Chapter 6: Evaluate advantages & limitations of different host systems available for recombinant protein expression	3				
7	- Chapter 7: Outline general strategies used for isolation/purification of recombinant proteins	3				
8	- Chapter 8: Assess utility of biochemical properties of a protein in developing strategies for its production.	3				
9	- Chapter 9: Case studies of production and application of recombinant protein in healthcare.	6				
	Total	30	6			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Analytical Platform for Small Molecules

Course code: PMAB6.10

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Thi Kieu Oanh, Dr. Le Hong Luyen

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	12 h
	Discussion	
	Total	36 h
Prerequisites	Analytical chemistry	
Recommended background knowledge		
Course description:	This course is designed to provide students with a critical understanding of the various ways in analysis of small molecules in biology and pharmacology fields. The students will be introduced the various applications of light spectrum, fluorescence, NMR, mass spectrometry. Also, the students will acquire knowledge on the different chromatographic methods for separation of biological products.	
Objectives & Out-come	The objective of this course is to introduce to the students the available analytical instruments for small molecules characterization. The course will focus on the principle, composition, procedure and application of each hyphenated instrument including UV-VIS, ICP-MS, GC-MS, HPLC-DAD/FLD, UPLC-QqQMS, UPLC-QToFMS and MALDI-ToFMS. In addition, students can apply these techniques for their real samples (if any) to a suitable expectation.	
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.	

Required Textbooks and Other Course Materials:	1. Sharma, B.K. "Instrumental Methods of Chemical Analysis: Analytical Chemistry", Krishna Prakashan Media (P) Ltd, 2014 2. Haven, Mary C., et al., "Laboratory Instrumentation ". 4th Edition, Wiley India Pvt Ltd, 2010 3. Philopose P.M. Analytical Biotechnology. Domihant Publishers & distributors, New Delhi, 2016.
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COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	UV-VIS spectrophotometer: principle, composition, procedure and application	3	1			
2	Introduction to ICP-MS: principle, composition, procedure and application	3	1			
3	Introduction to GC-MS: principle, composition, procedure and application	4	2			
4	Introduction to HPLC-DAD/FLD: principle, composition, procedure and application	3	2			
5	Introduction to UPLC-QqQMS: principle, composition, procedure and application	4	2			
6	Introduction to UPLC-QToFMS: principle, composition, procedure and application	4	2			
7	Introduction to MALD-ToFMS: principle, composition, procedure and application	3	2			
	Total	24	12			

Part 3. Doctoral Courses for PhD Program on Information and Communication Technology

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	ICT6.01	Deep Learning: Methods and Applications	3	Dr. Nghiem Thi Phuong
2	ICT6.02	Artificial Intelligence and Machine Learning in Medicine and Healthcare	3	Dr. Tran Giang Son
3	ICT6.03	Computer Networks: Performance Evaluation by Simulation and Analysis	3	Dr. Nguyen Minh Huong
4	ICT6.04	Advanced Computer Network Modeling: Stochastic Processes	3	Dr. Giang Anh Tuan
5	ICT6.05	Advanced topics in Computer Graphics	3	Dr. Nguyen Hoang Ha
6	ICT6.06	High-Performance Computing: Parallelization on CPU and GPU	3	Dr. Tran Giang Son
7	ICT6.07	Recommendation Systems Specialization	3	Dr. Doan Nhat Quang

Hanoi, March 15, 2024

Detailed Course

1. Course name: Deep Learning: Methods and Applications

Course code: ICT6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nghiem Thi Phuong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	20 h
	Practice	10 h
	Discussion	6 h
	Total	36 h
Prerequisites	Python Programming; Basic Artificial Intelligence and Machine Learning	
Recommended background knowledge	Basic Knowledge of Image and Text Data	
Course description	This course will provide graduate-level introduction to deep learning from theory to applications. Deep learning is now the important branch of artificial intelligence and machine learning with a wide range of applications in all fields. The course first brings to graduate students the critical theory of deep learning (linear neural networks, multilayer perceptron neural networks, convolutional neural networks, recurrent neural networks). Then it presents some up-to-date	

	applications of deep learning in the fields of computer vision and natural language processing.
Objectives & Outcomes	The objectives of this course is to provide students with fundamental theory of deep learning methods and practice them with some up-to-date applications of deep learning in the domains of computer vision and natural language processing. At the end of the course, students are expected to: • Understand the critical concepts and techniques of deep learning methods. • Be able to use these concepts and techniques in some applications of deep learning in the domain of computer vision and natural language processing.
Assessment/ Evaluation	Scientific report and project presentation (100%)
Required Textbooks and Other Course Materials	[1] Aston Zhang, Alexander J. Smola, Zachary Lipton, Mu Li. Dive into Deep Learning (1st edition), 2023.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignments
		Lect	Prc.	Dis.		
1	Introduction to Deep Learning	2		1	Chapter 1 [1]	
2	Linear Neural Networks for Regression and Classification	3	1		Chapter 3, 4 [1]	
3	Multilayer Perceptron Neural Networks	3	1		Chapter 5 [1]	
4	Convolutional Neural Networks	3	2	1	Chapter 7, 8 [1]	
5	Recurrent Neural Networks	3	2		Chapter 9, 10 [1]	
6	Computer Vision	3	2	2	Chapter 14 [1]	
7	Natural Language Processing	3	2	2	Chapter 15, 16 [1]	
	Total	20	10	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Artificial Intelligence and Machine Learning in Medicine and Healthcare

Course code: ICT6.02

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Tran Giang Son

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	20 h
	Practice	10 h
	Discussion	6 h
	Total	36 h
Prerequisites	Python Programming, Basic Artificial Intelligence and Machine Learning	
Recommended background knowledge	Basic Knowledge of Medical Data	
Course description	This course provides a critical foundation of artificial intelligence and machine learning in medicine and healthcare for PhD students doing research in medical data analysis. Topics covered in the course include mathematical modeling of medical data, linear regression and classification of medical data, multi-layer perceptrons, convolutional neural	

	networks and recurrent neural networks in medicine and healthcare.
Objectives & Outcomes	The objectives of this course is to provide students with fundamental machine learning methods and practice them how to apply these methods in the field of medicine and healthcare. At the end of the course, students are expected to: • Understand different machine learning methods for medicine and healthcare. • Be able to apply these machine learning methods in some specific problems of medicine and healthcare.
Assessment/ Evaluation	Scientific report and project presentation (100%)
Required Textbooks and Other Course Materials	[1] Reza Borhani, Soheila Borhani, Aggelos Konstantinos Katsaggelos. Fundamentals of machine learning and deep learning in medicine. Springer, 2022.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	Introduction to Artificial Intelligence and Machine Learning in Medicine	2		1	Chapter 1 [1]	
2	Mathematical Modeling of Medical Data	3	1	1	Chapter 2 [1]	
3	Linear Regression of Medical Data	3	1		Chapter 4 [1]	
4	Linear Classification of Medical Data	3	2	2	Chapter 5 [1]	
5	Multi-Layer Perceptrons in Medicine and Healthcare	3	2		Chapter 6 [1]	
6	Convolutional Neural Networks in Medicine and Healthcare	3	2	2	Chapter 7 [1]	
7	Recurrent Neural Networks in Medicine and Healthcare	3	2		Chapter 8 [1]	
	Total	20	10	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Computer Networks: Performance Evaluation by Simulation and Analysis

Course code: ICT6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Minh Huong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	15 h
	Practice	6 h
	Discussion	15 h
	Total	36 h
Prerequisites	Two prior courses: - Computer Networks - Basic Programming	
Recommended background knowledge	- Principles of computer networks - Fundamentals of programming in C++ and Python	
Course description	Network Simulation is a technique of using a software program (a simulator) to model the behavior of a network. The subject focuses on 2 issues: - OSI model and Protocols at abstract layers of the model. - How they are modeled in a network simulator.	

Objectives & Outcomes	As a result of successfully completing this course, students are able to: - Be familiar with NS-3, the network simulator. - Describe Physical and MAC layers of a network in Programming C++/Python languages. - Design simulation scenarios regarding to requirements of a given research question in wireless networks (for example: Wifi, IoT, MANET, wireless sensor networks, LTE...). - Implement basic network protocols in programming tools (NS-3) to illustrate how they work. - Collect and Analyze simulation result.	
Assessment/ Evaluation	Mid-term Project report Final project report	40% 60%
Required Textbooks and Other Course Materials	[1] ns-3 tutorial. https://www.nsnam.org/docs/release/3.32/tutorial/ns-3-tutorial.pdf. [2] Andrews S. Tannebaum, Computer Networks, 4th edition, Prentice Hall, 2002. [3] Widjaja, Indra, and Alberto Leon-Garcia. "Communication Networks Fundamental Concepts and Key Architectures." Mc GrawHill: USA (2004).	

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	Introduction to Network Simulation	3	1	3		Install and Build NS-3
2	2.1. Networking Fundamentals Revises: 2.1.1. OSI model 2.1.2. Physical layers 2.1.3. Link layers 2.1.4. Network layers and Routing 2.1.5. Transport layers and Application layers 2.2. Wireless Networks	3	1	3		
3	3.1. Network models in NS-3 3.2. Design Simulation Scenario 3.2.1. Objectives of the simulation 3.2.2. Metrics to evaluate the network and how to collect them 3.3. Example: Mobile Ad hoc Network, Wifi network	3	1	3		- Run the first script - Building topologies - Description of a network simulation scenario
4	Implementing a network protocol	3	1	3		A NS-3 module corresponding to the implemented protocol
5	Evaluate a given protocol	3	2	3		Project report
	Total	15	6	15		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Computer Network Modeling: Stochastic Processes

2. Course code: ICT6.04

3. Credits points (ECTS): 3

4. Lecturer in charge: Dr. Giang Anh Tuan

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	21 h
	Practice	9 h
	Discussion	6 h
	Total	36 h
Prerequisites	Programming, Probability, Computer Network	
Recommended background knowledge	Linear algebra, Calculus	
Course description	This course provides an in-depth introduction to stochastic processes and their application for network modelling. The course begins with an overview of the point process, a narrow branch of stochastic processes. Later, the course focuses on the Poisson and the Markovian point processes. Finally, the course will be concluded with several typical network problems modelled precisely with those stochastic processes.	

Objectives & Outcomes	The students are expected to understand the fundamental mathematic background and the example network problems. Ultimately, the students should be able to apply the math results to model a specific network problem.
Assessment/ Evaluation	Oral examination or essay (100%)
Required Textbooks and Other Course Materials	[1] Daley, Daryl J., and David Vere-Jones. <i>An introduction to the theory of point processes: volume I: elementary theory and methods</i>. Springer New York, 2003. [2] Baddeley, Adrian, Imre Bárány, and Rolf Schneider. "Spatial point processes and their applications." <i>Stochastic Geometry: Lectures Given at the CIME Summer School Held in Martina Franca, Italy, September 13–18, 2004</i> (2007): 1-75.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	1. An overview of point processes 1.1. History of life table 1.2. Counting problems 1.3. Recent developments	6		2	[1] [2]	Essay
2	2. Poisson point processes 2.1. One-dimensional Poisson point processes 2.2. Multi-dimensional Poisson point processes 2.3. Homogeneous Poisson point processes 2.4. General Poisson point processes	6	3	2	[1]	Exercises
3	3. Markovian point processes 3.1. Markov equilibrium distribution 3.2. Markovian point processes	6	3	2	[1]	Exercises
4	4. Network problems 4.1. Wireless ad-hoc network modeling 4.2. Queuing buffer of wireless access point	3	3		[2]	Programming
	Total	21	9	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced topics in Computer Graphics

Course code: ICT6.05

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Hoang Ha

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	22 h
	Practice	11 h
	Discussion	3 h
	Total	36 h
Prerequisites	Linear Algebra, Basic Programming	
Recommended background knowledge	Students are expected to be fluent in C/C++ and familiar with modern development tools such as Visual Studio, XCode, or the GNU toolchain. Furthermore, experience in image processing is also useful for this subject.	
Course description	This course will provide graduate-level introduction to in Computer Graphics. The ultimate goal of this domain is to generate high-quality images from given data. The course first brings graduate students or advanced undergraduates with the concepts of the rendering pipeline. Then it presents some up-to-date ideas in research that bridge the gap between realism, compression and interactivity.	

Objectives & Outcomes	Students need to understand the principle and rendering pipeline and able to summary the contents of scientific papers in the domain.
Assessment/ Evaluation	Thematic report combined with a presentation (100%).
Required Textbooks and Other Course Materials	1. JungHyun Han. 2011. 3D Graphics for Game Programming (1st ed.)

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	- Main content 1: Basic concepts in 3D rendering 1.1. Virtual world and 3D modelling 1.2. Rendering pipeline	4			Chapter 1	
2	- Main content 2: Details of phases in rendering pipeline 2.1. Vertex processing 2.2. Rasterization 2.3. Fragment processing 2.4. Output merging	6		3	Chapter 2,3,4	
3	- Main content 3: Texturing 3.1. Concepts 3.2. Texture mode 3.3. Problems of Minification and magnification 3.4. Techniques to interpolates in texturing	4	4		Chapter 8	
4	- Main content 4: Illumination and ray tracing 4.1. Local Illumination 4.2. Global Illumination 4.3. Ray Generation 4.4. Ray Tracing Algorithms	4	4		Chapter 5	
5	- Main content 5: Research paper study and analyze Read and learn from recent research papers. Topics to be read include, but not limited to raytracing, 3D model generation by deep learning, 3d model segmentation and classification, recent Developments in Fast Offline Rendering	4	3			1

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect	Prc.	Dis.		
	Total	22	11	3		

Hanoi, March 15, 2024

Detailed Course

1. Course name: High-Performance computing: Parallelization on CPU and GPU

Course code: ICT6.06

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Tran Giang Son

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	20 h
	Practice	12 h
	Discussion	4 h
	Total	36 h
Prerequisites	Programming in Python	
Recommended background knowledge	Distributed Systems	
Course description	This code offers techniques guaranteed to boost code's effectiveness. Students will learn to evaluate hardware architectures and work with industry standard tools such as OpenMP and MPI. Data structures and algorithms best suited for high performance computing and techniques that save energy on handheld devices will also be covered in this course. There will be a massive tsunami simulation across a bank of GPUs in the course, as an illustration of how High Performance Computing works on a GPU platform.	

Objectives & Outcomes	This course provides students with fundamental knowledge of high performance computing with parallelization on CPU and GPU systems. At the end of the course, students are expected to understand the principle, architecture of high performance computing systems, notably parallelization methods on CPU and GPU. Additionally, students should be able to summary the contents of scientific papers in the domain.
Assessment/ Evaluation	Scientific report and project presentation (100%)
Required Textbooks and Other Course Materials	[1] Robert Robey and Yuliana Zamora. 2021. Parallel and High Performance Computing. Simon and Schuster. [2] Introduction to High Performance Computing for Scientists and Engineers.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assign ment(s)
		Lect	Prc.	Dis.		
1	1. Introduction to Parallel Computing					
	1.1. Why parallel computing?	1			Chapter 1 [1]	
	1.2. Planning	1			Chapter 2 [1]	
	1.3. Performance limits	1			Chapter 3 [1]	
	1.4. Data design and performance models	1			Chapter 4 [1]	
	1.5. Parallel algorithms and patterns	2	2		Chapter 5 [1]	
2	2. CPU: The Parallel Workhorse					
	2.1. SIMD with Vectorization	2			Chapter 6 [1]	
	2.2. OpenMP	2	2	1	Chapter 7 [2]	
	2.3. MPI for distributed systems	2	2	1		

					Chapter 10 [2]	
3	3. GPU: General Purpose Computing on GPU 3.1. GPU architecture 3.2. GPU programming model 3.3. Directive-based GPU programming 3.4. GPU language	2 2 2 2	 2 2 2	 1	Chapter 9 [1] Chapter 10 [1] Chapter 11 [1] Chapter 12 [1]	
	Total	20	12	4		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Recommendation Systems Specialization

Course code: ICT6.07

2. Credits points (ECTS): 03

3. Lecturer in charge: Dr. Doan Nhat Quang

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	15 h
	Practice	15 h
	Discussion	6 h
	Total	36 h
Prerequisites	Algebraic, Machine Learning, Data Mining	
Recommended background knowledge	Scientific programming languages: Matlab, Python, Scilab, R	
Course description	This course covers the fundamental techniques in recommendation systems, through content-based and collaborative filtering techniques, as well as advanced topics like matrix factorization, hybrid methods for recommendation systems. This specialization course is designed with theory and practice to serve both the data mining expert and the business data analyst.	

Objectives & Outcomes	- Provide the requirements and objectives of recommendation systems based on different application domains; - Understand different approaches to building recommendation systems; - Know how to analyze and discuss on results of recommendation.
Assessment/ Evaluation	- Attendance: 10% - Report: 50% - Presentation: 40%
Required Textbooks and Other Course Materials	Charu C. Aggarwal. Recommender Systems – Springer (2016)

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	1. Introduction to Recommendation Systems 1.1. Applications 1.2. Frameworks 1.3. Tools	3		3		
2	2. Content-based filtering	3	2			
3	3. Collaborative filtering (CF) 3.1. Memory-based CF 3.2. Model-based CF	3	3			
4	4. Graph-based Recommendation Systems	3	2			
5	5. Matrix factorization	3	2			
6	Project		6	3		
	Total	15	15	6		

Part 4. Doctoral Courses for PhD Program on Advanced Materials Science and Nanotechnology

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	AMSN6.01	Modern Trend in Nanoelectrochemistry	3	Assoc. Prof. Nguyen Van Quynh
2	AMSN6.02	Biosensors and Bioelectronics	3	Dr. Vu Thi Thu
3	AMSN6.03	Advanced BioMEMS	3	Dr. Pham Van Nhat
4	AMSN6.03	Nanostructured Functional Materials for Advanced Energy Applications	3	Dr. Le Thi Huong

Hanoi, March 15, 2024

Detailed Course

1. Course name: Modern Trend in Nanoelectrochemistry

Course code: AMSN6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Nguyen Van Quynh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	
	Discussion	12 h
	Total	36 h
Prerequisites	Students should know about fundamental physical chemistry, fundamental nanomaterials, and their applications.	
Recommended background knowledge	Have basic knowledge about concepts, such as conventional 3 electrodes electrochemistry system, various electrochemical techniques for deposition and characterization of bulk film, and nanostructured surface. Understanding Polarography; Chronopotentiometry; Chronoamperometry, Chronocoulometry, Linear Potential Sweep; Voltammetry; Cyclic Voltammetry, Impedance measurements; AC Voltammetry. Understanding factors affecting the electrochemical reaction rate: temperature, ionic strength of the solution, catalyst, pH and dielectric constant of the medium, micelle, reverse micelle & nanoparticles;	

Course description:	This course provides advanced knowledges in some current research fields with electrochemistry systems.
Objectives & Outcome	Students gained knowledge of liquid electrochemistry at nanointerfaces where the electrified interface between two immiscible electrolytes is the heterogeneous interface through which charge (ion or electron or ion-coupled-electron) transfer takes place. Students are introduced to some modern trend of nano electrochemistry for investigation of nano junction, nanopores system, metal-organic frameworks system...
Assessment/ Evaluation	Attendance/ attitude: 30% ; final exam/ scientific report: 70%
Required Textbooks and Other Course Materials:	1-Electrochemistry at nanoscale written by P. Schmuki and S. Virtanen; 2- Techniques and mechanisms in electrochemistry written by PA. Chirstensenand and A. Hamnett. 3- Electrochemistry of Nanomaterials written by Garyhodes 4- Electrochemistry Volume 12 – nano electrochemistry written by Richard Compton and Jay Wadhawan, 2013; DOI: 10.1039/9781849737333 5- Electrochemistry of organic compounds written by Walther Lob

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Nano electrochemistry at the liquid/liquid interfaces	3		1		
2	Electrochemistry at nanoelectrodes	3		2		
3	Electrochemistry within nanogaps	3		1		
4	Electrochemical applications of nanopore systems	3		2		
5	Electrochemistry within metal-organic frameworks	3		1		
6	Electrochemistry of graphene: the current state of the art	3		2		
7	Electrochemistry of semiconductor nanostructures	3		1		
8	Advanced electrochemical sensing system.	3		2		
	Total	24		12		

Hanoi, March 15, 2024

Detailed Course

1. **Course name: Biosensors and Bioelectronics**

Course code: AMSN6.02

2. **Credits points (ECTS): 3**

3. **Lecturer in charge:** Dr. Vu Thi Thu

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	20 h
	Discussion	
	Practice	16 h
	Total	36 h
Prerequisites	Chemistry, Physics	
Recommended background knowledge	Biochemistry, Genetics, Immunology Electronics, Nanomaterials, Medical instruments	
Course description	In this course, the basic principles and state-of-the-art on developing biosensing systems will be discussed.	
Objectives & Outcome	Upon completion of this course, a student should: - Become familiar with current <i>biosensing</i> technologies - Understand <i>working principles</i> of the most common biosensors - Able to design and propose manufacturing process of a simple biosensor - Become aware of the challenges in the development of next-generation biosensors	
Assessment/ Evaluation	Thematic report	

Required Textbooks and Other Course Materials:	No textbook. Profile of lecturer: https://www.researchgate.net/profile/Thi_Thu_Vu2 Research groups in this field: Nguyen Nam Trung, Mohammed zourob, Eichi Tamiya, Dong Pyo Kim, Benoit Piro, Martin Pumera, Scott R. White, Andreas Manz, David Sinton, GM Whitesides
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COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	1. Fundamentals on biosensors 1.1. Potential applications 1.2. Main components 1.3. Performance factors	4	3			
2	2. Transducers 2.1. Electrochemical transducers 2.2. Field-effect transistor (FET) 2.3. Electrochemi Luminescence (ECL) 2.4. Optical transducers	4	3			
3	3. Bio-recognition 3.1. Enzymatic reactions 3.2. Immuno assays 3.3. Molecular assays 3.4. Molecular imprinted polymer (MIP) 3.5. Aptamers	4	3			
4	4. Point-of-care devices	4	3			
5	5. Integration	4	4			
	Total	20	16			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced BioMEMS

Course code: AMSN6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Pham Van Nhat

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	21 h
	Practice	9 h
	Discussion	6 h
	Total	36 h
Prerequisites	Bionanotechnology and BioMEMS	
Recommended background knowledge	General Biology Bionanotechnology and BioMems	
Course description:	The course will cover some basic knowledge of Biology and Mechanical Electronic Microsystems and some advanced devices based on BioMEMS are also presented. The course will be focused on the mechanism of device, the procedure to fabricate the device (including the micro/nano fabrication and BioMEMS). A class of practice will be conducted to improve the practical skills for students.	
Objectives & Outcome	1. Have a basic knowledge about concepts, such as conventional MEMS materials, various lithography methods, and bulk and surface micromachining. 2. Understanding some fundamental structures and techniques to fabricate MEMS devices	

	3. Understanding microfluidic theories, important parameters, and components (such as micro-valves and micro-pumps) 4. Understanding theoretical principles and their biological and biomedical applications 5. Understanding the functional nanomaterials and their applications in medical as imaging agents, therapeutic and diagnosis - About skills: Reading scientific publications, Micro-fabrication and biological working. - About attitude: Serious and self-study and hard working
Assessment/ Evaluation	- Teaching methods: Lectures given by lecturer and some presentations and reports for mid-term and final exam.
Required Textbooks and Other Course Materials:	Mauro Ferrari. Volume III: Therapeutic Micro/Nanotechnology. BioMEMS and Biomedical Nanotechnology. Springer 2006

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	Chapter 1: Introduction and overview of BioMEMS and LOC	3		1		
2	Chapter 2: Microfabrication for BioMEMS 2.1. MEMS fabrication 2.2. BioMEMS fabrication and soft-lithography - Biosensors - Biochips	6	9	1		
3	Chapter 3: Microfluidics and components	3		1		
4	Chapter 4: Drug delivery and implant devices.	3		1		
5	Chapter 5: Microdevices for Oral Drug Delivery	3		1		
6	Chapter 6: Nano-designed Pore-Containing Systems for Biosensing and Controlled Drug Release	3		1		
Total		21	9	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Nanostructured Functional Materials for Advanced Energy Applications

2. Course code: AMSN6.04

3. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Le Thi Huong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	12 h
	Discussion	
	Total	36 h
Prerequisites		
Recommended background knowledge	Materials Science, Chemical Engineering, chemical physics.	
Course description:	This course will provide updated information of intensive study on the choice and use of functional materials with nanostructure to enhance performance of advance energy application. Extensively studies between conventional and advanced materials have been compared and selected. These nanomaterials have been optimized on the advanced batteries and supercapacitors. Moreover, the optimized investigated and discussed. The up-to-date, novel and promising nanomaterials will be studied to alternative the conventional materials, to improve performance and overcome drawbacks.	

	The course will cover the state-of-the-art design, preparation, and engineering of nanoscale functional materials as effective active layers/electrodes and also discuss on perspectives and challenges in future research.						
Objectives & Outcome	After this course, the successful student will: ✓ Be able understood the operation, fabrication and function of each component in certain energy applications. ✓ Master in the selection and use of efficient materials to improve device performance. Moreover, the optimization in materials and device fabrication have been provided to obtain higher efficiency and increase stability of devices. Enlarge knowledge to the novel and promising nanomaterials to replace the conventional materials. By these routes, the batteries, supercapacitors and photovoltaic devices tend to low cost, higher efficiency and longer utilization devices.						
Assessment/ Evaluation	<table> <tr> <td>Attendance/Attitude</td><td>10 %</td></tr> <tr> <td>Exercise(s) Practical/tutor</td><td>40 %</td></tr> <tr> <td>Final exam</td><td>50 %</td></tr> </table>	Attendance/Attitude	10 %	Exercise(s) Practical/tutor	40 %	Final exam	50 %
Attendance/Attitude	10 %						
Exercise(s) Practical/tutor	40 %						
Final exam	50 %						
Required Textbooks and Other Course Materials:	Nanostructured, functional, and flexible materials for energy conversion and storage systems. Alagarsamy Pandikumar and Perumal Rameshkumar. Elsevier 2020. Nanomaterials for Advance batteries and supercapacitors. Kenneth I. Ozoemena and Shaowei Chen. Springer 2016.						

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Nanostructured materials for photocatalytic energy conversion. - Titania-based catalysts - Graphite carbon-nitrite based nanocomposite materials. - Nanostructured materials (TiO ₂ nanohybrid, CNTs/TiO ₂ nanocomposite, Fe ₂ O ₃ , graphene/TiO ₂) - Hierarchically nanostructured materials for artificial photosynthesis (Fiber-like nanomaterials, GaN nanowire, ZnO-based, TiO ₂ nanotubes, Ag nanowire)	4				
2	Nanomaterials for fuel cells - Polymeric nanomaterials (in microbial fuel cells, hydrogen fuel cells and direct methanol fuel cells). - Electrocatalysts and Electrocatalysts. support materials (carbon-based, Ti-based, Sb-doped SnO ₂ and SiO ₂ -SO ₃ H) - Nanocomposite polymer electrolytes	4	4			
3	Nanomaterials for advanced batteries -Lithium-ion batteries • Cathode materials (layered compounds LiMO ₂ , spinel compounds LMO and LMNO, olivine compounds LiMPO ₄ • Anode materials (Metal oxide, Li alloy, Sn-based alloy) • Lithium titanates (Li ₄ Ti ₅ O ₁₂) • Rechargeable batteries (Li ₂ MnSiO ₄)-advantages and challenges. - Rechargeable Magnesium-ion batteries • Mg metal anode • Alternative metal anode (Bi, Sb, Bi- Sb alloy, Sn) - Sodium-ion batteries • Cathode/electrolyte/anode materials • Transition metal sulphide/selenide anode materials	4				

	- Nanocomposite polymer materials			
4	Nanomaterials for advanced supercapacitors - Cathode: Nanostructured oxides (transition metal oxides, intercalation compounds, conversion compounds). - Carbon materials (porous carbon, graphene, doped carbon and 3D graphene) - Flexible supercapacitor (carbon fiber-based fabric, CNT, graphene-based aerosol, conductive carbon-based) - Fiber supercapacitor (carbon fiber, CNTs, graphene fiber)	4	4	
5	Membrane separators - Battery technology - Supercapacitor technology	4		
6	Nanostructured materials for solar cells - Nanocarbon for perovskite solar cells - Non-fullerene acceptors for organic solar cells - Near-IR dyes for dye-sensitized solar cells - Nanostructured extremely thin absorber solar cells. - Quantum structure/Colloidal quantum dot. - Materials for flexible-printable solar cells - Materials for semi-transparent/transparent solar cells.	4	4	
Total		24	2	

Part 5. Doctoral Courses for PhD Program on Water-Environment Oceanography

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	WEO6.01	Hydrology Modelling	3	Dr. Nguyen Quoc Son
2	WEO6.02	Ecological Engineering	3	Dr. Nguyen Thanh Hien Dr. Pham Le Anh
3	WEO6.03	Instrumental Analysis for the Environment	3	Dr. Pham Van Nhat
4	WEO6.04	Data Analysis	3	Dr. Pham Le Anh
5	WEO6.05	Environmental Monitoring	3	Dr. Nguyen Quoc Son

Hanoi, March 15, 2024

Detailed Course

1. Course name: Hydrology Modelling

Course code: WEO6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Quoc Son

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	18 h
	Practice	12 h
	Discussion	6 h
	Total	36 h
Prerequisites	N/A	
Recommended background knowledge	N/A	
Course description:	This course consists of a description of a hydrologic models, familiarization with modelling through practical work (implementation on a simple real case, results analyses, sensitivity studies to schemes and parameterizations, process studies, comparison with observations)	
Objectives & Outcome	This module will deal with a learning school of SWAT (Soil and Water Assessment Tool) model (http://swat.tamu.edu/), which is a large used hydrological model that aims to simulate environmental scenarios contributing to water cycle and matter fluxes at the scale of watershed including diverse areas (rural, urban, hill, plain and floodplain). The study area will be Red river basin. After completing this course, students should be able to: - Understand the basic knowledge of hydrological modelling	

	- Understand the formation and the transfer of contaminants in the river - Understand the basic structure of a hydrological model - Work with the SWAT model
Assessment/ Evaluation	Presentation + report
Required Textbooks and Other Course Materials:	Maximum 5 textbook(s)/reference(s)

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	An overview about Hydrology processes	3				
2	Introduction about modelling in hydrology	3				
3	Introduction to SWAT model	3				
4	Modelling applications to a study case	3	6			
5	Personal/group presentations of the input/output data	3		3		
6	Practical work about results of the modelling and writing report of the modelling by personal/group	3	6	3		
	Total	18	12	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Ecological Engineering

Course code: WEO6.02

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Thanh Hien, Dr. Pham Le Anh

Teaching time	First semester	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	21 h
	Practice	12 h
	Discussion	3 h
	Total	36 h
Prerequisites	Students should hold a master's degree in the field of Natural Sciences, Environment Engineering, Civil Engineering, or other areas related to environmental science and technology.	
Recommended background knowledge	Background on one of the following subject areas; biology, ecology, engineering, or geology is preferable. Being good at natural sciences (mathematics, chemistry, physics) as well as processing skills in the field of environmental engineering, such as hydrology, microbiology, earth science, environmental management and environmental processes are an advantage.	
Course description:	This course carries 3 ECTS and consists of one theoretical part and one practical project focusing on application of ecological principles to natural resource management and problem solving.	
Objectives & Outcome	This course aims to provide students fundamental information on i) Ecosystems and their services by describing the biotic and abiotic components, interactions and physical drivers that define major ecosystem functioning; ii) Overview of how ecosystems are engineered and managed by getting insight into	

	principles of ecological engineering and design of sustainable ecosystems; iii) Particular application of ecological engineering in the restoration and management of ecosystems (wetlands, rivers and streams, lakes and reservoirs, coastal areas, etc.) Upon completing the course students will be able to - Understand and describe important physical, chemical, and biological processes that affect ecosystem integrity. - Apply knowledge of ecology, mathematics and engineering in finding solutions for environmental issues and management. - Understand and use modern techniques, skills and engineering tools for engineering practice. - Identify, design and conduct experiments as well as analyze and interpret data.
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.
Required Textbooks and Other Course Materials:	Jorgensen, S.E. (2009) Applications in Ecological Engineering. Elsevier, 393 pp. ISBN: 978 0 444 53448 4 Mitsch, W.J. and S.E. Jorgenson. (2004) Ecological Engineering and Ecosystem Restoration. John Wiley and Sons, Hoboken, New Jersey, 411pp. ISBN: 978 0 471 33264 0

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Introduction to ecological engineering + 1.1. Ecology and Ecosystem concept + 1.2. Ecosystem services and Energy flux	6				
2	- Ecological design principles + 2.1. Ecological principles in engineering + 2.2. Aquatic ecosystem remediations + 2.3. Terrestrial ecosystem remediations	6				
3	- Ecological - social impacts: Payment for ecosystem services	3				
4	- Design Project and Implementation	3	6			
5	- Seminar: Cutting-edge in ecological engineering	3	6	3		
	Total	21	12	3		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Instrumental Analysis for the Environment

Course code: WEO6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Bui van Hoi

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	22 h
	Practice	14 h
	Discussion	
	Total	36 h
Prerequisites	Basic knowledge on physical and structural chemistry (atomic and molecular structure, quantum mechanics, description of a photon), Fundamental of analytical chemistry	
Recommended background knowledge	General chemistry, basic of analytical chemistry, environmental chemistry	
Course description:	This course is designed to introduce the basic principles of different types of instrument used for monitoring contaminants in the environment. This course also present several specific application in environmental analysis.	
Objectives & Outcome	- Students will know principle of instrumental analysis applied in environmental science - Students will learn different types of instrument for both inorganic and organic analysis - Students will know how to choose a suitable technique to monitor any types of contaminants - Students will know how to develop a procedure for analyzing a sample	

Assessment/ Evaluation	Review's report: 20% Practical: 20% Exam: 60%
Required Textbooks and Other Course Materials:	1. Modern analytic chemistry, 2000, David Harvey 2. Basic Atomic and Molecular Spectroscopy J.M. Hollas, 2002 3. Quantitative chemical analysis, 8 edition, 2008, Daniel C. Harris 4. Mass Spectrometry, J.H. Gross, 2 nd edition 2010 5. Principles of instrumental analysis, 2007, 6 th edition, Douglas A. Skoog

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Introduction to instrumental analysis	2				
2	Spectroscopy methods Introduction to spectroscopy Molecular spectroscopy (UV-Vis, Fluorescence) Atomic spectroscopy (AAS, AES, ICP-MS) Application of spectroscopy for environmental analysis	6				
3	Chromatography methods Introduction to separation techniques Gas Chromatography Liquid Chromatography Application of chromatography for environmental analysis	8				
4	Sampling strategy and sample treatment Importance of sampling Sampling strategy Sample pretreatment and storage Sample preparation	4				
5	Mini reviews	2				
6	Practical Practical 1: Determination of heavy metal in sediment sample by ICP-MS Practical 2: Determination of some antibiotics in water sample by SPE-UPLC-MS/MS		14			
	Total	22	14			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Data Analysis

Course code: WEO6.04

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Pham Le Anh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	20 h
	Practice	16 h
	Discussion	
	Total	36 h
Prerequisites	Probability and Statistics	
Recommended background knowledge	Environmental Sciences	
Course description:	The course is intended to provide students required statistical techniques for environmental studies. The courses will help students develop their analytic and critical thinking abilities. Student will also learn to use statistical software R for analyzing environmental data.	
Objectives & Outcome	The aim of this subject is to equip students with the procedures and techniques required for processing and analysing research data in particular. After studying the subject, students will be able to (i) appreciate the importance of statistical techniques in environmental research (ii) how	

	to collect data (iii) understand and apply the statistical methods to process and analyse data using R.
Assessment/ Evaluation	Exercise, practice and thematic report.
Required Textbooks and Other Course Materials:	[1]. Bryan F.J. Manly. Statistics for Environmental Science and Management, Second Edition. Chapman and Hall/CRC, 2008. [2]. Crawley, M.J., 2009. The R book. Wiley, Chichester, England. [3]. C.Philip Wheeler and Penny A.Cook, Using Statistics to Understand the Environment, Routledge Introductions to Environment Series, Routledge, 2000.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Introduction to R and RStudio + Installing and general introduction to R and Rstudio. + Practice on basic functions for data handling in RStudio.	2	2			
2	- Descriptive Statistics + Brief summary of descriptive statistics: population and samples, central tendency, dispersion, measure of asymmetry. + Performing descriptive statistics using RStudio	2	2			
3	- Probability Distribution and data visualization in R + Brief summary of different probability distributions commonly found when handling environmental data. + Data visualization using RStudio	2	2			
4	- Significant tests + Brief summary of hypothesis testing and the significant test between two means + Performing the test in RStudio	3	2			
5	- Analysis of variance + Brief summary of the analysis of variance and the significant test between more than two means + Performing the test in RStudio	3	2			
6	- Relationship between variables + Brief summary of correlation and regression analysis + Performing the test in RStudio	3	2			
7	- Principle component analysis	3	2			

	+ Brief summary of the principle component analysis + Performing the test in RStudio					
8	- Time series analysis + Brief summary of the principle component analysis + Performing the analysis in RStudio	2	2			
	Total	20	16			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Environmental Monitoring

Course code: WEO6.05

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Quoc Son

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	16 h
	Practice	16 h
	Discussion	4 h
	Total	36 h
Prerequisites	N/A	
Recommended background knowledge	N/A	
Course description:	The course focuses on the application of modelling on analyzing and computing environmental data. Modelling includes two approaches, which are i) the empirical model which was based on the known relationship between environment parameters and ii) the data-driven approach which seeks for underlying relationship in the dataset. Among those, the second approach recently receives rising attention in environmental data analysis – machine learning. In particular, this module introduces the general definition of different types of problems in machine learning, as well as the general rules to apply and metrics to assess the performance of machine learning models in data analysis. Then, different problems in machine learning, including regression, classification and unsupervised learning will in	

	turn be explained in detail with regard to specific case studies.
Objectives & Outcome	The objective of the course is firstly to comprehend the process of data manipulation and preparation to have ready-to-use input data for modelling. Moreover, student can understand the basic concepts of modelling and/or machine learning, as well as comprehend the procedure of applying modelling and/or machine learning in specific problems of environmental data monitoring. After the course, students can process data for modelling and should be able to analyze the performance of such models, as well as to explain and understand the results.
Assessment/ Evaluation	Presentation + report
Required Textbooks and Other Course Materials:	Hsieh, W. (2009). Machine Learning Methods in the Environmental Sciences: Neural Networks and Kernels. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511627217

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	Data manipulation for bulk environmental data download	4	4			
2	General introduction to Machine Learning/modelling	4				
3	Regression and application in environmental monitoring	4				
4	Classification and application in environmental monitoring	4				
5	Personal/group presentations of the input/output data			4		
6	Practical work about results of the modelling and writing report of the modelling by personal/group		12			
	Total	16	16	4		

Part 6. Doctoral Courses for PhD Program on Ph.D. Program on Energy

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	EN6.01	Energy Audit	3	Dr. Duong Viet Anh Dr. Nguyen Xuan Quang
2	EN6.02	Analysis of Energy Systems: Management, Planning, and Policy	3	Dr. Hoang Trung Kien Dr. Phan Anh Tuan
3	EN6.03	Asset Management and Condition Monitoring in Power System	3	Dr. Nguyen Xuan Truong Dr. Hoang Trung Kien
4	EN6.04	Embedded System in Energy Monitoring and Analysis	3	Dr. Pham Xuan Tung Dr. Phan Thanh Hien
5	EN6.05	Control of Microgrids	3	Dr. Phan Anh Tuan Dr. Nguyen Cong Phuong
6	EN6.06	Applied Mathematics in Engineering	3	Dr. Nguyen Mai Chung

Hanoi, March 15, 2024

Detailed Course

1.Course name: Energy Audit

Course code: EN6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Duong Viet Anh, Dr. Nguyen Xuan Quang

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	21 h
	Practice	9 h
	Discussion	6 h
	Total	36 h
Prerequisites	Thermodynamics, Air Conditioning Systems	
Recommended background knowledge	Thermodynamics and Thermodynamics Systems	
Course description:	The pressure of Technological development in all sectors on the Renewable energy sources has led to the growing the cost of energy around the world. Efficient and judicious use of the available energy sources would lead to the easing of such pressures and drastic decrease in the operating costs of the organizations and industries. Thus, it is necessary to save and conserve energy to the maximum possible extent. The process of energy audit will help to identify the various possible avenues in which savings of energy can be effectively adopted.	

	This course makes students well acquainted in the techniques of energy analysis and saving in the fields of engineering. It also introduces students the energy audit procedures.
Objectives & Outcome	The aim of this course is to help the student to - Interpret energy conservation policies in Vietnam. - Carry out energy audit for any industrial environment (thermal system, electrical system....). - Propose and implement energy conservation technical solutions.
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.
Required Textbooks and Other Course Materials:	- Kumar L. A., and Ganesan G. Energy Audit and Management - Concept, Methodologies, Procedures, and Case Studies. CRC Press, 2022. - Desai S. Handbook of Energy Audit. McGraw-Hill INDIA, 2015. - Thumann A. Handbook of Energy Audit. Fairmont Press, 2008.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Chapter 1: Fundamentals of Energy Management and Energy Conservation + Introduction to Energy Auditing + Planning an Energy Audit + Energy Audit Concept + Portable Measuring Instruments + Typical Measurements and Instrumentation + Different Types of Losses in a Factory	3				
2	Chapter 2: Energy Conservation Opportunities in Thermal Systems + Energy Saving Proposals (ESP) in Boilers + Energy Saving Proposals in Steam Systems + Energy Saving Proposals in Furnaces + Energy Saving Proposals in Insulation and Refractories + Energy Saving Proposals in Waste Heat Recovery + Energy Saving Proposals in Cooling Towers	3	3			
3	Chapter 3: Energy Efficiency in HVAC and Refrigeration Systems + Classification of HVAC Systems + Vapor Compression Refrigeration System + Energy Conservation Opportunities	3	3	3		

	and Case Studies					
4	Chapter 4: Energy Efficiency in Furnaces + Industrial Furnaces + Simple Steps to Cut Down the Energy Consumption + Energy Saving Proposals and Opportunities	3	3	3		
5	Chapter 5: Energy Conservation Opportunities in Electrical Systems + Energy Saving Proposals in Electrical Systems Study + Energy Conservation in Electrical Motors + Energy Conservation in Lighting System	3				
6	Chapter 6: Role of Industry 4.0 in Energy Management Systems Opportunities in Electrical Systems + Introduction + Concepts of Industry 4.0 in Energy and Utilities Management + Industry 4.0 and Energy and Utilities Management	3				
7	Chapter 7: Nonintrusive Load Monitoring for Efficient Energy Management and Energy Savings + Introduction + Data Acquisition for NILM + Data Storage + Components	3				
	Total	21	9	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Analysis of Energy Systems: Management, Planning, and Policy

Course code: EN6.02

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Hoang Trung Kien, Dr. Phan Anh Tuan

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	18 h
	Practice	12 h
	Discussion	6 h
	Total	36 h
Prerequisites		
Recommended background knowledge		
Course description:	The analysis of energy systems is of paramount importance in modern societies, since it is fundamental to guarantee a sustainable economic development. It combines technical and economic research with a specific focus on quantitative modeling, in order to optimize the modalities of energy demand and supply globally. Management, planning, and policy are three key aspects in the study of complex energy systems, which have to be considered at the same time, because of the	

	“multidimensional” nature of energy-related interactions. Through effective energy management, it is possible to reduce consumption, thus enhancing energy efficiency, and to optimize supply and demand in the medium/short term.
Objectives & Outcome	After completing the course, NCS will be able to: - Understand the relation between energy transition and sustainability. - Analyze a microgrid under uncertainty condition - Analyze the cost-benefit for energy policies
Assessment/ Evaluation	The knowledge and skills expected to equip student will be evaluated throughout the course via learning activities, discussion, exercises, etc. A final exam will be provided by a written report on given topics related to the course.
Required Textbooks and Other Course Materials:	1. Vincenzo Bianco, <i>Analysis of energy systems: management, planning, and policy</i>; CRC Press, 2017. 2. Justin Gonzalez, <i>Energy Planning: Approaches and Assessment</i>; Nova Science Pub Inc, 2017. 3. Henrik Lund, <i>Renewable energy systems: a smart energy systems approach to the choice and modeling of 100% renewable solutions (2nd edition)</i>, Academic Press, 2014.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Chapter 1: Systemic interventions to achieve a long-term energy transition toward sustainability. 1.1. Multi-dimension of energy system transition. 1.2. Complex link between energy and development. 1.3. Co-benefit from the energy transition 1.4. Integrated policy interventions	3	2	1		
2	Chapter 2: Energy and climate planning: The role of analytical tools and soft measures. 2.1. Introduction. 2.2. Energy and climate planning: the policy framework. 2.3. Energy awareness and behavioral aspects 2.4. Energy planning methods and tools 2.5. Citizen's engagement and local action plans.	3	2	1		
3	Chapter 3: Competitiveness of distributed generation of heat, power, and cooling: system. 3.1. Introduction. 3.2. Distributed generation technologies. 3.3. Overview of policies, concern, and recommendation	3	2	1		

4	Chapter 4: Renewables optimization in energy-only markets. 4.1. Introduction. 4.2. Growth of RES-E. 4.3. Merit-order effect and the missing money problem 4.4. Market integration of high-level RES-E 4.5. RES-E optimization through market integration	3	2	1		
5	Chapter 5: Optimal scheduling of a microgrid under uncertainty condition 5.1. Introduction 5.2. Microgrid 5.3. Deliberated energy market structure 5.4. Uncertainty evaluation 5.5. Case studies	3	2	1		
6	Chapter 6. Cost-benefit analysis of energy policies 6.1. Introduction 6.2. Historical development of CBA 6.3. Assessing cost and benefits 6.4. Basic principles underpinning CBA 6.5. Appraisal tools to assess energy policies, program, and project 6.6. CBA on energy: institutional differences 6.7: Quality of the data and CBAs on energy	3	2	1		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Asset Management and Condition Monitoring in Power System

Course code: EN6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Xuan Truong, Dr. Hoang Trung Kien

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	16 h
	Practice	14 h
	Discussion	6 h
	Total	36 h
Prerequisites	Electrical Circuits	
Recommended background knowledge	Conversion of Energy; Electrical Machine	
Course description:	This course refers to reliability theories to optimize maintenance processes and modern asset management techniques in the electric power system. The course provides knowledge about the principles of operation of equipment (transformer, power lines, switch gear, and transmission/distribution network...), including failure modes and ageing and modern techniques for assessing asset condition. Factors affecting important over stresses occurring in power networks (including fault currents and lightning and switching over-voltages) are studied and methods of acceptance testing are reviewed. Principles of managing electrical assets in power networks in various stages of the life cycle are covered, including specification, procurement, operation and maintenance, and replacement. Students should have a background in basic electric network analysis including complex impedances, transients, and three-phase systems. A knowledge of basic probability theory and statistical distributions is also desirable.	

Objectives & Outcome	About knowledge: ✓ Determine the failure modes of the main types of assets that are contained in large high voltage electric power systems. ✓ Specify types of condition monitoring equipment required to detect impending failures. ✓ Specify electrical tests that will give confidence that dangerously high potential rises will not occur on exposed conducting parts of high voltage systems. - About skills: ✓ Apply assessment methods in the development of strategic asset management policies for electricity transmission and distribution networks. - About attitude: ✓ Deep discipline knowledge and intellectual breadth. ✓ Creative and critical thinking, and problem solving. ✓ Teamwork and communication skills.
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc. Final grade of the course: <i>Practice: 30%</i> <i>Thematic report: 30%</i> <i>Presentation and Discussion: 40%</i>
Required Textbooks and Other Course Materials:	[1] R.E. James and Q.Su. <i>Condition Assessment of High Voltage Insulation in Power System Equipment</i>. The Institution of Engineering and Technology, 2008. [2] ByN.H. Malik, A. A. Al-Arainy, M.I. Qureshi. <i>Electrical Insulation in Power Systems</i>. CRC Press, 2018. [3] Abdel-Salam, M. <i>High-Voltage Engineering: Theory and Practice</i>. Second Edition, Revised and Expanded (2nd ed. 2018). CRC Press.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Module 1: Overview of power system + Power system structure + Single line diagram + Protection devices in power system	6	0	0		
2	- Module 2: Asset management and condition monitoring + Basic principle + Abnormal Currents and Temperature + Abnormal Voltages and Travelling Waves + HV Insulation + Insulation Co-ordination	6	4	0		
3	- Module 3: Asset management in power supply utilities + Transformers + Power system earthing fundamentals. + Arcs and Circuit Breakers...	6	4	0		
4	- Module 4: Assignments + Assignment level 1: report based on the laboratory demonstrations. + Assignment level 2: how data from the condition monitoring system could be expeditiously collected and analyzed. + Assignment level 3: nominating a particular type of power system asset....	0	6	0		
5	- Module 5: Seminars on power system's asset management + Transformer monitoring equipment + Lightning Detection... + Report on a substation site visit (field notes)	0	0	6		
Total		16	14	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Embedded System in Energy Monitoring and Analysis

Course code: EN6.04

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Pham Xuan Tung, Dr. Phan Thanh Hien

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	16 h
	Practice	10 h
	Discussion	10 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	Embedded System; Microprocessor and Microcontroller	
Course description:	This course focuses on the theory and practical implementation of embedded energy monitoring and analysis systems. The course will cover the principles of energy monitoring and analysis, embedded systems, and their integration with energy monitoring devices. It will also cover energy management strategies, data acquisition, and processing. Students will learn to design and develop embedded energy monitoring and analysis systems. They also learn how to	

	analyze and interpret data from energy monitoring systems and identify opportunities for energy savings or optimization. Students should have a basic embedded system or microprocessor and microcontroller background. Knowledge of basic system design is also desirable.
Objectives & Outcome	About knowledge: ✓ Understand the principles of energy monitoring and analysis ✓ Design and develop embedded systems for energy monitoring and analysis ✓ Integrate embedded systems with energy monitoring devices ✓ Analyze energy consumption patterns using data collected from embedded systems ✓ Evaluate the effectiveness of embedded systems in energy monitoring and analysis. - About skills: ✓ Apply methods in developing an embedded system in energy monitoring and control. - About attitude: ✓ Deep discipline knowledge and intellectual breadth. ✓ Creative and critical thinking and problem-solving. ✓ Teamwork and communication skills.
Assessment/ Evaluation	Students could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc. Final grade of the course: <i>Practice: 30%</i> <i>Thematic report: 30%</i> <i>Presentation and Discussion: 40%</i>
Required Textbooks and Other Course Materials:	[1] Rabindra Nath Shaw, Ankush Ghosh, Saad Mekhilef, Valentina Emilia Balas, <i>Applications of AI and IoT in Renewable Energy</i>, Academic Press, 2022.

	[2] Kumar, P., Nikolovski, S., & Dong, Z.Y. (Eds.). <i>Internet of Energy Handbook (1st ed.)</i>. CRC Press, 2021 [3] Domenico Ciuonzo, Pierluigi Salvo Rossi. <i>Data Fusion in Wireless Sensor Networks: A Statistical Signal Processing Perspective</i>, Institution of Engineering & Technology, 2019 [4] Pachauri R., Pandey J., Sharmu A., Nautiyal O., Ram M. (Eds.). <i>Applied Soft Computing and Embedded System Applications in Solar Energy</i>, CRC Press, 2021.
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COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Chapter 1: Introduction to Energy Monitoring and Analysis 1.1. Overview of energy monitoring and analysis 1.2. Types of energy monitoring systems 1.3. Energy auditing process and condition monitoring 1.4. Standard and regulation related to energy monitoring and analysis	2	0	0		
2	Chapter 2: Designing Embedded Systems for Energy Monitoring 2.1. System design and architecture 2.2. Selection of components 2.3. Embedded system programming	4	2	2		
3	Chapter 3: Integrating Embedded Systems with Energy Monitoring Devices 3.1. Data acquisition and transmission 3.2. Sensor networks 3.3. Communication protocols	3	2	2		
4	Chapter 4: Analyzing Energy Consumption Patterns 4.1. Data analysis techniques 4.2. Energy management strategies 4.3. Predictive maintenance	4	2	2		
5	Chapter 5: Evaluation of Embedded Systems in Energy Monitoring and Analysis 5.1. Performance evaluation 5.2. Cost-benefit analysis 5.3. Case studies	3	2	2		
6	Chapter 6: Assignments 6.1. Assignment level 1: A report based on the laboratory demonstrations. 6.2. Assignment level 2: Presentation	0	2	2		
	Total	16	10	10		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Control of Microgrids

Course code: EN6.05

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Phan Anh Tuan, Dr. Nguyen Cong Phuong

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	6 h
	Discussion	6 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	Optimization	
Course description:	Our society is experimenting a transition from an energy system based on fossil fuels to a new energy system based on renewable energies and electric transportation systems. There is a need for control algorithms to cope with the intermittent, stochastic, and distributed nature of the generation and with the new consumption patterns. Microgrids are receiving a lot of interest from the research community because they are going to play a major role in this transition. The control of microgrids brings significant challenges which need to be addressed with advanced control techniques. The course offers a vision of the main problems encountered when controlling microgrids and provides appropriate solutions.	
Objectives & Outcome	After completing the course, students will be able to: i. Understand the challenges of microgrid control ii. Understand the hierarchical control of microgrids iii. Be able to apply fundamental techniques in power forecasting	

	iv. Be able to apply model predictive control in microgrid power flow control v. Be able to apply model predictive control for demand-side management
Assessment/ Evaluation	Combine several forms of assessment (exercise, essay, practice, thematic report, written exam, oral exam, etc.) in accordance with the requirements of the module; Final grade of the course - Thematic report: 40% - Presentation and discussion: 20% - Final exam: 40%
Required Textbooks and Other Course Materials:	1. C. Bordons, F. Garcia-Torres, and M. A. Ridao, Model Predictive Control of Microgrids. Cham: Springer International Publishing, 2020. doi: 10.1007/978-3-030-24570-2. 2. J. D. Kelleher, B. M. Namee, and A. D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies, 1st edition. Cambridge, Massachusetts: The MIT Press, 2015. 3. C. E. Rasmussen and C. K. I. Williams, Gaussian Processes for Machine Learning. 2005. doi: 10.7551/mitpress/3206.001.0001.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Introduction. + Microgrid and storage. + Control goals and challenges. + Hierarchical Control of Microgrids.	3				
2	- Power forecasting techniques + K-nearest neighbors. + Random forest regression. + Multi-layer perception. + Long short term memory. + Long short term memory. + Application in forecasting PV power generation and power demand of a microgrid.	6	3	2		
3	- System modeling. + State-space model. + Incremental state-space model. + Modeling of microgrids....	3				
4	- Model predictive control. + Overview. + Methodology. + Disturbances + Constraints	6	3	2		
5	-Demand-side management and electric vehicle integration. + Demand response techniques. + Formulation of model predictive control for demand response. + Integration of vehicles in microgrids. + Case study: EMS of a microgrid coupled to a V2G system.	6		2		
	Total	24	6	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Applied Mathematics in Engineering

Course code: EN6.06

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Mai Chung

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	36 h
	Practice	
	Discussion	
	Total	36 h
Prerequisites		
Recommended background knowledge	Students should have some background in mathematics	
Course description	This course covers advanced linear algebra and probability tools such as matrices, matrix operations and properties and determinants, vector spaces, linear transformations, eigenvalues, eigenvectors, diagonalization, discrete and continuous random variables.	
Objectives & Outcome	At the end of the course, students will: • employ techniques to classify and solve linear systems of equations • illustrate the use of matrices and determinants • utilize vector spaces and linear transformations • explore the concept of orthogonality in vector spaces • compute eigenvalues and eigenvectors of matrices • solve problems related to discrete and continuous random variables.	
Assessment/ Evaluation	Attendance	10%
	Active Student	10%
	Mid-term exam	30%
	Final exam	50%

Required Textbooks and Other Course Materials:	[1] Murray Spiegel, “Advanced Mathematics for Engineers and Scientists”, Mc Graw Hill. [2] Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, “Probability and Statistics”, Mc Graw Hill.
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COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s))
		Lect	Prc.	Dis.		
1	Part 1. Linear Algebra - Linear Equations: Systems of Linear Equations, Matrix Equations, Solution sets of linear systems, Linear Independence, Matrix Operations - Matrix Algebra: The Inverse of a Matrix, Matrix Factorizations, Introduction to Determinants - Vector Spaces: Subspaces, Null & Column Spaces, Bases, Coordinate Systems, Dimension & Rank - Orthogonality: Determinants' Properties 2 Cramer's Rule, Inner Product, Orthogonal Sets, The Gram-Schmidt Process	18				
2	Part 2. Probability - Basics probability: Sample space, axioms, probability definition, conditional probability, total probability theorem, Bayes rule, independence, conditional independence. - Discrete random variable: Definition, probability mass function (PMF), Conditional PMF, mean, variance, total probability and expectation theorem, independence, multiple discrete random variables. - Continuous random variable: Definition, probability dense function (PDF), Conditional on an event (PDF, mean, variance, total probability and expectation theorem, multiple continuous random variables), conditional on a random variable (PDF, mean, variance, total probability and	18				

	expectation theorem, independence, Bayes rule).					
	Total	36	0	0		

Part 7. Doctoral Courses for PhD Program on Space and Applications

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	SA6.01	Climate Change Assessment	3	Assoc. Prof. Ngo Duc Thanh
2	SA6.02	Atmospheric Circulation and Numerical Techniques	3	Dr. Nguyen Le Dung Dr. Nguyen Xuan Thanh
3	SA6.03	Spacecraft Operation	3	Dr. Phan Thanh Hien
4	SA6.04	Mordern Cosmology	3	Dr. Pham Tuan Anh (VNSC/VAST)
5	SA6.05	Unmanned Arial Vehicle (UAV) Integrated Sensors for Remote Sensing Applications	3	Dr. Tong Si Son
6	SA6.06	Satellite Radar Altimetry and Applications for Inland Hydrology	3	Dr. Pham Duc Binh

Hanoi, March 15, 2024

Detailed Course

1. Course name: Climate Change Assessment

Course code: SA6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Ngo Duc Thanh

Teaching time	36 hours	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	12 h
	Practice	18 h
	Discussion	6 h
	Total	36 h
Prerequisites	N/A	
Recommended background knowledge	Basic notions of the components of the Earth System and their interaction	
Course description:	Climate change is one of the most pressing issues that we are facing nowadays. This course aims to provide a concise and accessible overview of climate change and its impact. Tools and methodology for assessing past, present, and future climate changes at global and regional scales will be introduced. Students taking this subject will gain fundamental knowledge about the scientific basis of climate change and the impact of climate change and mitigation measures.	

Objectives & Outcome	• To introduce students a fundamental knowledge of climate change such as past and future global warming, greenhouse gas, and human-related climate change forces. • To introduce tools and methodology for assessing changes of certain climate elements and events such as temperature, precipitation, sea level, tropical cyclones, flood, droughts, etc. • To update students about the climate change scenarios on global and regional scales and in Vietnam. • To provide a basic knowledge of climate change impact and mitigation measures by introducing climate policy, global conflicts, and cooperation.
Assessment/ Evaluation	Tutorial/Exercise/Practical: 50% Project report/Presentation: 50%
Required Textbooks and Other Course Materials:	1. Ngo Duc Thanh, 2021: Climate change assessment. VNU Publisher, 257pp. (in Vietnamese) 2. Arias, P. A., N. Bellouin, E. Coppola, ..., T. Ngo-Duc, ..., X. Zhang, K. Zickfeld, 2021, Technical Summary. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. 3. Thomas Stocker, 2011: Introduction to Climate Modelling. Advances in Geophysical and Environmental Mechanics and Mathematics. DOI 10.1007/978-3-642-00773-6. Springer, 179 pages

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Introduction + Climate periods: Paleo-climate, present climate, future climate + Climate oscillation and climate changes + The concept of radiative forcings + Greenhouse gas and other human-related climate forcings + Greenhouse concentration scenarios ○ Special Report on Emission Scenarios (SRES) ○ Representative Concentration Pathways (RCPs) ○ Shared Socioeconomic Pathways (SSPs)	3	3	1	Ref. 1	
2	- Tools and methodology for assessing climate change + Assessing paleoclimate: proxy method + Trend analysis + Climate models ○ 0D-Energy balance model ○ 1D-Energy balance model ○ Global climate model versus regional climate model ○ Statistical downscaling versus dynamical downscaling	4	9	1	Ref. 1, 3	Report
3	- Evidence of climate changes + Paleoclimate + Current climate ○ Changes in atmospheric constituents and the Earth's heat balance ○ Changes in surface climate ○ Changes in the atmosphere ○ Changes in snow, ice, and frozen ground	3	6	1	Ref. 2	

	○ Changes in the oceans and sea level ○ Changes in extreme events +Projecting future climate change ○ Changes at global scale ○ Changes at regional scale +Climate changes in Vietnam					
4	- Impact of climate changes	1		1	Ref. 2	
5	- Responses to climate changes +Climate policy +International cooperation	1		2		Presentation
	Total	12	18	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Atmospheric Circulation and Numerical Techniques

Course code: SA6.02

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Le Dung, Dr. Nguyen Xuan Thanh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	15 h
	Practice	6 h
	Discussion	15 h
	Total	36 h
Prerequisites	None	
Recommended background knowledge	- Introduction to Earth System - Climate modelling	
Course description:	This course is designed to introduce atmospheric circulations and how those extremely complex motions can be approximately represented by numerical models. The atmosphere can be regarded as a continuous fluid medium, and the various physical quantities that characterize the state of the atmosphere are assumed to be continuous functions of space and time. The motions of the atmosphere can be expressed in a set of partial differential equations, called the primitive equation system (PES). To date, there exist no general solutions for PES. Numerical methods are thus applied to PES to approximately solve the atmospheric circulations. At the end of the course, students will have to	

	conduct a project to analyze a particular atmospheric phenomenon using models' outputs.
Objectives & Outcome	The objective of this course is to equip students with deep knowledge of atmospheric circulation and numerical techniques used for global atmospheric models. The students are expected to well understand three parts: (1) equations of motion and basic conservation laws; (2) multi-scale atmospheric circulations, and (3) ideas of discretization and numerical modeling.
Assessment/ Evaluation	Exam
Required Textbooks and Other Course Materials:	1. Holton J.R., 2004: An Introduction to Dynamic Meteorology, Fourth Edition. Elsevier Academic Press, 553 pp. 2. Lauritzen P.H., Jablonowski C., Taylor M.A., and Nair R.D. (editors), 2011: Numerical Techniques for Global Atmospheric Models. Springer, 577 pp.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignm ent(s)
		Lect.	Prc.	Dis.		
1	- Introduction + The atmospheric continuum + Physical dimensions and units + Scale analysis + Fundamental forces	3		3	Ref. 1	
2	+ Basic conservation laws - The momentum equation - Scale analysis of the equation of motion - The continuity equation - The thermodynamic energy equation - Thermodynamics of the dry atmosphere	3		3	Ref. 1	
3	+ Applications of the basic equations - Basic equations in isobaric coordinates - Balanced flow - Trajectories and streamlines - The thermal wind - Vertical motion - Surface pressure tendency	3		3	Ref. 1	
4	- Circulations + The circulation theorem + The observed structure of extratropical circulations + The quasi-geostrophic approximation + Fronts and frontogenesis + Mountain waves + Cumulus convection + Convective storms + Hurricanes	3		3	Ref. 1	
5	- Numerical modeling + Historical background + Horizontal discretization of the equations of motions + Vertical discretization + Time discretization + Stabilizing fast waves + The spectral method + Data assimilations + Predictability and ensemble prediction systems	3		3	Ref. 2	
6	Hand-on training: numerical solutions of the equations of motions using programming		6		Ref. 2	
	Total	15	6	15		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Spacecraft Operation

Course code: SA6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Phan Thanh Hien

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	12 h
	Practice	12 h
	Discussion	12 h
	Total	36 h
Prerequisites	None	
Recommended background knowledge	Solar System and Celestial Mechanics Introduction to Astronomy	
Course description:	This course provides important principles and aspects of the operation of space vehicles. It includes both lectures and exercises in seven topics for students of technical or scientific studies. Throughout the course, students will learn a brief summary of the space segment, which includes topics on space environment, space system engineering, and space communication. Then other fields of space mission operation are also discussed, which include the topics of ground infrastructure, flight dynamics, and mission planning. Detailed discussion on spacecraft subsystems for classic	

	unmanned satellites in Earth orbit and special requirements of other mission types are also included in this course.
Objectives & Outcome	After this course, students will be able to: • Describes the concept of a spacecraft mission; • Describes the physics of the Space Environment; • Understand the basics of Space System Engineering; • Describes the concept of Space Communications, establishing the connection to the ground segment. • Understand the classical fields of operations: mission operations, ground infrastructure, flight dynamics, and mission planning.
Assessment/ Evaluation	Tutorial/Exercise/Practical: 30% Project report/Presentation: 70%
Required Textbooks and Other Course Materials:	1. Sellmaier, F., Uhlig, T., & Schmidhuber, M. (2022, June 14). <i>Spacecraft Operations</i> (2nd ed.). Springer Nature. https://doi.org/10.1007/978-3-030-88593-9

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	1. Overview Space Segment 1.1 The Space Environment 1.2 Space Systems Engineering 1.3 Fundamentals of Space Communications	1		2		
2	2. Mission Operations 2.1 Mission Operations Preparation 2.2 Mission Operations Execution 2.3 Flight Experience	1		2		
3	3 Communication and Infrastructure 3.1 Control Center Design 3.2 Ground Station Network	1		2		
4	4 Flight Dynamic Operations 4.1 Orbital Dynamics 4.2 Attitude Dynamics	3	6			
5	5 Mission Planning 5.1 The Planning Problem 5.2 Mission Planning for Unmanned Systems 5.3 Mission Planning for Human Spaceflight Missions	2		2		
6	6 Spacecraft Subsystem Operations 6.1 Telemetry, Commanding and Ranging Subsystem 6.2 On-Board Data-Handling Subsystem Operations 6.3 Power and Thermal Operations 6.4 Propulsion Subsystem Operations 6.5 Attitude and Orbit Control Subsystem Operations 6.6 Repeater Operations	3	6	2		
7	7 Special Topics	1		2		

	7.1 Operations of On-Orbit Servicing Missions					
	7.2 Interplanetary Operations					
	7.3 Lander Operations					
	Total	12	12	12		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Mordern Cosmology

Course code: SA6.04

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Pham Tuan Anh (VNSC/VAST)

Teaching time	36 hours	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	18 h
	Practice	12 h
	Discussion	6 h
	Total	36 h
Prerequisites	N/A	
Recommended background knowledge	Basic knowledge of physics at the bachelor's level on electromagnetism, gravitation, thermodynamics.	
Course description:	This course offers an introduction to modern cosmology. It provides basic knowledge and covers a big picture of major topics in modern cosmology, including the standard cosmological models, observational cosmological parameters, Cosmic Microwave Background Radiation, the inflationary Universe, and the formation of galaxies in the early Universe. It aims to build a foundation for understanding current ongoing theoretical research and observational efforts in the field, and to cultivate practical research skills and tools.	

Objectives & Outcome	- After the course, students are expected to: + understand the basis of modern cosmological perspectives on the universe, including its origin with the Big Bang and its progression through the early stages of galaxy formation. + account for the most recent observational findings in cosmological research and gain understanding of the current challenges.
Assessment/ Evaluation	Oral examination
Required Textbooks and Other Course Materials:	Maximum 5 textbook(s)/reference(s) 1. An introduction to modern cosmology, 3rd Edition, Andrew Liddle, Wiley. 2. Introduction to cosmology, 2nd Edition, Barbara Ryden, Cambridge University Press. 3. First Light in the Universe, A. Loeb, A. Ferrara, R.S. Ellis, Saas-Fee Advanced Course 36, Springer.

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	- The expansion of the Universe + Observational overview + Homogeneous and isotropic universes, the cosmological principle + Scales and distances and the Hubble's law + Cosmic Microwave Background (CMB)	3	2	1	1	
2	- Newtonian Gravity + The Friedmann equation and the geometry of the Universe + The fluid equation + The acceleration equation + The equation of state	3	2	1	1	
3	- The cosmic microwave background + Observing the CMB + Recombination and decoupling + The physics of recombination	2	1	1	1, 2	
4	- Cosmological Parameters + Luminosity and angular-diameter distances + Standard candles and the Hubble constant + Universe Models: Flat Universe, Vacuum dominates, Multiple component Universe	3	2	1	1, 2	

5	Nucleosynthesis: The Origin of the Light Elements and the Early Universe + Nuclear Physics and Cosmology + Neutrons and Protons + Deuterium Synthesis and Beyond + Baryon-Antibaryon Asymmetry	2	2	1	2	
6	The Inflationary Universe: + The Flatness Problem + The Horizon Problem + The Monopole Problem	2	1	0	1	
7	Dark Ages and the Epoch of First Light + Formation of Dark Matter Halos & Gas Cooling and Baryonic Structures + Quasars and High-Redshift Objects + Cosmic History of Star Formation + Probes of Reionization and the Lyman-alpha Forest + Recent results from the James Webb Space Telescope, Hubble Space Telescope, VLT/MUSE, ALMA...	3	2	1	3	
	Total	18	12	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Unmanned Aerial Vehicle (UAV) Integrated Sensors for Remote Sensing Applications

Course code: SA6.05

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Tong Si Son

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture (hours)	18 h
	Practice (hours)	12 h
	Discussion (hours)	6 h
	Total	36 h
Prerequisites	None	
Recommended background knowledge	- Fundamental of Remote Sensing - Introduction to Geographic Information System	
Course description:	Unmanned Aerial Systems are developing aggressively due to the advantages of low altitude flying, flexibly taking data at various resolutions and times, and being cost-effective. Many government and non-government agencies are considering acquiring such systems for applications related to the environment, natural resources, and emergency cases. This course is designed to introduce some popular UAV integrated sensors such as Lidar sensor, RGB imager, multi-spectral sensor, and hyper-spectral sensors. Principles of data acquisition and data processing are also provided in this course. Moreover, detailed	

	applications related to each type of sensor are introduced and handed on to help students deeply understand the structure of data and the methods to process such data.
Objectives & Out-come	This course aims to provide knowledge of using Unmanned Aerial Vehicle (UAV) for remote sensing and its applications on the environment and natural resources, as well as the advantages, limitations, and future perspectives of UAV remote sensing. At the end of the course, students will have a clear view of how to integrate drones into projects by setting up a complete UAV mission from UAV-sensors selection to data post-processing techniques, taking into account the main characteristics of each mission type and objectives, and skills to process UAV images for some specific applications.
Assessment/ Evaluation	Assignment, report.
Required Textbooks and Other Course Materials:	1. Fahlstrom, P. and Gleason, T. 2012. Introduction to UAV Systems. 4th edition. United Kingdom. John Wiley & Sons Ltd. ISBN: 9781119978664. 2. Barnhart, R., Michael, M., Marshall, D., and Shappee, E. ed. 2016. Introduction to Unmanned Aircraft Systems, 2nd edition. Boca Raton. CRC Press. ISBN 978-1482263930

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Introduction to Unmanned Aerial Vehicle for mapping - UAV types - UAV applications - UAV components for mapping	4		2		
2	UAV integrated Lidar system - Principles of Lidar for surface investigation - UAV flight planning for Lidar data acquisition - Processing Lidar data - Applications of UAV Lidar data	3		1		
3	UAV integrated RGB sensors and applications -Introduction to photogrammetry - Camera properties - Flight plan for data acquisition - UAV photos processing - Analysis of products - Applications of orthophotos and DSMs for volume estimation and changes	4		1		
4	UAV integrated multi-spectral cameras. -Multi-spectral image acquisition -Multi-spectral images pre-processing -Applications of UAV multi-spectral images	3		1		
5	UAV integrated hyper-spectral scanning systems -Principles of UAV hyper-spectral scanning system -Designing for scanning hyper-spectral data -Preprocessing UAV hyper-spectral data -Post-processing hyper-spectral images and applications of UAV hyper-spectral data	4		1		
6	Hand-on training:		12			

	-Processing multi, hyper UAV data focusing on precision agriculture, and vegetation investigation. - Processing RGB UAV images for 3D model construction					
	Total	18	12	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Satellite Radar Altimetry and Applications for Inland Hydrology

Course code: SA6.06

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Pham Duc Binh

Teaching time	36 hours	
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	12 h
	Practice	12 h
	Discussion	12 h
	Total	36 h
Prerequisites	None	
Recommended background knowledge	- Fundamental of Remote Sensing - Introduction to Geographic Information System	
Course description:	This course is designed to introduce satellite altimetry data and its applications. After the course will understand how satellite altimetry works, how to get and process satellite altimetry data for different applications related to oceanography, glaciology, climate research, geodesy and geophysics, and inland hydrology. At the end of the course, students will have to conduct a project using satellite altimetry data for monitoring the variation of surface water height of lakes or rivers.	

Objectives & Out-come	The first objective of this course is to help students understand satellite radar altimetry and how it works, its applications in various scientific fields, and potential improvements of this technique in the future. The second objective is to provide hands-on training for students to process satellite altimetry data, focusing on applications of inland hydrology (lakes and rivers) using The Broadview Radar Altimetry Toolbox (BRAT) software, and data provided by some services, such as HYDROWEB (https://hydroweb.theia-land.fr/) or G-REALM (https://ipad.fas.usda.gov/cropexplorer/global_reservoir/).
Assessment/ Evaluation	Presentations and practical reports
Required Textbooks and Other Course Materials:	1. Fu, L-L. and Cazanave, A. 2001. Satellite altimetry and earth sciences. A handbook of techniques and applications. San Diego: Academic Press. 463pp. 2. Robinson, I.S. 1985. Satellite oceanography: an introduction for oceanographers and remote-sensing scientists. Chichester: Ellis Horwood. 455pp. 3. How to use altimetry for hydrology. Available at: https://www.aviso.altimetry.fr/fileadmin/documents/kiosque/education/Alti-hydro-modellers_en.pdf 4. Detlef Stammer, Anny Cazenave. 2017. Satellite Altimetry Over Oceans and Land Surfaces. CRC Press, 643 pages

COURSE CONTENTS & SCHEDULE

No.	Contents	No. of Hours			Ref./ Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Introduction to satellite radar altimetry	1				
2	How does satellite radar altimetry works? + Basic principle + From radar pulse to range + Frequencies used and their impact + High precision altimetry	1		2		
3	Data flow + Data acquisition + Data processing + Data qualification	1				
4	Satellite altimetry missions + Pass missions + Current missions + Future missions + Altimetry in planetary missions	2				
5	Applications of satellite radar altimetry + Oceanography + Glaciology + Hydrology and Inland + Climate + Atmosphere, wind, and waves + Coastal areas + Geodesy and geophysics	2		2		
6	Future improvement of satellite radar altimetry + Ka-band satellite altimetry + Altimetry interferometry + GNSS altimetry	1				
7	Satellite altimetry focusing on inland hydrology	1		2		
8	Introduction to the BRAT software	1	1			
9	Introduction to the HYDROWEB and G-REALM services	2	1			

10	Hand-on training: Processing satellite radar altimetry data for inland hydrology	10	6		
	Total	12	12	12	

Part 8. Doctoral Courses for PhD Program on Chemistry

No.	Course code	Course name	Number of ECTS	Lecturer(s)
1	CH6.01	Recent trends in Chemistry	3	Assoc. Prof. Tran Dinh Phong Dr. Tran Tuan Anh Dr. Le Phuong Thu
2	CH6.02	Advanced characterization tools for Quantitative analysis	3	Dr. Bui Van Hoi Assoc.Prof. Nguyen Thi Kieu Oanh Dr. Le Hong Luyen
3	CH6.03	Advanced characterization tools for Inorganic materials	3	Prof. Dinh Thi Mai Thanh Dr. Le Thi Ly Dr. Nguyen Ngoc Duc
4	CH6.04	Advanced characterization tools for Organic materials	3	Assoc. Prof. Nguyen Hai Dang Assoc. Prof. Nguyen Xuan Nhiem Dr. To Hai Tung
5	CH6.05	Targeted and non-targeted analysis	3	Dr. Vu Cam Tu Dr. Bui Van Hoi
6	CH6.06	Speciation analysis	3	Dr. Bui Van Hoi Dr. Vu Cam Tu
7	CH6.07	Biosynthesis of natural products	3	Assoc. Prof. Nguyen Hai Dang Dr. Tran Tuan Anh
8	CH6.08	Advanced Electrochemistry	3	Assoc. Prof. Nguyen Van Quynh Dr. Nguyen Ngoc Duc Dr. Le Thi Ly

9	CH6.09	OMICS	3	Assoc. Prof. Nguyen Thi Kieu Oanh Dr. Tran Tuan Anh
10	CH6.10	Advanced Solid-State Chemistry	3	Dr. Nguyen Van Quyen Dr. Le Thi Ly
11	CH6.11	Advanced chemistry of Materials in Energy conversion and Storage	3	Dr. Le Thi Ly Dr. Nguyen Ngoc Duc
12	CH6.12	Novel Methods in Organic Synthesis	3	Dr. Nguyen Duc Anh Dr. To Hai Tung
13	CH6.13	Advanced nanochemistry	3	Dr. Nguyen Thi Quyen Dr. Nguyen Van Quyen
14	CH6.14	Surface interaction and transportation	3	Dr. Vu Cam Tu Dr. Nguyen Van Quyen
15	CH6.15	Biosensors and biochips	3	Dr. Vu Thi Thu Dr. Nguyen Duc Anh
16	CH6.16	Bioinspiration and Biomimicry in Chemistry	3	Assoc. Prof. Tran Dinh Phong

Hanoi, March 15, 2024

Detailed Course

1. Course name: Recent Trends in Chemistry

Course code: CH6.01

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Tran Dinh Phong, Dr. Tran Tuan Anh, Dr. Le Phuong Thu

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	18 h
	Practice	0 h
	Tutorial	18 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	No	
Course description:	This course is designed to provide recent trend of research in chemistry field.	
Objectives & Outcome	The aim of this scientific opinion is to update students on the most interesting and attractive trend of research in chemistry globally. The student will gain an overview and state-of-art toward modern chemical sciences including chemistry for life sciences, chemistry for energy conversion and storage, chemistry for environmental	

	sciences.
Assessment/ Evaluation	Thematic report
Breaking Score	Reports: 100%
Required Textbooks and Other Course Materials:	none

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Recent trend in chemistry for life sciences	6				
2	Recent trend in chemistry for energy conversion and storage	6		6		
3	Recent trend in chemistry for environmental sciences	6		6		
	Total	18		18		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Characterization Tools for Quantitative Analysis

Course code: CH6.02

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Bui Van Hoi, Assoc.Prof. Nguyen Thi Kieu Oanh, Dr. Le Hong Luyen

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	16 h
	Practice	16 h
	Tutorial	4 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	Analytical chemistry, chromatography	
Course description:	This course carries 3 ECTS and consists of one theoretical part and one practical project focusing on the application of modern instruments for analyzing the legacy and emerging contaminants (both inorganic and organic) in different types of samples.	
Objectives & Outcome	The first part of this course will introduce to students the basic concept of instruments for quantification.	

	In the second part, students will learn how to collect samples, to treat and to prepare samples before analyzing by instrument. The third parts, students will learn how to develop and to validate a new method in quantitative chemical analysis. Finally, students will try to apply their knowledge to practice the analyzing of real samples in the laboratory
Assessment/ Evaluation	essay, thematic report and oral exam
Breaking Score	Attendance: 10%; Reports: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	4. Quantitative chemical analysis, Daniel C. Harris, 9th edition, 5. Modern analytic chemistry, David Havey, 2000, McGraw Hill 6. Quality assurance and quality control in the analytical chemical laboratory: A practical approach. Piotr Konieczka, 2nd edition, 2018, CRC press

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Introduction to instrumental analysis	1				
2	Trace elemental analysis: + Atomic Absorption/Emission Spectroscopy + Inductively Coupled Plasma – Mass spectrometry	5				
3	Organic pollutants analysis: + Gas Chromatography + Liquid Chromatography + Ionic Chromatography	5				
4	Sample preparation + Digestion techniques + Extraction techniques + Clean up	3				
5	Method validation + Instrumental optimization + Reference materials and inter-laboratory comparison + Validation parameters	2				
7	Documentations (Reviews and presentations)			4		
8	Practical		16			
	Total	16	16	4		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Characterization Tools for Inorganic Materials.

Course code: CH6.03

2. Credits points (ECTS): 3

3. Lecturer in charge: Prof. Dinh Thi Mai Thanh, Dr. Le Thi Ly, Dr. Nguyen Ngoc Duc

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Tutorial	
	Practice	12 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	general chemistry, inorganic chemistry, solid state chemistry	
Course description:	This course is designed to introduce the characterization methods for inorganic materials. Students will learn how to analyse structure, microstructure, shape, size...of inorganic materials.	
Objectives & Outcomes	• Understand the basic information of characterization methods for Inorganic materials. • Describe the structure, principle works of the systems. • Understand the important role of preparation steps. • Understand well the results of characterization methods. • Understand the characterization methods used for Inorganic	

	materials. From the results can confirm the structure, microstructure, shape, size, of inorganic materials
Assessment/ Evaluation	Thematic reports and writing final exam
Breaking Score	Attendance: 20%; Presentation: 20% Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lec	Prc.	Dis.		
1	Part I: Characterization methods for structure and morphology of inorganic materials:			0		
1.1	X-ray diffraction	2	2			
1.2	Ultraviolet-visible spectroscopy (UV – Vis)	2				
1.3	Fourier -Transform InfraRed spectroscopy (FTIR)	2	1			
1.4	Raman spectroscopy	3				
1.5	Thermogravimetric analysis (TGA)	2	1			
1.6	Differential Scanning Calorimetry (DSC)	2	1			
1.7	Scanning electron microscopy (SEM) with Energy dispersive X-ray spectroscopy (EDX)	2	2			
2	Part II: Characterization methods for microstructure of inorganic materials					
2.1	Transmission electron microscopy (TEM) and high-resolution transmission electron microscopy (HRTEM)	2	2			
2.2	X-ray photoelectron spectroscopy (XPS)	3				
3	Other characterization methods of inorganic materials					
3.1	Brunauer-Emmett-Teller (BET)	2	1			
3.2	Dynamic light scattering (DLS)	1	1			
3.2	Zeta-potential analyzer	1	1			
	Total	24	12			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Characterization Tools for Organic Materials

Course code: CH6.04

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Nguyen Hai Dang, Assoc. Prof. Nguyen Xuan Nhiem, Dr. To Hai Tung

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Tutorial	6 h
	Practice	6 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	No	
Course description:	This course is designed to provide advanced characterization tools, which are modern physical spectroscopies, for the structure determination of organic materials. This is the in-depth knowledge as well as exercises using methods to determine the complex structure. Besides that, the application of these methods in chemistry and relative fields are also introduced. These methods include Infrared (IR); Ultraviolet-Visible (UV-Vis); Nuclear Magnetic Resonance (1D and 2D); Mass Spectrometry (MS) and Circular Dichroism (CD).	

Objectives & Outcome	- About knowledge: Students master basic and in-depth knowledge of spectroscopic methods so that they can apply and analyze in determining the chemical structure of organic compounds - About skills: Students have access to modern equipment; exchange and solve experimental problems
Assessment/ Evaluation	Students must attend at least 70% of lecture sessions Essay, Thematic reports and Writing final Examination.
Breaking Score	Attendance: 20%; Presentation: 20% Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	1. L. D. Field, H. L. Li, A. M. Magill, Organic Structures from Spectra, 6th Edition, Wiley, 2020. 2. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, Introduction to Spectroscopy, 5th Edition, Cengage Learning, 2015. 3. Robert M. Silverstein, Francis X. Webster, David Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, 8th Edition, Wiley, 2014.

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Pr.	Dis.		
1	- Chapter 1: Molecular Absorption Spectroscopy – UV-Vis and IR spectra + Recall knowledge about the UV-Vis and IR spectra + Application of two methods in structural determination of organic material. + In-depth application of two methods in other fields of chemistry and relative fields.	3		3		
2	- Chapter 2: Mass spectrometry (MS) + Recall knowledge about the UV-Vis and IR spectra + Application of MS method in chemistry and relative fields	3				
3	Chapter 3: Nuclear Magnetic Resonance (NMR) + The principle of the NMR method and introduction about the instrument. Recall the knowledge about the ^1H -NMR and ^{13}C -NMR + Introduction to the 2D-NMRs - <i>COSY spectrum</i> - <i>NOE effect and NOESY/ROESY spectrum</i> - <i>TOCSY spectrum</i> - <i>HSQC and HMBS spectra</i> - <i>Combination of HSQC-TOCSY</i> + Application of NMR method (1D and 2D) in complex structural determination + Other application in relative fields	3 6 6				
4	- Chapter 4: Circular Dichroism	3				

	spectroscopy (CD) + Introduction and principle of CD spectrum + Application of CD spectrum in absolute configuration of chiral compounds					
	Total	24	6	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Target and Non-Target Analysis

Course code: CH6.05

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Vu Cam Tu, Dr. Bui Van Hoi

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	18 h
	Practice	18 h
	Tutorial	
	Total	36 h
Prerequisites	No	
Recommended background knowledge	Analytical chemistry Physiochemistry Biological chemistry	
Course description:	This course is designed to provide definitions, nomenclature and application for targeted and non-targeted analytical approaches.	
Objectives & Outcome	The aim of this scientific opinion is to contribute to the common understanding of targeted and non-targeted analyses through novel definitions, concepts, and the applicability across different research areas. This opinion course, therefore, presents biological, chemical, and microscopy, chromatography-based examples of targeted and non-targeted approaches while studying the associated possibilities and limitations for analytical	

	authentication.
Assessment/ Evaluation	Thematic report
Breaking Score	Report: 100%
Required Textbooks and Other Course Materials:	none

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Main content 1: Introduction and nomenclature of targeted vs non-targeted analysis + Content 1.1. General introduction + Content 1.2. nomenclature	2			Chapter 1	
2	- Main content 2: Analytical makers + Content 2.1. The primary makers + Content 2.2. The secondary makers	2			Chapter 2	
3	- Main content 2: Quantitative and Qualitative analysis + Content 3.1. Quantitative analysis + Content 3.2. Qualitative analysis	3			Chapter 3	
4	- Main content 3: Targeted analysis + Content 4.1. Profiling + Content 4.2. Signature + Content 4.3. Application	3	6		Chapter 4	
5	- Main content 4: Non-targeted analysis + Content 5.1. Profiling + Content 5.2. Fingerprinting + Content 5.3. Application	3	6		Chapter 5	
6	- Main content 5: Target versus non-target analytical methods + Content 6.1. Analytical chemistry techniques • Spectroscopy techniques	3	6		Chapter 6	

	• Chromatography + Content 6.2. Microscopy based techniques + Content 6.3. Molecular biology techniques					
7	- Main content 6: Target or non-target analysis, possible and limitation	2			Chapter 7	
	Total	18	18			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Speciation Analysis

Course code: CH6.06

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Bui Van Hoi, Dr. Vu Cam Tu

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	18 h
	Practice	12 h
	Tutorial	6 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	Analytical chemistry, chromatography	
Course description:	This course is designed to provide basic concepts in elemental speciation, its origin and toxicities. Then, the next part will give the different techniques for analyzing these species.	
Objectives & Outcome	The first part of this course will introduce to students the knowledge of elemental species existing in different matrices as well as the toxicities of these species. The second part will help students: - To define the problem, the importance of speciation analysis - To take and to store the samples	

	- To use different technique for preparing the sample - To develop, validate and applicate the method for analyzing elemental species
Assessment/ Evaluation	essay, thematic report and oral exam
Breaking Score	Attendance: 10%; Reports: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	7. Handbook of elemental speciation: techniques and methodology, Rita Cornelis, 2003, Wiley. 8. Trace element speciation for environment, food and health, Les Ebdon, Les Pitts, 2001, The Royal Society of Chemistry 9. Elemental speciation: Waters, Sediments, and Soils, Graem E Batley and Simon C Apte, 2019, Elsevier 10. Trace Metal Speciation with ICP-MS Detection Eva Krupp, Fabienne Seby, Rosa Rodr'iguez Mart'ın-Doimeadios, Alison Holliday, Mariella Moldov'an, Gunda K"ollensperger, Stephan Hann and Olivier F X Donard. 2005 Blackwell Publishing Ltd.

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	Introduction to elemental species	1				
2	Accumulation of elemental species in different compartments	1				
3	Sampling and sample preparation + Sample collection, storage + Sample pre-treatment + Sample preparation – Extraction	3				
4	Separation techniques + Liquid Chromatography + Gas Chromatography + Other methods	6				
5	Detection techniques + AAS + ICP – MS + Electrochemical methods + Biosensors	4				
6	Environmental risk assessment + Environmental risk assessment and ecology + Predicted No Effect Concentration (PNEC) + Determination of Predicted Environmental Concentration (PEC)	3				
7	Documentations (Reviews and presentations)			6		
8	Practical		12			
	Total	18	12	6		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Biosynthesis of Natural Products

Course code: CH6.07

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Nguyen Hai Dang, Dr. Tran Tuan Anh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	28 h
	Practice	8 h
	Tutorial	0 h
	Total	36 h
Prerequisites	- Basic Organic Chemistry. - Basic Biology.	
Recommended background knowledge	Knowledge of organic chemistry and biology. Essential knowledge of basic biology	
Course description:	- Help students to understand the impact of natural products in drug development and diverse structure as well as activities of these compounds. - Provide the knowledge of Biosynthesis classes of natural products from common sources. - Provide basic understanding of the potential of DNA sequencing in predicting natural products capacity of common organisms.	

Objectives & Out-come	Understand the impact of natural products in drug development and diverse structure as well as activities of these compounds. Biosynthesis of natural products from common sources Biosynthetic classes of compounds from different sources Natural product potential of target organisms based on genetic information. Apply on real-life case studies.
Assessment/ Evaluation	Essay, thematic report and oral exam
Breaking Score	Attendance: 10%; Reports: 30%, Oral Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	Christopher T Walsh, Yi Tang; Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery, 1 st edition, 2017, Royal Society of Chemistry.

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Introduction of Natural product chemistry	1				
2	Mechanism of drug action: enzyme, receptor, and nucleic acid as drug targets.	3				
3	Process of drug development	3				
4	Natural product derived drugs in healthcare	3				
5	Application of genome mining to seek novel natural compounds					
6	Plant natural product biosynthesis and applications	3				
7	Bacterial natural product biosynthesis and applications (part 1)	3				
8	Bacterial natural product biosynthesis and applications (part 2)	3				
9	Fungal natural product biosynthesis and applications	3				
10	Case studies of natural product biosynthesis	3				
	Practice: Genome mining of a bacterial natural product producer		8			
	Total	28	8			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Electrochemistry

Course code: CH6.8

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc. Prof. Nguyen Van Quynh, Dr. Nguyen Ngoc Duc, Dr. Le Thi Ly

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	14 h
	Practice	12 h
	Tutorial	10 h
	Total	36 h
Prerequisites	Fundamental of Electrochemistry; interfaces; General Chemistry; solid state physic; Physical chemistry.	
Recommended background knowledge	- Have basic knowledge about concepts, such as a conventional 3-electrode system, various electrochemical techniques for depositing and characterizing bulk film, and nanostructured surfaces. - Mastering to application of Chronopotentiometry; Chronoamperometry, Linear Potential Sweep; Voltammetry; Cyclic Voltammetry, Impedance measurements in advanced material science research. - Understanding factors affecting the electrochemical reaction rate: temperature, ionic strength of the solution, catalyst, pH, and dielectric constant of the medium, micelle, reverse micelle & nanoparticles;	
Course description:	- This course provides advanced knowledge in some current research fields with electrochemistry systems.	

Objectives & Outcome	- Students have advanced knowledge of liquid electrochemistry at nanointerfaces. - Fully understanding of the theory of an electrified interface and processes occurring at heterogeneous interfaces where ion or electron or ion-coupled-electron transfer takes place. - Inspiring students with some modern trends of nanoelectrochemistry for investigating nano junction, nanopores systems, metal-organic framework, etc... Apply on real-life case studies.
Assessment/ Evaluation	Essay, thematic report and oral exam
Breaking Score	Attendance: 10%; Reports: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	Electrochemistry at nanoscale written by P. Schmuki and S. Virtanen; Techniques and mechanism in electrochemistry written by PA. Chirstensenand and A. Hamnett.

COURSE CONTENT & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lect.	Prc.	Dis.		
1	Nano electrochemistry at the liquid/liquid interfaces	3	3			
2	Electrochemistry at nanoelectrodes	3		5		
3	Electrochemical applications of nanopore systems	2	3			
4	Electrochemistry within metal-organic frameworks	2	3			
5	Electrochemistry of graphene: the current state of the art	2	3			
6	Advanced electrochemical sensing system.	2		5		
	Total	14	12	10		

Hanoi, March 15, 2024

Detailed Course

1. Course name: OMICS

Course code: CH6.09

2. Credits points (ECTS): 3

3. Lecturer in charge: Assoc.Prof. Nguyen Thi Kieu Oanh, Dr. Tran Tuan Anh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	12 h
	Tutorial	0 h
	Total	36 h
Prerequisites		
Recommended background knowledge		
Course description:	This course carries 3 ECTS focusing on the introduction of systemic techniques such as metabolomics, transcriptomics, proteomic, metagenomics, genome editing and their application in drug development and biomedicine fields.	
Objectives & Outcome	This course provides students with the recent trends in life sciences: (i) Omics techniques: metagenomics, proteomics, transcriptomics and metabolomics, (ii) metabolomics and genome mining project rationale and designs. Upon completing the course students will be able to	

	• Define what is omics techniques especially metabolomics and metagenomics and what is genome mining approaches • Present the different stages in metabolomics, proteomics, transcriptomics metagenomics and genome mining approaches • Analysis the applications of these above-mentioned approaches in drug development and biomedicine. Investigate drug discovery pipelines to pinpoint limitations of traditional approaches as well as related research in Vietnam. • Get along with modern techniques and approaches towards drug discovery • Acknowledge fundamentals of genome mining in natural product discovery and application of Biotechnology in this field
Assessment/ Evaluation	Could choose one or combine several forms of assessment: exercise, essay, practice, thematic report, exam, oral exam, etc.
Breaking Score	Attendance: 10%; Reports: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect	Prc.	Dis.		
1	Introduction to OMICS	3				
2	Metabolomics and application in drug discovery, biomedicine, and drug development	9				
3	Pipeline for transcriptomics, proteomics, and case studies	3				
4	Metagenomics analysis and case studies	3				
5	Genomics and genome mining project rationales and designs.	6				
	Practice 1: Metabolomic analysis		6			
	Practice 2: Genomic analysis		6			
	Total	24	12			

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Solid-State Chemistry

Course code: CH6.10

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Van Quyen, Dr. Le Thi Ly

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	0 h
	Tutorial	12 h
	Total	36 h
Prerequisites	General chemistry, physical chemistry, solid state physic.	
Recommended background knowledge	Knowledge in chemical bonding, structure of molecules, condensed materials and general physic are demanded.	
Course description:	The course covers solid state chemistry in a broad manner with emphasis on fundamental concepts and inorganic/organic materials. Subjects covered are: Bonding and structure in solids, phase transitions, defects and nonstoichiometry, relationships between structure and electronic, magnetic and optical properties.	
Objectives & Outcome	After completion of the course the student should be able to: - Give a qualitative description of bonding in solid materials, crystal classes and symmetries as a basis for space groups and the most important crystal structures and other more complex compounds - Give a qualitative description of old and new	

	concepts to describe the structure of inorganic solids. - Define solid-solid phase transition based on thermodynamic, kinetic and structural characteristics of a phase transition and knowledge of some of the most important phase transition in functional materials - Give a qualitative and quantitative representation of 0, 1 and 2 dimensional defects in solids and knowledge of defects related to non-stoichiometry in some important classes of inorganic materials. - Give a qualitative representation of the relationship between structure/bonding and electronic, electrical, magnetic, ferroic and optical properties of solids with emphasis on some of the most important classes of inorganic materials. - Give a qualitative description of emerging directions in materials science.
Assessment/ Evaluation	Exercise, report and oral exam
Breaking Score	Attendance: 10%; Reports: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	1. Shackelford, J. <i>Introduction to Materials Science for Engineers</i>. 6th edition. Upper Saddle River, NJ: Pearson, 2004. ISBN: 9780131424869

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	Structure of the Atom, Bonding and Molecules	2			Lectures will be provided	
2	Electronic Materials	3			Lectures will be provided	
3	Crystalline Materials	2			Lectures will be provided	
4	Amorphous Materials	2			Lectures will be provided	
5	Nanostructured and low-dimensional Materials	3			Lectures will be provided	
6	Optical and Mechanical properties of solids	3		3	Lectures will be provided	
7	Magnetic and Electrical properties of solids	3		3	Lectures will be provided	
8	Thermal Properties of solid	3		3	Lectures will be provided	
9	Solid state ionic devices: batteries, fuel cells	3		3	Lectures will be provided	
	Total	24		12		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Chemistry of Materials in Energy Conversion and Storage

Course code: CH6.11

2. Credits points (ECTS): 03

3. Lecturer in charge: Dr. Le Thi Ly, Dr. Nguyen Ngoc Duc

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	36 h
	Practice	0 h
	Tutorial	0 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	general chemistry, inorganic chemistry, solid state chemistry, electrochemistry, catalysis	
Course description:	This course is designed to introduce the definition, theory, and current progress in the domain of Chemistry toward Materials in Energy conversion and Storage systems. The candidate will learn different technique to convert and store energy	
Objectives & Outcome	- Understand the advanced knowledge of energy conversion and storage - Describe the detail fundamental, method and materials for energy conversion and storage - Describe the key concepts and understand the terminology as well as the various working mechanisms that are currently	

	proposed for energy conversion and storage. - Describe the current progress regarding material and device engineering for solar fuels production and rechargeable battery. - Analyze advantages and disadvantages of solar fuels technology in comparison to rechargeable batteries and solar cells. - Propose suitable approach to design/develop novel materials and devices
Assessment/ Evaluation	Reports, Presentation and Writing examination
Breaking Score	Attendance: 10%; Presentation: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	1. Solar cells new approaches and reviews 2. Solar Fuels 3. Photoelectrochemical solar fuel production 4. Rechargeable batteries: History, progress, and applications

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lec	Prc.	Dis.		
1	Chapter 1: Solar cells - Thin films - Perovskite compounds - Inorganic-organic perovskite - Quantum dots - Bulk heterojunction	9		0		
2	Chapter 2: Solar Fuels - Solar Thermochemical and Concentrated Solar Approaches - Artificial Photosynthesis and Solar Biofuel Production - Photocatalytic CO₂ Reduction to Fuels - Solar-Driven Water Splitting	9				
3	Chapter 3: Photoelectrochemical solar fuel production - Fundamentals - Methods - Materials and devices	9				
4	Chapter 4: Rechargeable batteries - Lithium -ion batteries - Na and K-ion batteries - Magnesium rechargeable batteries - Aqueous RBs - Pb-acid, Ni-Cd and Ni-MH batteries - Zinc-ions RBs - Metal-air batteries Flexible RBs	9				
	Total	36	0	0		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Novel Methods in Organic Synthesis

Course code: CH6.12

2. Credits points (ECTS): 03

3. Lecturer in charge: Dr. Nguyen Duc Anh, Dr. To Hai Tung

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	0 h
	Discussion	12 h
	Total	36 h
Prerequisites	No	
Recommended background knowledge	No	
Course description:	The course provides PhD students the novel methods and techniques in organic and polymer chemistry including bond formation, multicomponent reaction, catalysis in organic, assisting techniques and controlled polymerization.	
Objectives & Outcome	After the course, the student is expected to: - Understand novel methods and techniques in organic and controlled polymer syntheses. - Propose an appropriate synthesis route for organic compounds.	

Assessment/ Evaluation	Reports, Presentation and Writing examination
Breaking Score	Attendance: 10%; Presentation: 30%, Final exam: 60% (Writing exam)
Required Textbooks and Other Course Materials:	1. Serie “Advances in Organic Synthesis”, Bentham Book Publisher 2. Serie “Reversible Deactivation Radical Polymerization”, Oxford University Press, 2019

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignment(s)
		Lect.	Prc.	Dis.		
1	- Chapter 1: New approaches in bond formation + C-H Activation/C-C Cross-Coupling Reactions + C-H Activation/C-Heteroatom Cross-Coupling Reactions + Other Transition-metal catalysts for Cross-coupling reaction	4		2		
2	- Chapter 2: Application of Multicomponent reactions (MCRs) + Introduction to models of Multicomponent reactions + Application of MCRs in organic synthesis and relative fields	4		2		
3	Chapter 3: Organocatalysts in Organic synthesis + Introduction and the development of organocatalysts + Application of organocatalysts + Asymmetrical organocatalysts	4		2		
4	- Chapter 4: Modern techniques assisting for Organic Synthesis + Alternative energy input: mechanochemical, microwave and ultrasound-assisted organic synthesis + Ionic liquids in organic synthesis + Computer-assisted in Organic Synthesis	4		2		

5	Chapter 5: Advances in polymerization methods + Controlled polymerizations + Modern techniques for polymerization systems + Post-polymerization processes	8		4		
	Total	24		12		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Advanced Nanochemistry

Course code: CH6.13

2. Credits points (ECTS): 3

3. Lecturer in charge: Dr. Nguyen Thi Quyen, Dr. Nguyen Van Quyen

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	30 h
	Exercise	6 h
	Total	36 h
Prerequisites	General chemistry, Inorganic Chemistry, Organic Chemistry, Electrochemistry	
Recommended background knowledge	General knowledge of chemistry, inorganic chemistry, organic chemistry and electrochemistry are required. Knowledge in chemical bonding, structure of molecules and condensed materials, principles of chemical reactions (thermodynamic and kinetic aspects) are demanded.	
Course description:	This course discusses on: (i) Chemical and physical methods for preparation of nanomaterials with desired structure and function. (ii) Chemistry of materials at nanoscale. The first part deals with different chemical approaches/ chemical processes and physical approaches for preparing a functional nanomaterial: e.g. via top-down or bottom up approaches. Chemical strategies for post-functioning a nanomaterial in order to achieve a desired structure and operation will be also discussed	

	in parallel with magical one-pot preparation. The second part deals with the relationship of chemical properties of materials in nanoscale and catalytic properties. A comparison in chemistry at nanoscale to that achieved for a molecule or a bulk material in the milimetric scale will be discussed.
Objectives & Outcome	After this course, the students should be able to: • Understand the reason behind a choice made in the literature for preparing a nanostructured and functional nanomaterial with a special application perspective. • Be able to analyze the demand and propose an appropriate chemical process/ strategy for designing and preparing a functional nanomaterial with desired structure and function. • Understand the differences in chemical properties (reactivity, catalytic activity, etc) of a material in nano size in comparison with an equivalence in molecular or bulk (milimetric) scale. • Be able to propose a nanostructure to respond an application perspective.
Assessment/ Evaluation	Thematic report and exam
Score breaking	Exercises: 20%; Midterm Examination: 30%; written final exam: 50%
Required Textbooks and Other Course Materials:	[1] NanoChemistry : A chemical approach to nanomaterials by Geoffrey A. Ozin and Andre C. Arsenault, RSC Publishing 2005 <i>Note:</i> A hard copy of this text book is available at USTH Library.

COURSE CONTENTS & SCHEDULE

Class	Contents	Hours			Ref./Resources	Remarks
		Lect.	Pr.	Prc.		
1	Class 1: Introduction Nanochemistry basics (Why nano, general concepts of nanomaterials, nanostructure, nanophysics and nanochemistry)	1			Lecture materials will be provided	
Part I: Chemical and physical methods for preparation of nanomaterials with desired structure and function						
2	Class 2: General concepts - Acid-base reaction - redox reaction, - bottom up and top down process to achieve nanosized materials	1			Lecture materials will be provided	
3	Class 3: Principles of nanomaterials growing in solution Nucleation and growth process (Surface tension, size dependences, elemental steps, stabilization of nanomaterials, thermodynamic versus kinetics, some detailed examples, effect of temperature, surfactant, introducing of surface charges, effect of solvents <i>etc</i>)	5			Lecture materials will be provided	
4	Class 4: Synthesis of nanoparticles in homogeneous solution - From metal salts as precursors (Turkevich, Brust method for Au NPs) - From Organometallic/complexes precursors	5			Lecture materials will be provided	
5	Class 5: Preparation of nanostructured materials and its properties Nanostructures: nanosphere, nanorods, nanowires, nanopillars, nanotubes, hollow structure - Physical approaches (ALD, CVD, PVD, electrospinning...) - Chemical approaches (Metal assisted chemical etching, exfoliation, synthesis with	6			Lecture materials will be provided	

	soft and hard templates, SAMS, LBL...)					
6	Class 6: Characterization of nanostructured materials Some selected nanostructured materials example are discussed on the use of SEM, TEM, AFM, XRD, XPS, EXAFS, XANES, Mossbauer, BET, TGA, ICP-MS...to characterized nanomaterials	2			<i>Lecture materials will be provided</i>	
	Class 7: Presentation on selected research topics			3		
Part II: Chemistry of materials at nanoscale						
7	Class 8: Chemical reactivity in dependence of size, morphology, structure and chemical composition of nanomaterials Some selected examples are discussed	3			<i>Lecture materials will be provided</i>	
8	Class 9: Catalytic performance in dependence of size, morphology, structure and chemical composition of nanomaterials (Continued) Some selected examples are discussed (e.g. nanocatalysts for the hydrogen evolution reaction, water oxidation reaction, oxygen reduction reaction)	3			<i>Lecture materials will be provided</i>	
9	Class 10: Nanomaterial for Programmable Catalysis Chemical device used in catalysis will be discussed and a principal to modulate the catalytic reaction.	4			<i>Lecture materials will be provided</i>	
10	Class 11: Presentation on selected research topics			3		
Total		30		6		

1. Course name: Surface Interaction and Transportation**Course code:** CH6.14**2. Credits points (ECTS): 3****3. Lecturer in charge:** Dr. Vu Cam Tu, Dr. Nguyen Van Quyen

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	24 h
	Practice	0 h
	Tutorial	12 h
	Total	36 h
Prerequisites	General Chemistry, Physical chemistry, basic solid-state chemistry, and surface science.	
Recommended background knowledge	Chemical science and engineering Material engineering Environmental engineering Nano science and technology	
Course description:	This course is designed to provide physio-chemical concepts dealing with the field-scale transport. The first part will deal with the transport in the environment by interaction with surface and pore-scale forces such as fluid drag, diffusion, and gravity. The second part will deal with the ionic transport in solid material and soft material with some examples. The course will provide basic and advance information about these interactions and forces and how they can be addressed and simulated at nano to field scales.	
Objectives & Outcome	This course aims to guide the students to explore not only the genuinely fascinating and complex subject of material transport in water environment (surface water, groundwater, etc), but also in energy storage devices.	
Assessment/ Evaluation	Thematic report and exam	

Score breaking	Assignment report: 30%; presentation and discussion: 20%; written final exam: 50%
Required Textbooks and Other Course Materials:	1. Colloid (Nano- and Micro-Particle) Transport and Surface Interaction in Groundwater / William P. Johnson and Eddy F. Pazmiño - Guelph, Ontario, Canada, 2023. 161 pages, ISBN: 978-1-77470-070-9 DOI: doi.org/10.21083/978-1-77470-070-9 2. Transport and Surface Phenomena/ Kamil Wichterle & Marek vecer. 2020 Elsevier, ISBN: 978-0-12-818994-8 3. Porous media transport phenomena. Civan, F., 2011. Wiley, New York.

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lect.	Pr.	Dis.		
1	- Main content 1: Introduction to sizes, scales, forces, and energies of materials + Content 1.1. Size and scales + Content 1.2. Forces and Energies	3			Chapter 1	
2	- Main content 2: Nanoscale interaction + Content 2.1. Solute interaction with nanoscale solid materials + Content 2.2. Nanoscale materials interaction with surfaces	3			Chapter 2	
3	- Main content 3: Pore and field scale transport processes + Content 3.1. Pore-scale transport process + Content 3.2. Simulating pore-scale material transport + Content 3.3. From pore to field scale transport of solid materials	3		3	Chapter 3	
4	- Main content 4: Network of solid material transport on a continuum scale + Content 4.1. Experimentally observed continuum scale material transport + Content 4.2. Simulating continuum scale material transport	3		3	Chapter 4	
5	- Main content 5: Ions transport in solid material + Content 5.1. General features of ion transport.	12		6	Lecture material will be provided.	

	+ Content 5.2. Ionic transport in ionic conductor. + Content 5.3. Ionic transport in mixed ionic conductor. + Content 5.4. Examples					
	Total	24		12		

Hanoi, March 15, 2024

Detailed Course

1. Course name: Biosensors and Biochips

Course code: CH6.15

2. Credits points (ECTS): 03

3. Lecturer in charge: Dr. Vu Thi Thu, Dr. Nguyen Duc Anh

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	20 h
	Practice	0 h
	Tutorial	16 h
	Total	36 h
Prerequisites	None	
Recommended background knowledge	Analytical chemistry, Electronics, Immunology, Molecular biology, Biochemistry	
Course description:	There are 6 chapters on this course: (1) Introduction (General introduction on biosensors and biochips); (2) Bio-recognition (related recognition mechanism often employed in biosensing platforms); (3) Transducers (the most often used transducing elements to convert specific bio-recognition into measurable signals); (4) Minuturization – Microsytems (technologies for microfabrication and integration); (5) Examples on biosensors; (6) Point-of-care devices (sensing devices for personalized medicine).	

Objectives & Outcomes	
Assessment/ Evaluation	- Report
Score breaking	- Assignment report: 100%
Required Textbooks and Other Course Materials:	Handbook of Biosensors and Biochips – Robert S. Marks, Christopher R.Lowe, David C, Wiley.

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resource s	Assignment(s)
		Lec	Prc.	Dis.		
1	1. Introduction 1.1. Fundamentals on biosensors 1.2. Applications of biosensors	2				
2	2. Bio-recognition 2.1. Enzymatic reactions 2.2. Immuno assays 2.3. Molecular assays 2.4. Molecular imprinted polymer (MIP) 2.5. Aptamers	4				
3	3. Transducers 3.1. Electrochemical transducer 3.2. FET transducer 3.3. SERS transducer 3.4. Other transducers	4				
4	4. Miniturization – Microsystems 4.1. Silicon based technologies 4.2. Polymer based technologies 4.3. Paper based technologies 4.4. Integration	4				
5	Examples on biosensors ○ Glucometer ○ Pregnancy test ○ HIV tests ○ HBV test Covid tests	4	0			
6	Point-of-care devices	2	0			
	Practical (Nano and Bio Lab): Acetylcholinesterase based electrochemical sensors for pesticide detection	0	0	16		
	Total	20		16		

1. Course name: Bioinspiration and Biomimicry in Chemistry**Course code: CH6.16****2. Credits points (ECTS): 03****3. Lecturer in charge: Assoc. Prof. Tran Dinh Phong**

Teaching time		
Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	27 h
	Practice	0 h
	Tutorial	9 h
	Total	36 h
Prerequisites	Inorganic Chemistry, Physical Chemistry, and Chemistry of Nanomaterials	
Recommended background knowledge	Bioinorganic chemistry	
Course description:	This course discusses how chemists could learn from natural systems to design chemical objects (ranging from molecules to nanomaterials) for targeted applications. To this end, case studies will be presented and discussed. For each case, the structure and function of natural system will be first described following by how chemists could inspire from these features to design their desired objects. Representative chemical objects which have already been designed and synthesized will then be presented. Comparison between synthetic objects and natural systems will be emphasized in order to draw out the challenges that still remained. Case studies will be selected to discuss a large scope of application ranging from catalysis, energy conversion & storage, healthcare to environment analysis & treatment.	
Objectives & Outcome	Objectives: - Describe natural systems as a source of inspiration for chemists aiming to innovate the chemical sciences; - Get students familiar with concepts of bioinspiration and biomimicry as well as few successful examples when	

	chemists inspire the natural systems to design their desired objects - Train students the ability to analyze the structure and operation of natural systems, draw out the key features and propose the inspiration. Outcomes: - Students are familiar with key concepts of bioinspiration & biomimicry; able to describe few representative examples of bioinspired molecules, bioinspired nanomaterials; - Students are able to analyze and compare different bioinspired, biomimetic systems: versus the natural systems and versus other bioinspired, biomimetic systems; - Students are able to point out challenges remained in the bioinspired, biomimetic systems of their interests (<i>e.g.</i> close to their PhD study topics). - Students are able to propose design(s) of desired objects, which are relevant to their PhD study topics, via bioinspiration, biomimetic approach.
Assessment/ Evaluation	Written exam, Assignment report and presentation
Score breaking	Assignment report: 30%; presentation and discussion: 20%; written final exam: 50%
Required Textbooks and Other Course Materials:	Bioinspiration and biomimicry in chemistry, Edited by Gerhard F. Swiegers, Wiley Publication, 2012

COURSE CONTENTS & SCHEDULE

Class No.	Contents	No. of Hours			Ref./Resources	Assignments
		Lect.	Prc.	Dis.		
1	The concepts of biomimicry and bioinspiration in chemistry + Definitions + Seek inspiration or bioinspiration? + Biomimicry and sustainability + Biomimicry and nanostructure + Bioinspiration and function Assignments will be given to each PhD student in function of his/ her interests and his/her PhD study topics (e.g. catalysis, energy conversion & storage, environment, chemistry of functional nanomaterials, etc)	3			Chapter 1	
2	Bioinspired self-assembly + Concepts of self-assembly, thermodynamic and kinetic features + Molecular clefts, capsules and cages + Enzyme mimics and models: the case of hydrogenase + Ion channel mimics + Bioinspired frameworks	6			Chapters 2, 3	1
3	Bioinspired materials chemistry + Silicate based bionanocomposites as bioinspired systems + Biomimetic strategies for silica-based materials + Biomimetic membranes + Biomimetic bone materials + Bioinspiration for preparation of semiconductors, nanoparticles and nanowires	3			Chapters 5,6	1
4	Bioinspired catalysis + Brief history of our understanding of the Enzymes structure and catalysis operation + Relationship between enzymatic catalysis	6			Chapter 7 and additional reviews	1

	and nonbiological homogeneous and heterogeneous catalysis + Selected enzymes relevant to energy conversion: PSII, hydrogenases, CO-deshydrogenases, Nitrogenases; enzymes relevant to environmental issues: nitrate reductases. + Biomimetic and bioinspired catalysts for H₂ evolution, CO₂ reduction, N₂ fixation, water oxidation, etc.					
5	Bioinspired dendritic light-harvesting systems + Dendrimer architectures (dendrimer as a chromophore, dendrimer as a Scaffold); + Electronic processes in light harvesting dendrimers. + Light harvesting dendrimers in clean energy technologies	3			Chapter 13	1
6	Biomimicry in organic synthesis + Biomimetic synthesis of natural products + Biomimetic reactions in organic synthesis + Biomimetic considerations as an aid in structural assignment	3			Chapter 14 and additional reviews	1
7	Biomimetic principles in macromolecular science + Polymer synthesis versus biopolymer synthesis + Biomimetic structural features in synthetic polymers + Movement in polymers + Antibody-like binding and enzyme-like catalysis in polymeric networks + Self-healing polymers	3			Chapter 11	1
8	Presentation of assignment 1 & discussion			3		
9	Presentation of assignment 2 & discussion			3		
10	Presentation of assignment 3 & discussion			3		
	Total	27		9		