SDC

The university partnership
Denmark – China

# Course Catalogue Autumn 2019

## All courses related to the programmes

# Contents



This document was updated November 2019.

# Chemical and Biochemical Engineering

## Industrial Reaction Engineering

7,5 ECTS

CONTENT

A major part of chemical reactions in production processes and in gas cleaning processes takes place in multi-phase reactors, e.g. production of pharmaceuticals, calcination of lime in the production of calcium hydroxide, production of cement, combustion of solid and liquid fuels in the production of power and heat, catalytic and non-catalytic cleaning of flue gas and catalytic production of important products in different reactors including two or more phases. The examples are homogeneous or heterogeneous catalysed, gassolid, gas-liquid, liquid-solid and gas-liquid-solid reactions that take place in a number of different reactor types (batch fixed bed, moving bed, spray absorbers, packed towers, membrane reactors, fluidized bed reactors, entrained flow reactors etc.). The theory covering the different types of reactions and a number of the reactors is expounded together with examples. During the semester, the students cooperate in teams solving practical oriented reactor design problems.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- characterise solid particulates with respect to size, size distribution, shape, porosity, texture.
- calculate effective diffusion coefficients in simple structures.
- establish and solve mathematical models for gas-solid reactions (transport phenomena coupled to chemical reactions).
- evaluate structure models for gas-solid reactions.
- establish and solve models for gas-liquid-solid reactions.
- explain the enhancement factor for gas-liquid reactions.
- analyse and simplify complicated reaction engineering problems in order to establish mathematical models for the main phenomena.
- evaluate calculations for reaction engineering problems in order to use the results for practical design.

EXAMINATION

The course is evaluated based on solutions of three home exercises, three course assignments and an individual oral exam of 10 minutes. In the oral exam, each student is examined based on questions related to one of the course assignments chosen randomly by the examiners. No aid is allowed in the oral exam. External examiner.

RE-EXAMINATION

The re-exam consists of re-submission of home exercises and course assignments specified by the teacher based on results of the ordinary exam, and an individual oral exam of 10 minutes following the same rules as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Transport Processes

10 ECTS

CONTENT

Mechanisms for the transport of momentum (flow), energy and mass in chemical and biological systems. Introduction to computational fluid dynamics (CFD) as basis for analysis and simulation of transport processes. Applications in the design of equipment and analytical instrumentation in the chemical, biotechnological and pharmaceutical industry.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- describe the molecular processes behind viscosity, thermal conduction and diffusion.
- obtain analytical solutions for flow problems with simple boundary and initial data.
- formulate and analyse models for combined flow and heat transport.
- formulate and analyse models for combined flow and diffusion.
- formulate and analyse models for combined flow and chemical reaction.
- do order of magnitude estimates for key quantities such as fluxes, reaction rates and equilibration times.
- use CFD for the simulation of flow with combined heat and mass transport (COMSOL).
- evaluate the accuracy of approximations obtained by Computational Fluid Dynamics.
- formulate models for transport with a small or large parameter (boundary layers).

EXAMINATION

The report on Project 1 contributes 20%, and the report on Project 2 contributes 20% of the final grade. Each project is estimated to amount to about 1week's full time work. Project reports are limited to 10 pages each, not including a title page. Turn-in of reports resulting in a grade of at least 00/40 for each is a mandatory condition for participation in the written exam. The final 4-hour written exam (all aids except internet) contributes 60% of the final grade.

RE-EXAM

Grades for projects 1 and 2 carry over from the ordinary exam (weights 20% and 20%), and no new or substitute project reports can be submitted for the re-exam. The re-exam only covers the 4-hour written exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Industrial Bioreaction Engineering

5 ECTS

CONTENT

Role of fermentation in industrial manufacture of chemicals. Stoichiometry of cellular reactions, degree of reduction balances, yield coefficients and black box models. Mass balances evaluation of the feasibility of fermentation processes in an industrial context. Growth kinetics. Thermodynamics of bioreactions and heat balances. ATP balances and energetics. Scale-up and design of fermentation processes. Process evaluation project.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- describe the role of fermentation processes in the context of processes for production of industrial chemicals.
- calculate mass balances for fermentations including gas-liquid mass transfer.
- calculate carbon and degree of reduction balances for fermentation processes.
- evaluate the feasibility of fermentation processes in an industrial context.
- analyse the consistency of experimental data using simple models.
- describe different types of growth kinetic models.
- calculate the heat of production of fermentation processes.
- describe the principles for design and scale-up of a bioreactor.

EXAMINATION

- a process evaluation project (50%). The project will evaluate a given chemical made by fermentation on the basis of techno-economic performance and sustainability. The analysis will be used to identify a research and development plan. Projects are in groups of 2 and include a presentation and submission of a single written report of around 20 pages.
- A written exam (50%). The exam will be 4 hours, with aids, but without internet access.

RE-EXAM

The same as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Biorefinery

5 ECTS

CONTENT

To provide the students with basic knowledge about the biorefinery concept and integrated processes that convert biomass into multiple products of bioenergy, biomaterials and biochemicals.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- Describe the physical and chemical structures of biomass and their potential use for production of bioenergy, biomaterials and biochemicals
- Identify and describe biomass resources (forest, agricultural, municipal and marine biomass), their occurrence and application in a biorefinery concept
- Identify and describe biomass constituents (starch, cellulose, hemicellulose, lignin, pectin, protein, lipids)
- Outline the principles of a biorefinery including chemical, biological and thermo-chemical conversion methods
- Outline and compare various methods of biomass processing for production of bioenergy products, biomaterials, chemicals and building blocks for chemical synthesis
- Design a theoretical and creative biorefinery based on scientific references

### Content and perspective:

The course will give a broad perspective over the biorefinery concept by introducing the key integrated processes, such as biomass production, pretreatment, and chemical-, biological- and thermo-chemical-conversion. The lectures will focus on bioresources and single processing steps and will include industrial and scientific examples. In the case study the students will combine multiple processing steps into a novel biorefinery concept. There will be emphasis on sustainable systems throughout the course.

### Module structure and teaching approach:

The course is divided into four main blocks:

- Chemical characterization of biomass and recovery of biochemicals of industrial interest. Calculations include mass balances and stoichiometry.
- Green processes/techniques used in biorefineries: Enzyme technology, Membrane technology, Clean solvents, Integration reaction-separation, Use of microwaves/ultrasound.
- Introduction to Energy from biomass: Physical, microbiological and thermodynamical processes. Gasification and pyrolisis. Biogas. (To be continued in course "Production of Biofuels")
- Other applications: Biomaterials.

EXAMINATION

Attendance is mandatory

The course is evaluated based on: 1) a project report (max. 5 pages per student) that the students develop in groups of 4 people (50%). Each group shares the same raw material, but each of the students work on the production of an individual different product. Therefore, the assessment of the report is individual, and 2) a written exam (50%). The written exam is 2 hours and 25 minutes and consists of a theoretical quiz (25 minutes) and a calculations part (2 hours). No aids allowed only a simple calculator for the final written exam.

RE-EXAMINATION

The re-exam is evaluated based on: 1) an individual project report of max 5 pages (50%) and 2) a written exam (50%). The written exam is 2 hours and 25 minutes and consists of a theoretical quiz (25 minutes) and a calculations part (2 hours). No aids allowed only a simple calculator for the final written exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Laboratory Experiments (1. – 3. Semester)

5 ECTS

CONTENT

The course contains six experiments in laboratories at Institute of Process Engineering (IPE)

- CaCo2 decomposition in TGA
- Enzyme immobilisation in membranes
- Membrane separation
- Gas adsorption
- Dissolution of cellulose by ionic liquid
- Catalysts synthesis and evaluation

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- collaborate in team work during experiments.
- understand the appropriate approaches and the fundamentals of process engineering by carrying out the experiments.
- treat experimental data in a scientific way.

EXAMINATION

Perform six laboratory experiments in groups of 2-3 students in rotation. Each group will submit a report in a standard template for each experiment. The final marks are given based on the marks for the six reports (16.6 % each).

RE-EXAMINATION

The form of re-exam will be the same as the ordinary exam, but will only cover the experiments that fail in the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Progress in Research (1. – 3. Semester)

5 ECTS

CONTENT

This course will provide the student with information on both academic research from Denmark and China and industrial research and development from companies with activities in both Denmark and China.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- describe examples of industrial research and development.
- describe examples of front line academic research.
- understand the difference between academic and industrial research.
- read and understand scientific literature.
- participate in research based discussions.

EXAMINATION

Each student has to complete at least 10 reports about the individual research presentations. Each report is three pages, including an introduction to the research organization, a summary of a research paper related to the presentation, and a description of the student's opinions about the research challenges and potential research ideas. Evaluation pass/non-pass based on the reports.

RE-EXAMINATION

The re-exam consists of re-submission of reports that are failed in the ordinary exam.

GRADING

Passed / not passed

## Technology Economics Management and Organization (3. Semester)

10 ECTS

### CONTENT

The student is introduced to theories and models of business design, management and organization and to specific issues such as planning, organizing, leading, controlling, strategy, innovation, and business models.

### LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- identify and summarise key theories and models from the curriculum.
- explain and describe business models, organisational design and management activities in a specific case.
- apply theories and models from the curriculum in a solution proposal for a specific problem and explain the relevance of the chosen theories and models.
- analyse a specific case from a strategic, tactical and operational perspective.
- formulate a synthesis including managerial, organisational and business perspectives in relation to a specific problem.
- select organisational interventions and management activities from the curriculum to support the implementation of a strategy in a company and make an argumentation for the selection.
- outline the assumptions and preconditions of a specific problem and give an account of the consequences on the possible solution if these assumptions and preconditions are changed.

### EXAMINATION

The course is evaluated based on an individual 45 minutes multiple choice exam on the entire syllabus (30%) and a written group report on a business challenge from a company (70%).

### RE-EXAMINATION

The same as the ordinary. The written report can be written individually or in groups of up to 3 students provided that other students are taking the re-exam.

### GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Combustion and High Temperature Processes (3. Semester)

5 ECTS

CONTENT

Topics covered in the course include combustion of gaseous, liquid and solid fuels in different combustion systems such as gas turbines, motors, pulverised fuel combustors, fixed bed and fluid bed, as well as related industrial high temperature processes. The different systems are treated theoretically and the students solve larger, practically oriented problems during the course.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- set up mass and energy balances for combustion systems.
- estimate flue gas amount and composition from stoichiometric calculations.
- use simplified and detailed chemical models to estimate combustion rate and formation of pollutant species.
- couple chemical and thermal analyses of reacting systems.
- set up simplified conservation equations for reacting flows.
- explain conceptual and practical differences between premixed and diffusion flames.
- assess the impact of turbulence on combustion rates.
- set up and use simplified models for droplet evaporation and combustion.
- set up and use simplified models for particle heating and pyrolysis.
- set up and use simplified models for char oxidation.
- use the above tools together with numerical solvers to evaluate and optimise industrial high temperature processes.

EXAMINATION

Evaluation of exercises/reports. The grade is determined from an overall evaluation of two course exercises (90%) and five problem sets (10%).

RE-EXAMINATION

The same as the ordinary exam

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Fluidization and Multiphase Flow (3. Semester)

5 ECTS

CONTENT

- Fluidization phenomena
- Flow regime
- bubbling and circulating fluidized bed
- Multi-phase flow dynamics
- Models for the two-phase flow
- Application of fluidized bed

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- understand the flow regime of gas-solid flow and state of the art of research and application.
- manage basic calculations and solve practical problems related to fluidization.
- overview the modelling approached.
- design a fluidized bed reactor with preliminary requirement.

EXAMINATION

Evaluation of exercises/assignments. The grade is determined on the basis of an overall evaluation of two course exercises (70%) and two assignments with presentation (30%). The exercises take the form of basic calculations and solving practical problems of design and scale-up of fluidized bed reactors. The assignments take the form of overview of literature on selected topics and oral presentations.

RE-EXAMINATION

The re-exam is based on resubmitted exercises/assignments and an oral exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales

# Innovation Management

## Contemporary Theory of Innovation and Innovation Management

5 ECTS

Course Coordinator: Dmitrij Slepniov, Associate Professor, Aalborg University (ds@business.aau.dk)

CONTENT

The aim of the module is to provide students with a broad understanding of the dominant theories of innovation and innovation management as well as the foundational concepts of the innovation discipline.

During the course, the students will be exposed to the dynamic nature of innovation and its role in various geographic, organisational and functional contexts. The course will begin with looking into what is innovation and why it matters. The audience will be introduced to various perspectives on innovation, including the analysis of innovation as a core business process. Following this, the course will continue unravelling the complex nature of innovation by introducing the various types of innovation (e.g. product vs. process, incremental vs. radical, open vs. closed, disruptive vs. sustaining, technological vs. non-technological) and sources of innovation (e.g. external vs. internal, demand-driven vs. supply-driven, technology-driven vs. design-driven). The course will also link the discussion of innovation to the closely related concept of entrepreneurship and the role of entrepreneurs, i.e. those who are behind the act of doing and leading innovation. Besides covering the foundational concepts of contemporary theory of innovation and innovation management, part of the course will be dedicated to how China and the emerging Asian economies engage with innovation and what are some of the theoretical and practical implications of this engagement.

The course consists of interactive sessions, which entail active class participation, work with practical cases, as well as traditional lectures which introduce students to the supporting theoretical concepts and empirical material for a 'topic of the day'. The teaching philosophy of the course balances a theoretical foundation with engaging students in supervised practice. Therefore, the lectures of the course are designed around mini-projects and exercises that connect insights to actions and help the students to achieve the learning objectives of the course.

LEARNING OBJECTIVES

Following the successful completion of the module, the students will be able to:

- define and reflect on key concepts and theories within innovation/innovation management.
- critically discuss the importance of innovation at various levels (micro-, meso-, and macro)
- distinguish between different types and sources of innovation
- understand innovation as a core business process and get insights into routines, measures and models of innovation management
- critically discuss the concepts and theories of the course in relation to specific organizational situations and company practices

EXAMINATION

Individual written exam and a non-graded written assignment (as the exam prerequisite requirement)

- The exam is a 3 hour written exam with all aids incl. PC with internet access.
- The written assignment is prepared by the students in groups (recommended group size is 4-5 members). It is performed in the course of the module period. The assignment is not graded, but the assignment submission is the prerequisite for taking the course exam.

RE- EXAMINATION

The re-exam is subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Organisation and Management of Innovation

7.5 ECTS

Course coordinator: Yimei Hu, Associate Professor, Aalborg University (yimei@business.aau.dk)

### CONTENT

The aim of the module is to give students an understanding of the dominant theories of organisation and management and relate them to the innovation management theory and practice. The course offers specific emphasis on various aspects of managing organizational structures, people, change processes in the context of innovation.

At the outset, the rational, natural and open systems perspectives on organizations will be presented and analysed. The students will be acquainted with a fundamental understanding of the characteristics and behaviour of organizations, how they act and influence the actions of employees and vice versa. Furthermore, the students will get insights into how the external context and environment influences the organization. Throughout the course a special attention will be paid to contemporary issues within the field, including the emergence of new organizational forms, popularisation of networked, organizations, platforms and eco-systems.

The course is organized as a combination of lectures and seminars. The theoretical concepts and frameworks are applied and to different examples of innovative firms, best practices, success stories in various sectors and localities.

### LEARNING OBJECTIVES

Following the successful completion of the module, the students will be able to:

- define and critically discuss key concepts and determinants of behaviour in different organizations.
- understand how the dominant theories of organisation relate to the innovation management theory and practice.
- envision and implement organizational change initiatives especially in the context of innovation projects and innovation-driven organisations.

### EXAMINATION

The exam is a 4 hour written exam with all aids incl. PC but without internet access.

### RE- EXAMINATION

The re-exam is subject to the same regulations as the ordinary exam.

### GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Research Methods

7.5 ECTS

Course coordinator: Jonas S. Eduardsen, Assistant Professor, Aalborg University (jse@business.aau.dk)

CONTENT

The aim of the course is to provide students with the skills required for conducting different types of research and preparing research project reports. During the course, students will be introduced to basic concepts and frameworks of theory of science and how to design and conduct qualitative as well as quantitative research. The focus will be on understanding steps that are necessary for conducting research: formulating research questions, research design, data collection, data analysis, and drawing inferences and reporting results. The goal is to acquaint the students with a variety of different research methods and to enable students to select research designs and methods appropriate for a research objective.

The course will provide students with insights in the following main areas:

- A discussion of theory of science: What do we mean by theory of science and what different paradigms exist within social science
- Research design: How to match research questions with research designs and data collection methods
- The intercultural dimension of academic research: How to handle intercultural research projects
- The nature of qualitative research methods: How to design and perform qualitative research
- The nature of quantitative research methods: How to design and perform quantitative research

The course will focus on introducing students to theory of science, group work and project writing. Furthermore, the module introduces students to both qualitative and quantitative research methods. Here a collection of articles that exemplifies different research methods will be used throughout the course for inspiration and examples. The lectures will be combined with group work seminars

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- define and compare alternative scientific paradigms.
- define and discuss strengths and weaknesses of alternative research designs.
- use qualitative and quantitative methods for collecting and analysing data.
- develop research designs suited to investigate a variety of different research purposes.

EXAMINATION

The examination is a 4 hour written exam with all aids incl. PC but no internet access.

RE- EXAMINATION

Re-take examinations are subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Semester Project I

10 ECTS

Course coordinator: Dmitrij Slepniov, Associate Professor, Aalborg University (ds@business.aau.dk)

CONTENT

The aim of the Semester Project I is to help the students to acquire insights and skills in problem identification, analysis and solving within innovation/innovation management using scientific methods and theoretical reflections .

The module is based on identifying and analysing real-life innovation problems. The identified problem must be addressed by an activation of the theoretical insights gained in other modules and the methodological learnings from the module Research Methods. The students will be provided with guidance/supervision throughout the project period.

The theme for Semester Project I is the innovation problems and issues faced by companies and societies today as they were presented and discussed in the previous modules of the 1st semester. The semester project is expected to deal with an issue related to the previous modules and adopt a concrete perspective related to innovation financing and/or innovation performance as presented in the module Financing of Innovation.

Students work in groups and each group is assigned a supervisor for discussing the topic to work on and subsequently supporting the group in relation to data collection, analysis, theoretical reflections and solutions.

The topic for the semester project is chosen by the students in consultation with supervisors and approved by the coordinator. The topic must be a real-life problem to allow for theory-practice integration. Furthermore, it must be a problem that can be properly researched within the available period of the Semester Project I. Collaboration with companies is encouraged, but should be discussed with the supervisor to make sure that it is realistic to collaborate and compile the necessary data within the given period of the module.

LEARNING OBJECTIVES

Following the successful completion of the module, the students will be able to:

- formulate a complex problem in the area of innovation/innovation management with basis in reality highly exposed to global trends.
- analyse the formulated problem using practical insights, scientific methods and theoretical reflections from the modules of the semester.
- prepare and execute the empirical part of the project (data selection, collection and analysis) using the Methodology module.
- develop solutions to the problem and communicate these through a project document.
- experience and advance their understanding of working in diverse intercultural groups

EXAMINATION

Individual oral examination based on a written project.

- The project is prepared in groups (recommended group size is 4-5 students). The length of the project is min. 30 and max. 50 standard pages. The number of pages includes the text and tables while executive summary, references and annexes are excluded.

- The oral exam is 25 minutes per student (incl. grading) and includes an individual presentation (max eight minutes) on a topic related to the project, a discussion of the presentation and the project, the grading and the feedback.

RE- EXAMINATION

Individual oral examination based on a written project. The project is an individual mini-project of 10 standard pages. . The stipulated number of pages excludes abstract, annexes and reference list, but includes tables and footnotes. The oral exam is 25 minutes (incl. grading).

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Research Based Internship / Project (3. Semester)

30 ECTS

For this course students have two options:

Research based internship

Research based project

1. Research Based Internship

Course coordinator: Dmitrij Slepniov, Associate Professor, Aalborg University (ds@business.aau.dk)

CONTENT

The aim of a research based internship is to train the student to independently develop solutions to a management problem within innovation areas in a host company or organisation through the integration of theoretical reflection and practical action.

The internship is an opportunity to combine theories and methods from the study programme with the practices of companies, organizations and institutions. The internship must have an educational aim as well as contribute to the development of the internship hosts.

The student is part of the host organization and works on assignments agreed upon by the host and the student and approved by the internship coordinator. The internship period duration is 3-4 months of full time employment. The student receives guidance from SDC supervisors. The internship host also assigns a contact person to support the student.

LEARNING OBJECTIVES

Following the successful completion of the module, the students will be able to:

- identify and formulate an innovation/innovation management problem relevant to the internship host, but also reflects the interests of the student.
- prepare and apply a methodological design for how to collect and analyse data and provide solutions to the problem.
- review, critically discuss and select appropriate theories for analysing and providing solutions to the defined problem.
- get insights into how the host organisation is organised and managed.
- reflect on work experiences and learnings acquired during the internship period.

EXAMINATION

The examination is an individual 45 minutes oral exam based on the written internship report submitted at the stipulated deadline. The report must be minimum 40 and maximum 75 standard pages in length excluding executive summary, references and annexes.

RE- EXAMINATION

Re-take examinations are subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

2. Research Based Project

Course coordinator: Dmitrij Slepniov, Associate Professor, Aalborg University (ds@business.aau.dk)

CONTENT

The aim of the research based project is to train the student to independently formulate, analyse and provide solutions to an innovation/innovation management problem through theoretical reflections and scientific methods.

The students work independently or in groups on an innovation/innovation management problem of theoretical or practical relevance and approved by the project coordinator. The student receives guidance from SDC supervisors.

LEARNING OBJECTIVES

Following the successful completion of the module, the student will be able to:

- identify and formulate an innovation/innovation management problem of theoretical and practical nature.
- prepare and implement a methodological design for how to select, collect and analyse data and provide solutions to the problem.
- review, critically discuss and select appropriate theories for analysing and providing solutions to the defined problem.
- highlight and discuss practical implications of the project.
- reflect on conducting a research study using scientific rigour.

EXAMINATION

The examination is an individual 45 minutes oral exam based on the written project report submitted at the stipulated deadline. The report must be minimum 40 and maximum 75 standard pages in length excluding executive summary, references and annexes.

RE- EXAMINATION

Re-take examinations are subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

The details of the internship semester procedures are further described in the Innovation Management Internship Guidelines.

# Life Science Engineering and Informatics

## Omics brush-up

5 ECTS

CONTENT

The course will give the student the essential minimum knowledge to follow the first courses in (analytical) biochemistry, molecular biology and bioinformatics offered in the master's programme. Experimental work will generally not be a part of the curriculum, but computer-based exercise may be relevant.

Precise details will exclusively depend on the student's qualifying bachelor degree.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- communicate basic concepts and knowledge within the individualised topics in oral form.
- independently acquire additional knowledge related to the individualised topics.

EXAMINATION

Oral Exam in the form of a 15 minutes presentation on the "Brush up" topic followed by 5 minutes questioning.

RE-EXAMINATION

Same as the ordinary exam.

GRADING

Pass/not pass.

## Introduction to Omics

6 ECTS

CONTENT

1. Omics: history and prospects
2. Introduction to genomics
3. Transcriptomics: from microarray to deep-sequencing
4. Introduction to Proteomics
5. Interaction studies using Omics
6. Introduction to metabolomics
7. Genomics and systematic biology
8. Bioinformatics and computational biology

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- understand information contained - and outline the methods used - in genomics.
- understand and describe the use of microarrays in transcriptomics.
- describe and understand the information obtained by qualitative and quantitative proteomics and outline the methods used.
- describe the role of posttranslational protein modifications and the use of proteomics to determine these.
- discuss the importance of protein interaction and outline the methods used to study these.
- understand and describe the levels of metabolomics and the methods involved.
- outline the use of bioinformatics tools in various Omics studies.
- explain how systems biology is used to describe the function of biological systems.

EXAMINATION

Report of up to 10 pages (20.000 characters) excluding figures and references describing the use of Omics in a hypothetical research project. 30 minutes oral defence of the report.

RE-EXAMINTION

Same as the ordinary exam.

GRADING

Pass/not pass.

## Analytical biochemistry and sample preparation for Omics

8 ECTS

CONTENT

The theory behind methods used for separation and purification of RNA, DNA, proteins, peptides and metabolites will be covered, including methods based on affinity, hydrophobicity, polarity, charge and size:

- Extraction and purification of proteins, RNA, DNA and metabolites from biological samples.
- Chromatographic techniques
- Electrophoretic techniques
- Selective purification/enrichment for post-translational modifications
- Labelling and quantitation for proteomics
- Sample preparation and data analysis in metabolomics
- Sample preparation for lipidomics
- Sample preparation for genomics/transcriptomics
- Digestion of biomolecules
- Interfacing chromatography with mass spectrometry

Practical laboratory work will include:

- Reverse phase liquid chromatography
- Gas chromatography
- Lipid purification
- Protein purification
- Two-dimensional electrophoresis
- MALDI peptide mass finger printing and MALDI MS/MS for identification; data analysis
- Sample preparation for transcriptomics
- Sample preparation for genomics

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- explain the principles behind the analytical techniques presented in the course.
- evaluate strengths and limitations of different separation/purification techniques.
- select the best separation/purification technique(s) for a specific omics investigation.
- assess the quality of data from separation/purification analyses as presented in original scientific literature.
- evaluate and reflect on the use of separation/purification techniques applied in original research articles.
- operate equipment and perform experiments using the techniques taught in the practical laboratory exercises.

Participation in laboratory exercises are mandatory.

EXAMINATION

4-hours written exam.

All aids except internet.

RE-EXAMINATION

Same as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Unix and Python for Data Science

5 ECTS

CONTENT
The course exposes the student to practical problems a data/computer scientist will encounter in a two-fold fashion. 1) The Unix command line will be used to do file manipulation, I/O redirection, file system manipulation using the path, file hierarchy and file access control. 2) Python will be used to cover the most basic concepts of data science and data processing going into various data types and data structures and introducing the concept and use of algorithms.

The course is as such an introductory course in Unix and Python and will have a heavy focus on practical problem following basic programming principles and good programming practices. The problems will be centered around common bioinformatics problems such as parsing and manipulating bioinformatics data files. Performance and memory considerations will be introduced.

LEARNING OBJECTIVES
At the end of the course, the student is expected to:

- Explain what an algorithm is and give examples of algorithms
- Demonstrate insight in how to design and implement an algorithm in Python
- Use various data types and built-in functions in Python
- Decompose a computational task using sub-routines.
- Find and correct errors in a program based on its behaviour
- Define and use regular expressions (computational pattern recognition)
- Write code so others can understand it, and understand others code
- Analyze and plan the execution of a minor computational project.

EXAMINATION
The grade will be based on the exercises handed in during the course and a 10-page individual project. The exercises and project count 50%/50% towards the grade.

RE-EXAM
4 hours written exam without aids.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Personalized Track

7 ECTS

CONTENT

This course aims to provide the individual student with the basic knowledge required to select a theme for the master's thesis, and more over provide a contact that can serve as a "help-desk" throughout the whole study, although with main emphasis on the final master's thesis. Thus, this course will be the glue of the entire study programme.

The objective is to introduce a range of applications of Omics and presentation of various relevant areas of research, which will help the student in selecting his/her personal "biological" question that will follow the student through the study programme and form the basis for the master's thesis. Skills acquired in the courses focused on technical, analytical, biological and bioinformatics as well as "entrepreneurship" will be applied to the personal "biological" question selected.

Moreover, the student will learn about project management, scientific writing and oral presentation of a scientific topic to peers and to non-experts. Standards in publication ethics and scientific conduct will be discussed. Scientific standards that are expected by peer-reviewed journals will be presented.

Suggested topics for biological areas:

- Omics in medical applications (e.g. metabolic-, degenerative-, and cancer diseases)
- Omics and microbiology
- Omics and plant biology
- Omics and agriculture (e.g. animal breeding, food and soil).

LEARNING OBJECTIVES

At the end of the course, the student is expected to be able to:

- critically evaluate scientific results in the original research literature.
- present scientific results in an oral seminar given in English.
- discuss strengths and limitations of modern techniques in Omics.
- identify scientific problems connected to Omics-approaches and reflect on application of the different available techniques to solve relevant biological questions.
- identify the "method of choice" for analysis of a given biological sample.
- select the "method of choice" for answering a specific biological question.
- demonstrate skills in general experimental design, planning of experiments, interpretation of experimental data and note keeping in execution of experiments.
- independently take responsibility for his/her own professional development and specialisation, including application for financial research support.
- disseminate research based knowledge and discuss professional and scientific problems with both peers and non-experts.
- write a scientific paper presenting the results from the Thesis. This paper should ideally be submitted to a peer-reviewed scientific journal.

EXAMINATION

The evaluation is based on performance of the student in an oral presentation, oral discussion of research project and a written project assignment. Each evaluation accounts for 1/3 of the final grading (pass/not-pass).

Description of the evaluations: an oral presentation (15min) of a group work. A written project assignment submitted to the course responsible (consisting of a one page abstract). An oral discussion of research projects with evaluation of acquired skills and knowledge (study design, identify method of choice, hypothesis formulation) underlying the research project

RE-EXAMINATION

Re-exam will follow the same format.

GRADING

Pass/Not-pass

## Thesis (3. Semester)

60 ECTS

CONTENT

All students must follow the SDC Thesis Regulations 10 Steps.

The student will be assigned a Danish and a Chinese supervisor who are to approve the topic.

The student must submit a thesis contract signed by the supervisors and the student to the SDC Office.

The thesis contract contains the thesis topic, a description of the thesis with appropriate selected references, name of the institute and laboratory for execution of the practical work, and submission deadline.

The thesis is to be delivered digitally at the SDC Office.

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The thesis and the oral defence are assessed by the supervisors and an external examiner.

LEARNING OBJECTIVES

After completing the thesis, the student is expected to master and be able to:

- state the purpose of an experimental omics project in context of the background of the research field.
- independently retrieve scientific literature relevant to the thesis, and outline the current knowledge based on this literature.
- describe materials and methods used in the thesis in such details that an equally qualified person can reproduce the experiments.
- describe, document and explain results obtained in the thesis, so professionals in the field can follow the experiments and the experimental strategy.
- Discuss the thesis results in context of existing knowledge on the topic, relate the outcome of the experimental work to the purpose of the thesis, and devise obvious future work and perspectives.
- present his/her own research in the format of a scientific manuscript.
- orally disseminate his/her own research, and discuss it with peers.
- explain the principles of the main methods used in the thesis.
- describe the biological foundation central to the thesis.

EXAM

The thesis must be written in English throughout. The thesis should be built around the outline of a manuscript for an international scientific journal. The exact journal, from which the format is observed, will depend on the topic of the thesis and should be chosen by the student and the supervisors in agreement. The thesis should be constructed as follows:

- A cover page with all relevant information on thesis title, student, supervisors, study programme and period of thesis work.
- A scientific manuscript prepared according to the guidelines provided by the chosen scientific journal.
- List of abbreviations if this is not requested by the journal's guidelines

- Supplementary material, which presents e.g. elaboration on methods, relevant data not included in the manuscript and discussions on such methods/data with references. Supplementary material is not a compulsory section, but may be useful depending on the thesis project and outcome.
- An electronic media for software developed as part of the thesis, when relevant.

The scientific manuscript must not exceed 40 pages including all figures and tables when following the journals' guidelines for formatting. There is no minimum for supplementary material, since it is not compulsory, but the maximum length is 80 pages all included.

### Defence

The defence has the form of an oral exam, which is initiated by an approximately 30 minutes student presentation on the thesis. The subsequent examination should not exceed 90 minutes.

### RE-EXAMINATION

The same as the ordinary exam attempt. For more information, see SDC Thesis Regulations 10 Steps.

### GRADING

For the Danish/international students, grades are given according to the Danish 7 step and the Chinese thesis grading scales.

For the Chinese students, grades are given according to the Danish 7 step grading scale only.

The details of the thesis procedure are described in SDC Thesis Regulations 10 Steps.

# Nanoscience & Technology

## Unifying Concept in Nanoscience

15 ECTS

Course responsible:

CONTENT

Nanosized systems have special properties. The objective of the course is to learn about the unifying concepts that form the scientific basis of these special properties.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

Knowledge:
- Describe concepts of absorption, spontaneous emission and stimulated emission.
- Define concepts on electron tunneling, transport and transfer including Coulomb blockade
- Explain concepts of high-resolution microscopy, including single molecule fluorescence spectroscopy and fluorescence correlation spectroscopy.
- List concepts of energy transfer (FRET, Dexter)
- Describe concepts on molecular electronics, OLED, OFET and thin film devices.
- Explain concepts on biological and artificial membranes
- List and identify properties of nanomaterials such as graphene, carbon nanotubes, nanowires, quantum dots, small metal clusters and nanoparticles.
- Relate concepts on the different properties of bulk material versus nanomaterials.

Skills:
- Apply the above knowledge for evaluating and calculating nanoscale system properties and behavior.

Competencies:
- Read and analyze nanoscience literature, present and evaluate this work in a concise manner, and write a reflective self-consistent essay on it.
- Write and evaluate specific nanoscience concepts, techniques, literature reviews and design a research proposal.

EXAMINATION

Essay (34%)

30 min. oral exam, no aids (33%)

Assignments (33%)

To qualify for the exam students, have to hand in 3 assignments during the course, present two research articles, and write a 15-page essay on a chosen topic.

RE-EXAMINATION

Same as ordinary. The assignments and essay must be completed before the oral re-exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales

## Nanobiotechnology

5 ECTS

Course responsible:

CONTENT

This course introduces students to the selected areas in nanobiotechnology – the field which employs nanoscience for biomedical applications. The students will learn how artificial entities can support their biological counterparts. The course helps students to better understand health impacts and the risks of nanoscience and technology by obtaining an introduction to nanotoxicology. Further, microfluidic concepts and omics techniques for biomedical application will be addressed. For all topics, basic knowledge, key concepts and real experiments will be discussed.

LEARNING OBJECTIVES

This course will cover the following areas in nanobiotechology:

- General overview over basic biotechnological and nanobiotechnological concepts.
- Self-assembly
- Artificial enzymes, organelles and cells
- (Biological) Nanobots
- Nanotoxicology
- Microfluidics
- Omics

SKILLS

After completing this course, the student will be able to:

EXAMINATION

Compulsory report (25% of the grade) and written 48 h take home exam (75% of the grade) in the form of an essay. Aids are allowed. Internal censorship.

RE-EXAMINATION

Same as ordinary. The compulsory report must be completed before the re-exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales

## Nanocharacterization

10 ECTS

Course responsible:

CONTENT

In this course students will learn the basic physical principles behind a number of nanocharacterisation tools. Five main areas will be addressed in detail:

- Electron microscopy
- X-ray diffraction
- scanning probe microscopy
- surface spectroscopies
- nuclear magnetic resonance

The first part of the course will introduce the theoretical background and implementation of the techniques as well as discuss application examples based on scientific literature. The last part of the course will involve hands-on exercises on a number of the techniques.

In the first five weeks of the course, the five main areas/techniques are covered through a combination of lectures, exercises, student discussions and student presentations. In the last two weeks experimental exercises are performed, typically in groups of three students.

LEARNING OBJECTIVES

At the end of the course the students should be able to introduce a number of essential methods for nanocharacterisation and to build the power to select and apply these methods to obtain specific information from given experimental systems.

EXAMINATION

Report/essay based on the experimental exercises. Written exam (three hours, without aides). The course grade is based both on the report (25%) and the written exam (75%).

RE-EXAMINATION

Same as ordinary, report must be completed before the re-exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales

## Thesis (3. Semester)

60 ECTS

CONTENT

All students must follow the SDC Thesis Regulation 10 Steps. The purpose of the thesis is to allow students to demonstrate their ability to work independently with an academic topic, which is an important part of the individual student's academic profile.

The thesis amounts to 60 ECTS credits. It must be of an experimental nature, i.e. they must contain the student's own production of academic work in the form of the generation of original data/original material.

Two supervisors will be appointed, one Chinese from CAS/UCAS and one Danish from a Danish University.

If the thesis is completed at an external institution (e.g. a company), the student will also be assigned an external supervisor from the external institution. The external supervisor from the external institution participates in the planning of the thesis studies in collaboration with the two supervisors.

The external supervisor does not participate in the defence or the grading.

Thesis contract

A thesis contract is completed at the start of the thesis work, which sets out the thesis framework content. The thesis contract is also an exam registration and must be signed by the student and the two supervisors. The supervisors are responsible for approving the problem formulation.

Before completing the thesis contract, the student and the supervisors are to agree a plan for the thesis supervision that covers issue. The plan should include the following: how often and how supervision is to be carried out, what is expected of the supervisors and the student at supervision meetings, conditions concerning the collection of primary data/experimental work, and general mutual expectations to the working relationship.

Deadline for submission

The supervisors are responsible for ensuring that the scope of the thesis is such that it can be completed within the set timeframe, and that the student receives regular feedback as to whether his/her work is progressing at a pace that will allow him/her to comply with the timeframe.

All deadlines can be found in the Thesis Regulation 10 Steps.

The deadline for submission set out in the thesis contract is binding, and exceeding the deadline counts as an exam attempt.

LEARNING OBJECTIVES

A student who has completed the thesis has acquired the following competences:

*Knowledge*

Knowledge that allows the student to:

- identify scientific problems within the study programme's subject areas.

- summarise a suitable combination of methodologies/theories based on international research for use in his/her work with the problem formulation.
- discuss theories/models on the basis of an organised value system and with a high degree of independence.

*Skills*

Skills that allow the student to:

- apply and critically evaluate theories/methodologies, including their applicability and limitations.
- assess the extent to which the production and interpretation of findings/material depend on the theory/methodology chosen and the delimitation chosen.
- discuss academic issues arising from the thesis.
- draw conclusions in a clear and academic manner in relation to the problem formulation and, more generally, consider the topic and the subject area.
- discuss and communicate the academic and social significance, if any, of the thesis based on ethical principles.

If the thesis includes experimental content/data production, the student will also be able to:

- substantiate the idea of conducting experimental work/producing his/her own data in order to shed light on the topic as formulated in the problem formulation.
- process data through a choice of academic analysis methods and present findings objectively and in a concise manner.
- assess the credibility of his/her own findings based on relevant data processing.

*Competences*

Competences that allow the student to:

- initiate and perform academic work in a research context.
- solve complex problems and carry out development assignments in a work context.

EXAMINATION

The thesis is concluded with a two-part individual exam consisting of the preparation of a written thesis report and a subsequent oral presentation/defence of the thesis report. The oral defence must be held no later than one month after the submission of the thesis report, and the grade must be awarded on the same day as the thesis defence is held.

The thesis is assessed by the two supervisors and an external examiner, and a single grade is given for the thesis report and the oral defence. In addition to assessing the academic content of the thesis, where the abstract is included on a par with the other components, the examiners will also assess the student's spelling and writing proficiency.

If the student requests such, the main supervisor and the external examiner are, in connection with the assessment, to prepare a written academic and methodical evaluation, which is to be presented to the student no more than seven working days after publication of the grade.

Requirements for taking the exam

For the oral thesis defence to be held, a thesis report must have been handed in by the deadline.

The thesis report and its references make up the syllabus at the thesis exam.

Published theses, articles, peer-reviewed articles or manuscripts with several authors may be used either in the thesis report or as annexes, but only if (co-)author statements can be obtained which specify the scope of the student's contribution.

The thesis is concluded with an oral defence lasting approx. 60 minutes, including a presentation lasting approx. 30 minutes.

RE-EXAMINATION

The same as the ordinary.

GRADING

For the Danish/international students, grades are given according to the Danish 7 step and the Chinese thesis grading scales.

For the Chinese students, grades are given according to the Danish 7 step grading scale only.

The details of the thesis procedure are described in SDC Thesis Regulations 10 Steps.

# Neuroscience and Neuroimaging

## Basic Neuroscience

15 ECTS

CONTENT

The course introduces students to key concepts in neuroscience and neuroimaging. The course will be initiated with an overall description of the physiological function of, and the interactions between the different organ systems within animals. All in the content of neuroscience. Hereafter, the course will make an introduction to the molecular and cellular components of the central nervous system (CNS), their development and organization. The course will provide an elementary overview of the structures and functions of the nervous system, with special emphasis on functional systems responsible for sensorimotor, autonomous, and cognitive function, as well as their importance for major brain diseases within the fields of neurology, neurosurgery and psychiatry. Furthermore, there will be an introduction to the different signalling pathways, as well as an introduction to the electrical and receptor-neurotransmitter mediated signalling between neurons and other cells in the CNS. The fundamental principles of diagnostics and treatment of major brain diseases will be discussed including knowledge of the dysfunction of the different signalling systems. The course also includes a description of molecular aspects of the coupling between function, flow and metabolism of the brain. Based on this knowledge, the students will be introduced to the molecular neurobiological aspects underlying different brain imaging methods. Specifically focusing on the basis for our understanding of the biology linked to the use of positron emission tomography (PET), magnetic resonance spectroscopy (MRS), optical imaging, two-photon imaging and hyperpolarized MR-substances.

LEARNING OBJECTIVES

*Knowledge*

During the course, the student will gain knowledge in and understanding of:

- the basic structural and functional properties of neuronal and glial cells and their networks in the central nervous system.
- basic insights in the chemical and electrical signalling of neurons and glial cells, both in the developing, mature and diseased nervous system.
- basic human neuroanatomy.
- basic aspects of ligands used to map neurotransmitter systems.
- aspects of cerebral blood flow and its regulation as well as mapping of glucose metabolism.
- neurovascular coupling and its regulatory mechanisms.
- research relevant aspects, e.g., Alzheimer's disease, Parkinson's disease, multiple sclerosis, schizophrenia and stroke.

*Skills*

The students will be able to:

- demonstrate skills at a basic level related to the understanding of the general principles of the structure and function of cells in the central and peripheral nervous system.
- use and understand neuroanatomical nomenclature.
- identify neuroanatomical structures from brain images and illustrations.
- identify neural structures of importance for major brain diseases.
- point to suitable methodologies utilized to investigate properties of neurons and glial cells, including their interactions.

- display skills with respect to actions of pharmacological substances and other treatments of the nervous system at an introductory level.
- choose the best possible ligands for molecular cell type imaging reflecting their specific biological processes.

*Competences*

At the end of the course the student will be able to:

- work independently as well as in teams, in relation to trans-disciplinary scientific projects using a variety of methods.
- critically review published literature, understand the main brain structures and functions, and thereby indicate avenues for further neuroscience and neuroimaging research.
- formulate short lectures on the basic structure and function of the central nervous system and present these to the scientific community.
- navigate within the human nervous system and handle self-generated neuroanatomical data.
- Understand and reflect on the basic biological mechanisms and their interactions in molecular brain. imaging research.
- have a sound knowledge and a basic critical approach to scientific understanding in order to study more advanced topics within neuroscience and neuroimaging.

EXAMINATION

The final exam is a 4-hour written examination, where no aids are allowed. The examination will be based on the full course curriculum, and will be balanced to cover a broad range of the different topics covered during the course. In the examination paper, it will be indicated how much each main question contributes to the complete score of the final examination. The examination will be assessed by teachers and an internal examiner.

One final grade is awarded, combining the scores of the 30% hand-in assignments and the 70% final examination. The final grade will be awarded according to the 7-step/100 points grading scale.

The purpose of the examination is to assess the students' ability to:

- integrate knowledge of neuroanatomy, neurophysiology, neurotransmission, movement and sensation, complex brain functions, neuropharmacology, neuroimaging, neural blood flow, brain plasticity and stem cells.
- utilise the above-mentioned knowledge in a coherent understanding of the complex interplay between brain structures and functions; both at the macroscopic, cellular and molecular level.

RE-EXAMINATION

The re-examination will consist of a 4-hour written examination, where no aids will be allowed. The score of the re-examination will account for 100% of the grade. The examination will be based on the full course curriculum, and will be balanced to cover a broad range of the different topics covered during the course. In the examination paper, it will be indicated how much each main question contributes to the complete score of the final examination. The examination will be assessed by teachers and an internal censor.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Fundamental Biomedical Signal Processing

10 ECTS

CONTENT

The aim of this course is to provide the student with a basic foundation in signal processing techniques commonly encountered in biomedical applications. We begin the course with an introduction to computers, algorithms, and scientific computing. The goal of this part is to be able to write simple algorithms, including loops, functions, and conditional statements, which can be used for efficient analysis of data and signals. During this part the students are introduced to the MATLAB programming environment, which is used for signal processing in both this course and later ones.

The course then continues by covering relevant mathematical concepts from linear algebra and calculus, as well as their application, e.g., in the context of optimization and Fourier analysis.

The second part of the course covers topics from digital signal processing and analysis. First, the foundations of signal processing are introduced, e.g. analog to digital conversion, discrete time signals, Shannon's sampling theorem, convolution, and filters. This will be followed by an introduction to basic tools from stochastic signal processing, including autocorrelation and power spectrum. The course is concluded with image processing methods, with special emphasis on techniques relevant for the analysis of neuroimaging data.

LEARNING OBJECTIVES

*Knowledge*

At the end of the course the students will have gained knowledge of:

- Scientific computing
- Linear algebra and calculus in the context of biomedical signal processing
- Optimization
- Discrete Fourier analysis
- Digital filters
- Deterministic and stochastic discrete signals
- Autocorrelation function and power spectral density of a noisy signal
- Basic image processing techniques in two and three dimensions

*Skills*

During the course, the student will have obtained skills to be able to:

- Write simple algorithms to process data and analyze signals
- Use techniques from linear algebra and calculus to manipulate data
- Describe basic concepts for discrete-time signals e.g. sampling and quantization.
- Apply Shannon's sampling theorem.
- Apply the discrete Fourier transform.
- Design filters in both time-domain and frequency-domain.
- Explain the structure of simple FIR and IIR filters.
- Compare and relate deterministic and stochastic discrete signals.
- Calculate the autocorrelation functions of a random signal.
- Calculate the power spectral density of a random signal.
- Analyze 2D and 3D images using basic image processing techniques in MATLAB.

*Competences*

Through the course, the student is expected to gain the competences to be able to:

- Analyze and reflect on particular problems and identify relevant mathematical techniques for solving the problems.
- Provide concise description of solution strategies.
- Interpret and analyse digital signals and images.

EXAMINATION

The written examination will be in the format of mathematical and signal processing problems to be solved using MATLAB or pen and paper. In addition, essay questions may be formulated. The exam content will reflect the content of the course, with approximately 50% scientific computing and mathematics, and 50% signal- and image-processing. Each problem / question will be indicated how it contributes to the total grade. Duration of examination: 4 hours. All aids are allowed including dictionaries, text books and a computer for solving MATLAB problems. Internet connection is not allowed. No phones are allowed (not even used as a calculator).

RE-EXAMINATION

Will be in the same form as the original exam

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Medical Imaging Techniques

5 ECTS

CONTENT

The aim of the MIT course is to give a short introduction to three imaging techniques frequently used in biomedical research and/or clinical practice: Optical imaging, X-ray imaging, and radionuclide imaging. The course will cover the theoretical background as well as practical utilization, strengths, and limitations of the various techniques.

Recommended student requirements:

Knowledge and competences within mathematics equivalent to the Neural Signal Processing course in the Neuroscience and Neuroimaging Master's program. Basic knowledge of physics and chemistry.

LEARNING OBJECTIVES

*Knowledge*

The student will gain knowledge of:

- interaction of light and ionising radiation with biological tissue.
- Methods and design of instrumentation used for optical imaging (luminescence, fluorescence, and super-resolution imaging), X-ray imaging (planar and CT), and radionuclide imaging (gamma camera, SPECT, and PET).
- the importance of optimisation of protocol and imaging parameters for a particular purpose.
- key specifications for different imaging systems.
- advantages and disadvantages of the different imaging techniques.

*Skills*

At the end of the course the student will be able to:

- understand and assess the performance of various imaging systems.
- identify the best imaging techniques to solve a particular problem in biomedical research and clinical practice.
- optimize protocol and key imaging parameters for best image quality.

*Competences*

This course enables the student to:

- contribute to implementation, optimisation, and development of imaging techniques for biomedical research and clinical practice.
- participate in imaging based biomedical research as a member of an interdisciplinary team.
- educate health professionals and others about basic principles of several imaging techniques.

EXAMINATION

3-hour written examination with a combination of 30 multiple choice questions (60%) and three essay questions (40%). For each question, it will be indicated how much it contributes to the exam.

Aids: A pocket calculator and a dictionary in paper format.

Graded by teachers and internal censor, using the Danish 7-step scale and the Chinese 100 points scale.

The purpose of the examination is to assess the student's ability to fulfil the learning objects of the course.

RE-EXAMINATION

Same format as original exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Thesis (3. Semester)

60 ECTS

CONTENT

The SDC Master's Degree in Neuroscience and Neuroimaging is concluded by a master thesis equivalent of 60 ECTS. The student should work independently with a research topic at a suitable research laboratory under the supervision of a Chinese and/or Danish university professor affiliated with the SDC. The student should prepare a dissertation of the conducted work at the end of the master thesis, which will be assessed together with an oral presentation of the work (the defence).

Module structure and teaching approach

Independent work in a research laboratory along with theoretical studies of the topic. Guided and supervised by a Chinese and a Danish university professor affiliated with the SDC.

LEARNING OBJECTIVES

*Knowledge*

During the study, the student will:

- obtain extensive knowledge and understanding in the research topic of the master study.
- reflect on the acquired knowledge to plan and execute scientific experiments.

*Skills*

The student will acquire:

- the ability to analyse, critically discuss, and review scientific articles.
- disseminating skills for the presentation of personal scientific data to the non-specialists and research community.

*Competences*

At the end of the study the student will be able to:

- define, describe and test scientific hypotheses.
- independently plan and conduct a larger scientific research project through the use of the theory and techniques obtained during the education.
- analyse, critically discuss and evaluate scientific problems.

EXAMINATION

Written report and oral examination.

The written report should contain the same sections as a scientific paper. Please include a section on method optimisation as appropriate.

The maximum length of the thesis is 132,000 characters excluding blanks (equivalent to approximately 60 normal pages). There is no minimum length of the thesis and it does not have to reach the maximum length.

Deadline for the written report is set by the SDC in Thesis Regulations. Guidelines for the Master's thesis will be displayed on Moodle.

Oral defence

The oral defence will take place after the thesis is handed in, following the deadlines set by the SDC.

Chinese students:

45 min oral presentation of the project followed by 45 min of questions from examiners.

Examiners: Chinese supervisor, Danish supervisor, external censor.

Danish/International students:

45 min oral presentation of the project followed by 45 min of questions from examiners.

Examiners: Chinese supervisor, Danish supervisor, external censor and for the Chinese grading also a Chinese expert.

RE-EXAMINATION

The same as the ordinary exam attempt. For more information, see Moodle's 10-step guide.

GRADING

For the Danish/international students, grades are given according to the Danish 7 step and the Chinese thesis grading scales.

For the Chinese students, grades are given according to the Danish 7 step grading scale only.

The details of the thesis procedure are described in SDC Thesis Regulations 10 Steps.

# Public Management and Social Development

## Comparing Societies and Economic Systems

7.5 ECTS

Course coordinator: Kjeld Erik Brødsgaard (keb.egb@cbs.dk)

CONTENT

This course aims to provide a broad overview of the most important features of the two societal systems primarily addressed in the programme, the Chinese and the European system (as well as variations within Europe). The course will serve as a broad introduction to the general themes and framework of the programme. This will include introductions to key theories and concepts of state, power, socioeconomic systems, citizenship and governance. The course will also discuss and illustrate how to conduct comparative inquiries in the social sciences.

The course combines lectures with student discussions and presentations. Active student participation in terms of preparing for classes and involvement in discussions with the faculty and fellow students is expected.

The students must combine social scientific methods and theoretical concepts to analyse a specific issue in public policy, government-business relations or social development, which they choose in dialogue with the project supervisors.

The theme for the assignment and oral exam is comparative policy analysis related to the issues discussed in the course. The assignment and oral exam must have a comparative component, for example cross-nationally or between organisations/companies, regions and the like.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- demonstrate knowledge about the key features of the societal systems presented in the course readings.
- identify different societal models and compare their origin and development.
- relate the interaction between economic, social and political structures and processes analytically.
- apply knowledge about societal systems in comparative analyses of a particular research question related to the course topics.

The assignment and oral exam should demonstrate a strong ability to:

- identify and define relevant policy problems related to the themes of the course.
- select appropriate conceptual frameworks and theories for understanding and reflecting upon the problem.
- select and apply appropriate methodology for analysing the problem.
- Persuasively present independent analyses

EXAMINATION

The exam is comprised of an assignment. Students will work on the assignment individually or in small groups of 2-3 students. The topic for the assignment is chosen by the student(s) in consultation with the supervisors and approved by the programme coordinators.

The assignment is to be submitted at a stipulated date. The assignment must not exceed 10 standard pages when written as individually, 15 when writing in pairs and 20 if writing in groups of 3. This includes tables and footnotes, but not front page, bibliography and appendices.

RE- EXAMINATION

The same as the ordinary. A new assignment must be submitted. The project can be written individually or in groups of up to 3 provided that other students are taking the re-exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

The grading is based on an overall assessment of both the assignment and the oral exam – with an emphasis on the latter.

## Government and Business

7.5 ECTS

Course coordinator: Xin Li (xl.int@cbs.dk)

CONTENT

The course aims to provide students with insights into the relationships between government and business, such as how governments at different levels affects business practice, how businesses respond to and influence government policy, conflict and alignment of interests between government and businesses, and the changing role of national government in the era of globalisation.

The course introduces three different lenses or perspectives for understanding government and business relations, namely, the boundary, interest, and power lenses. After introducing these theoretical perspectives, we discuss nine specific topics that are associated with each of the three lenses, including: state-owned enterprises (SOE), the political strategy of business, China's health care system, Chinese government's role in the internationalisation of Chinese firms, innovation policy and industrial policy, supra-national governance and its' impacts on businesses, etc.

LEARNING OBJECTIVES

At the end of the course, the students should be able to account for and explain:

- power relationships between government and businesses.
- conflict and alignment of interests between government and businesses.
- varieties of capitalist economic and business systems and the underlying institutional logics behind such varieties.
- how the interactions between government and business influence the economic performance of a nation.

In addition, students should have a demonstrated ability to:

- identify a real-life problem related to the government-business relations at international, national or subnational levels.
- critically select and apply relevant theories and concepts in the analyses of the identified problem(s) and arrive at well-founded recommendations addressing such problems.
- concisely and convincingly present analyses and recommendations in writing.

EXAMINATION

The examination is an individual 48 hours assignment. Students are requested to choose and complete one of the three assignments stated in the exam paper.

The written report should be no more than 10 standard pages in length, excluding cover page, table of content, references and any appendix.

RE- EXAMINATION

The re-exam is the same as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Research Methods

7.5 ECTS

Course coordinator:

CONTENT

The aim of this course is to provide students with the skills required for conducting different types of research and apply research methods in projects. During the course, students will be introduced to basic concepts and frameworks of social science research methods and how to design and conduct qualitative as well as quantitative research. The focus will be on understanding the necessary steps involved in doing research: formulating research questions, research design, data collection, data analysis, and drawing inferences. The goal is to acquaint the students with the most important and commonly used research methods in the social sciences, to enable students to select research designs and methods appropriate for a particular research objective, and to give students a sufficient understanding of a set of methodologies that they can build on in future projects.

The course serves as an introduction to social science research methods and methodological considerations in relation to conducting academic research. The course establishes the meta-theoretical context for discussing and developing academic research. The central focus is on understanding different approaches, research designs and research techniques, which is crucial in order to design and conduct research projects that are creating valid and reliable knowledge.

The course will provide students with insights in the following main areas:

1. How to match research questions with research designs and data collection methods: How to select the most appropriate research design
2. The nature of qualitative research methods: How to design and perform qualitative research
3. The nature of quantitative research methods: How to design and perform quantitative research
4. Introduction to social network analysis: How to design and perform social network analysis

The course focuses on introducing students to both qualitative and quantitative research methods. Here a collection of articles that exemplifies different research methods will be used throughout the course for inspiration and examples. For the qualitative part, the lectures will be combined with group work exercises where students develop and present research designs based on each of the research methods introduced throughout the course. Presentations are prepared in project groups. All groups will get to present at least once. For the quantitative part, lectures will be accompanied by lab sessions where students will apply what they have learned on specific data sets.

LEARNING OBJECTIVES

At the end of the course, the students should be able to:

- define and compare alternative scientific paradigms.
- define and discuss strengths and weaknesses of alternative research designs, including methods for collecting and analysing data.
- develop research designs suited to investigate specific research purposes
- Perform rudimentary analyses using a set of different methods

EXAMINATION

24-hour individual written exam. Students are evaluated according to the above learning objectives and are expected to present a coherent and persuasive research design. The research design should include consideration of chosen philosophical and epistemological positions , and research methods. The research design should demonstrate the ability to justify methodological and method choices in terms of research objectives and logical consistency.

RE-EXAMINATION

The re-exam is the same as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Organisation and Management

7.5 ECTS

Course coordinators: Anders Villadsen (avilladsen@mgmt.au.dk) and Yulia Muratova (yulia.muratova@mgmt.au.dk)

CONTENT

The course aims to provide students an understanding of the dominant contemporary theories of organisation and management and how organisations differ (or are alike) across nation states and cultures and the private and public sectors. The latter part of the course also provides an account of organisational processes and dynamics.

The course consists of two parts:

- Part 1) introduces and explores general concepts of and approaches to organizational and management studies at an advanced level. The readings will address core issues such as the institutional environment of organizations, modes of coordination within and between organizations, organizational resources, contracting across legal and economic contexts, strategic partnerships and the power of networks.
- Part 2) explores cross-national variations in organisational structure and political and economic institutional regimes. It then moves to analyse how organisations and management best respond to challenges of internationalisation and cross-culturalism and how organisations evolve and what their internal power structures are. Finally, part two also deals with differences between public and private sector organisations and explores features of public sector organisations.

Between the two parts of the course a workshop will be conducted with the aim of applying the theoretical tools learned in part one to contemporary China.

The teaching will primarily consist of lectures with short group exercises and a workshop embedded in the lectures.

LEARNING OBJECTIVES

At the end of the course, students should be able to:

- define and explain the key concepts and assumptions of different organisation and management theories.
- understand and analyse the organisational and managerial challenges particular to organisations operating across cultures and sectors.
- understand organisational change and internal dynamics.

EXAMINATION

The examination is a 4-hour individual written exam based on questions.

All aids incl. PC/tablet are allowed, but internet access is prohibited.

RE- EXAMINATION

The re-examination is subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

## Research Based Internship / Project (3. Semester)

30 ECTS

For this course students have two options:

Research based internship

Research based project

1. Research Based Internship

Course coordinator: Nis Høyrup Christensen (nhc.int@cbs.dk)

CONTENT

The aim of the internship is to train the student to independently formulate, analyse and provide solutions to a management/organisational or policy/political economy problem through the integration of theoretical reflection and practical action.

The internship provides an opportunity to combine theories and methods from the programme with the practices of companies, organisations and institutions. The internship must have an educational aim as well as contribute to the development or the operations of the host organisation.

The student is part of the host organisation and will work on assignments agreed upon by the host and the student and approved by the internship coordinator. The internship period should have a duration of 3-4 months of full time employment. The student receives guidance from an SDC supervisor in the preparation of the internship report. The internship host also assigns a contact person to support the student.

It is allowed for two students to do internship together as a group work and submit a common internship report.

LEARNING OBJECTIVES

At the end of the internship, the students should be able to:

- formulate a research problem of relevance to the internship host's operations based on the tasks solved during the internship.
- design and execute a theoretically informed research design based on the task(s) solved for the internship host organisation
- suggest solutions to challenges faced by the host organisation based on the analysis.
- reflect on her/his interaction with the host organisation and its members during the internship as well as how the host organisation is organised and managed.

EXAMINATION

The examination is an individual 45 minutes oral defence based on the written internship report submitted at the stipulated deadline. The report must be minimum of 30 standard pages in length. A minimum of 60 pages is required if students work in pairs.

The supervisor and an external examiner make the assessment. The grading is based on an overall assessment of both the oral presentation and the written report – with an emphasis on the latter.

RE-EXAMINATION

Re-examinations are subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

2. Research Based Project

Course responsible: Nis Høyrup Christensen (nhc.int@cbs.dk)

CONTENT

The aim of the research based project is to train the student to independently formulate, analyse and provide solutions to a management/organisational or policy/political economy problem in a theoretically supported and empirically based way.

The research-based project should preferably be done in collaboration with an organisation that may benefit from the knowledge you produce (e.g. a company, a government agency, an NGO or an international organisation). Even if the student does not collaborate with a particular organisation, the project must be practice-related.

The student works independently, alone or in groups, on a management/organisational/policy/political economy problem or topic of theoretical and practical relevance and approved by the project coordinator. The student receives guidance from an SDC supervisor in the preparation of the project report.

It is allowed for two students to do a research based project together as a group and submit a common project report.

LEARNING OBJECTIVES

At the end of the research based project the students should be able to:

- formulate a research problem of theoretical and practical nature.
- prepare and implement a research design for how to collect and analyse data and provide solutions to the problem.
- review and critically discuss and select appropriate theories for analysing and providing solutions to the defined problem.
- identify and discuss practical implications of the project.
- work independently on the conducting of a study with scientific rigor.

EXAMINATION

The examination is an individual 45 minutes oral defence based on the written project report submitted at the stipulated deadline. The report must be minimum 30 and maximum 60 standard pages in length. For a group, it must be minimum 60 and maximum 90 standard pages in length.

The assessment is made by the supervisor and an external examiner. The grading is based on an overall assessment of both the oral presentation and the written report – with an emphasis on the latter.

RE-EXAMINATION

Re-take examinations are subject to the same regulations as the ordinary exam.

GRADING

Grades are given according to the Danish 7 step and the Chinese 100 points grading scales.

# Water and Environment

## Hydrology, Freshwater Ecology and Biogeochemistry (Module 1)

15 ECTS

CONTENT

The overall aim of the course is to give a general overview of freshwater systems, based on hydrology; i.e. input and output of water, and processes related to transport; ecological mechanisms and interactions along the soil-water continuum and in freshwater systems, including biogeochemical cycles and interactions between sediment/soil and water.

### Hydrology

The Hydrology sub-module provides an introduction to the different components of the hydrological cycle, their governing physical equations, the measurements and sensors used and relevant modeling approaches used to estimate those components, with emphasis on novel data sources. The course is structured around three main topics:

(1) Land- atmosphere interactions with the study of atmospheric water and precipitation, evaporation and actual evapotranspiration.
(2) Surface processes describing soil water infiltration, rainfall runoff processes and river routing.
(3) Hydrogeology focused on groundwater recharge, evaluation of groundwater resources and effect of abstractions on groundwater level and stream discharge.

The Hydrology sub-module consists of lectures in combination with practical tutorials and assignments with real-world hydrological problems. Notes, lecture slides and supporting material will be provided.

### Freshwater Ecology

The aim of the Freshwater Ecology sub-module is to introduce the student to the fundamental conditions of freshwater ecosystems; the use of resources such as nutrients, carbon and light, the complexity and dynamics of the freshwater system including physical, chemical and biological mechanisms and interactions controlling flora and fauna dynamics (the biological structure) and the important role of macrophytes in the systems. There will be focus on interactions in food chains, impacts of human activity, and interaction with the catchment by including the functional role of wetlands as buffer zones.

### Biochemistry

The aim of the Biogeochemistry sub-module is to present the biogeochemical cycles of the most important elements (C, N, O, S, P, certain metal cations), describing the sources, pools and flows including transformations of matter in the different spheres with integration on a global scale. The significance of the most important processes such as oxidation/reduction, weathering/precipitation and sorption/desorption processes including their microbial and inorganic contributions will be demonstrated. Particular focus will be given to interaction between the sediment and water in lakes and how the internal loading of phosphorus impacts the overall water quality. It will be discussed to what extent the global cycles are being perturbed by human activities, and how global climate change causes perturbation of the global element cycles of C, N, P and S.

Both the Freshwater Ecology and the Biogeochemistry sub-modules consist of lectures in combination with colloquiums including student presentations and discussions and calculation exercises. Besides field sampling will be demonstrated and exercises will be performed to test the methodologies learned.

All lectures will be based on a combination of textbooks and peer reviewed manuscripts pin-pointed as key papers in respect to the course content. Lectures will be combined with colloquiums, where students will present the content of relevant papers followed by a discussion on the content and its conclusions. Exercises will be a combination of practical and theoretical exercises. Practical exercises will have focus on sampling techniques, sample handling and handling in the laboratory; basic elements in order to get high quality data. The practical part will be performed during a 1 day excursion. The theoretical exercises will run parallel with the relevant topics presented in the lectures, and will include calculations on physical properties in streams, calculations on nutrient dynamics and practical data analysis in freshwater and terrestrial systems.

LEARNING OBJECTIVES

The objectives of the course are:

- To learn how the hydrological cycle works and of what components it consists, to learn physical hydrological equations and how measurements and sensors are relevant in modeling approaches used to estimate components in the hydrological cycle.
- To learn how freshwater systems function in respect to biological, physical and chemical aspects, to get insight into how microbial loops are part of freshwater systems, and to understand how freshwater systems are affected by human impact and catchments.
- To learn how elements distribute between the different spheres, to get an overview of which biogeochemical processes govern distribution, transfers and transformations of the elements, to describe the interactions between the cycles of the different most important elements in different ecosystems, and to learn how human activities perturb the biogeochemical cycles on a global scale.

*Knowledge*

After completing the course, the student should have knowledge on:

- The governing processes of the hydrologic cycle including exchange processes between atmosphere and soil surface, surface water runoff, and groundwater flow.
- Describing hydrological processes in mathematical terms and the limitations of hydrological data.
- Analysing problems related to water resources development including groundwater and surface water.
- Understanding mechanisms in freshwater systems, in respect to biological interactions, the impact of nutrient and to nutrient dynamics.
- Understanding how and why freshwater systems are affected by changes in the use of catchments.
- Having knowledge on how human impact can affect both physical and biological elements in freshwater systems.
- The cycling of nutrients between sediment and water in lakes, especially regarding the retention and biogeochemical transformation of phosphorus.
- The biogeochemical cycles of major biologically active elements and the main biological and abiotic processes governing the distribution and flows of elements between the different spheres.
- Methods to quantify biogeochemical processes at different scales.
- How human activities perturb the cycling of key elements at both local and global scales, and how systems react to perturbations.

*Skills*

After completing the course, the student should be able to:

- describe the governing processes of the hydrologic cycle including exchange processes between atmosphere and soil surface, surface water runoff, and groundwater flow.
- formulate hydrological processes in mathematical terms and work with and recognize the limitations of hydrological data.
- demonstrate and give an overview of the complexity in freshwater ecosystems, especially the importance of submerged macrophytes to the other biological elements; applying how human activity can affect this complexity; demonstrate the general principles of freshwater chemistry, particular in respect to nutrients (nitrogen and phosphorus).
- understanding the cycling of nutrients in lakes and how this interacts with the biological structure.
- delineate the major biogeochemical cycles from molecular to global scales and identify process variables critical to the cycles.
- calculate distribution of elements and flows at ecosystem scales based on the processes taking place, and to take interactions between elements into account.

*Competences*

After completing the course, the student should have the competences to be able to:

- extract useful knowledge from primary literature while maintaining a critical view on same literature.
- interpret data from different sources. Extract the most important information from these data.
- present methods, data and conclusions from the curriculum, to fellow students.
- make the relevant hypothesis and suggest a methodology which can be used to respond to the hypotheses, when presented with a given problem.

EXAMINATION
The exam comprises

- three assignments during the Hydrology part
- a 2-hour written midterm exam following the Hydrology part All aids allowed. No internet.
- colloquiums with presentations for fellow students in the Freshwater Ecology part.
- a 4-hour written exam covering Freshwater Ecology and Biogeochemistry. All aids allowed. No internet.

There will be one common grade for the entire course, where assignments and colloquiums count 30 % and the written examinations 70 %.

The assignments in Hydrology are individual or group assignments with individual evaluation. Each group consists of 2-3 members and the topics are fixed. The assignments are focused on the main learning objectives in Hydrology:

- Water balance; effect of deforestation on catchment water balance in a specific study site (including data collection during a two-day field trip) – duration 7 days (Graded)
- Ecohydrological modeling using VIP model – duration 13 days (Graded)
- Groundwater flow – duration 7 days (Graded with pass/fail).

For all assignments, all necessary information and calculations must be included in the assignment and handed in as a pdf file..

The written sub-examination of the sub-module Hydrology is a 2-hour written presence examination based on short questions all related to the topics and learning objectives of the course. Questions require short text (1-3 lines) answers and calculations. All aids including laptop/tablet are allowed, but internet access is prohibited.

In Freshwater Ecology colloquiums are held during the course.  Colloquiums are a group based (2-3 members) presentation of an appointed peer reviewed paper. The group is expected to read, discuss and present the content for their fellow students, followed by a general discussion of the paper in class.

There are no colloquiums in the Biogeochemistry sub-module.

The written examination of the two sub-modules Freshwater Ecology and Biogeochemistry is a 4-hour written presence examination based on short questions all related to the topics and learning objectives of the course. Questions require short text (1-3 lines) answers and/or small calculations. All aids including laptop/tablet are allowed, but internet access is prohibited.

RE-EXAMINATION

A 6-hour written examination based on questions related to all topics and learning objectives of Hydrology, Freshwater Ecology and Biogeochemistry. Questions are requiring short text (1-3 lines) answers and calculations. All aids including laptop/tablet are allowed, but internet access is prohibited.

GRADING

One final grade is given according to the Danish 7 step and the Chinese 100 points grading scales.

## Pollutants and Pollution Control (Module 2)

15 ECTS

CONTENT

The aim of the course is to introduce the fate and processes of the contaminants, the current status of the soil and water pollution and the techniques for the pollution control and water treatments. The course is divided into 3 sub-modules with the following objectives:

The first sub-module *Pollutants – fate and processes* aims at giving a fundamental introduction to the abiotic and microbial processes as well as pollutant physicochemical properties that govern the fate of pollutants. Physicochemical properties, sources, distribution, speciation, and transformation processes and selected microbial effects of natural and anthropogenic contaminants in soil and water are introduced.

The second sub-module *Pollution control and water treatment* aims at training the students in basic principles for the treatment of wastewater in conventional wastewater treatment systems and nature-based and environmentally friendly technologies for wastewater treatment and management.

The third sub-module *Soil and groundwater pollution* aims at giving the student a platform for a professional assessment of soil and groundwater contamination from diffuse sources and contaminated sites, and remediation of contaminated sites.

LEARNING OBJECTIVES

Following the successful completion of the course, the students will acquire a broad spectrum of knowledge and tools. Specific knowledge, skills and competences for the different sub-modules are listed below.

When the sub-module *Pollutants – fate and processes* is finished the student is supposed to be able to:

*Knowledge*

- Explain the fundamental principles and processes that influences the fate of pollutants in soil and water
- Understand the abiotic and biotic soil and water properties that are critical to the fate of pollutants
- Obtain insight with models that can be used to perform metal speciation, equilibrium computation and to predict properties of organic pollutants.
- Describe the physicochemical properties of a given pollutant in the environment, and how these properties affect the fate
- Describe the basic microbial processes that are critical for the sensitivity of the ecosystem to natural and anthropogenic stress and for the fate of pollutants
- Quantify a specific pollutant speciation, availability, mobility, and transformation by use of standard calculations

*Skills*

- Compute and evaluate physicochemical properties, speciation, and fate of natural and anthropogenic pollutants from environmental data
- Identify and evaluate the critical variables and methods that may be used to quantify pollutant sources, distribution, retention, transformation and degradation rates, and metabolite formation in soil and water
- Critically evaluate scientific papers within pollutant chemistry and microbiology

*Competences*

- Combine information from literature/databases predictions, model calculations and general knowledge on pollutant properties, soil and water properties as a basis for exposure calculations.

Following the successful completion of the sub-module *Pollution control and water treatment* the students will be able to

*Knowledge*

- Describe the main inorganic and organic pollutants in domestic wastewater and their influence on choice of treatment processes, and how they are analysed
- Summarize typical effluent standards
- Describe the main degradation and removal processes of suspended solids, organic matter and nutrients in activated sludge systems
- Describe the main processes for the treatment of industrial wastewaters
- Describe the main processes for sludge treatment and disposal
- Describe different types of ecotechnologies used for the treatment of domestic wastewater and agricultural runoff with focus on wetland systems
- Describe and characterize the key processes of importance for nutrient removal in wetlands
- Describe the functional roles of different types of plants in wetlands
- Characterize the hydraulics of treatment wetland systems

*Skills*

- Evaluate removal processes of organic matter and nutrients in activated sludge, constructed wetland systems.
- Prepare conceptual designs of activated sludge and constructed wetland systems based on loading characteristics, site-conditions and effluent standards
- Compute the expected removal and effluent quality of activated sludge and wetland systems using accepted biokinetics models

*Competences*

- Combine information from different sources to propose a suitable wastewater/sludge treatment process based on wastewater characteristics and discharge requirement

Following the successful completion of the sub-module *Soil and groundwater pollution* the students will be able to

*Knowledge*

- Acquire a good understanding of soil and groundwater pollution
- Distinguish between diffuse pollution sources and contaminated sites and identify important contaminants
- Demonstrate conceptual understanding of hydrogeological and hydrogeochemical properties controlling contamination in soil and groundwater
- Describe important elements in risk assessment of contaminated sites
- Calculate and select parameter values (for instance sorption, hydrodynamic dispersion or degradation constants) which govern transport and fate of contaminants and relate results to risk assessment
- Demonstrate overview over selected remediation technologies and understanding of their strengths and weaknesses
- Identify design parameters for selected remediation technologies based on conceptual process understanding
- Select the most suitable remediation technologies in relation to actual hydrogeological, geochemical and compound data

*Skills*

- Identify and apply the theory on contaminant properties, subsurface hydrology and hydrogeochemistry to examine and solve subsurface pollution problems
- Acquire a sound understanding of methods for site investigation and risk assessment at contaminated sites
- Identify and critically evaluate different soil and groundwater remediation technologies

*Competences*

- General knowledge and understanding of contaminants fate and transport in the subsurface
- Quantification of key hydrogeological, hydrogeochemical and contaminant properties controlling contaminant transport
- Understanding soil and groundwater remediation technologies and their applicability
- Experience on conservative and reactive transport of organic and inorganic compounds

CONTENTS

The course will give you in depth knowledge of the following subject areas:

*Pollutants – fate and processes*

- Pollutants and their retention in soil: Pollutant properties, soil and water characteristics, sorbent characteristics and sorption reactions, redox transformations, soil solution composition, metal speciation, hydrolysis and photo degradation, degradation kinetics
- Simple methods  for equilibrium computation and QSAR estimations
- Environmental microbiology including microbial ecology, metal transformations and effects, degradation pathways and kinetics, antibiotic resistance

*Pollution control and water treatment*

- Understanding of processes of importance for the transformation and removal of selected pollutants from wastewater and contaminated surface water
- Training in the use of process modelling in activated sludge systems
- Tools to prepare conceptual designs of treatment systems capable of achieving specific treatment goals

*Soil and groundwater pollution*

- Sources to soil and groundwater pollution
- Transport, mixing, attenuation and degradation of pollutants in soil and groundwater
- Diffuse source (arsenic, pesticides) contamination in aquifers
- Soil and groundwater chemistry of heavy metals, creosote compounds, petroleum hydrocarbons related to contaminated sites
- In situ and ex-situ technologies for remediation of polluted soil and groundwater

MODULE STRUCTURE

There will be ten teaching weeks in total.

Weeks 1-4: Sub-modules 1 & 2: Pollutants – fate and processes & Pollution control and water treatment

Weeks 5-10 (with Christmas break): Sub-modules 3: Soil and groundwater pollution

TEACHING AND LEARNING METHODS

Lectures, theoretical and practical exercises, calculations and small computer exercises, reading material, hands-on tutorials, group work and group presentations.

EXAMINATION

The exam comprises

- 3 assignments during the course, where the students are required to submit at least 2 out of the 3 assignments and the two best of these assignments will each account for 15% of the grade
- a written examination which accounts for 70% of the grade

The assignments are group assignments with individual oral presentation and questions. Each group consists of 3-4 members, and the topics are fixed.

The assignments are focused on the 3 main learning objectives of the sub-module *Pollution control and water treatment*:

- Evaluate removal processes of organic matter and nutrients in activated sludge, constructed wetland systems
- Prepare conceptual designs of activated sludge and constructed wetland systems based on loading characteristics, site-conditions and effluent standards
- Compute the expected removal and effluent quality of activated sludge and wetland systems using accepted biokinetics models

The students will present their findings orally and will be evaluated individually on this basis.

The assignments are:

Assignment 1: Engineering Wetland Systems
Number of standard pages 12. Duration ~6 days.

Assignment 2: Activated Sludge Processes
Number of standard pages 10. Duration ~11 days.

Assignment 3: Treatment processes
Number of standard pages 10. Duration ~30 days.

The assessment is made by the teachers.

Written examination

3 hours written presence examination. The assessment is made by the teachers.

Content of exam

The exam is based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the first sub-module *Pollutants – fate and processes* and the last sub-module *Soil and groundwater pollution*. No exams from previous years will be distributed, but class tutorials and wrap-up sessions will include questions and exercises from previous years' exams.

Exam aid: All aid incl. PC/tablet is allowed but no internet access.

RE-EXAMINATION

The re-exam will take place as an oral exam covering the full module.

GRADING

One final grade is given according to the Danish 7 step and the Chinese 100 points grading scales.

## Thesis (3. Semester)

60 ECTS

CONTENT

All students must follow the SDC Thesis regulation 10-steps.

The student should work independently with a research topic at a suitable research laboratory under the supervision of a Chinese and a Danish supervisor. The student should prepare a dissertation, which will be assessed together with an oral presentation of the work.

The dissertation should contain the same sections as a scientific paper, say:

- Preface
- Acknowledgement
- Abstract
- General Introduction
- Objectives
- Literature Review
- Research hypothesis
- Materials and Methods
- Results
- Discussion
- Conclusion
- Perspectives
- References

LEARNING OBJECTIVES

After having completed the thesis the student should have:

Knowledge about:

- Scientific problems and state-of-the-art in the thesis subject area.
- Theories and practical solutions supporting the thesis subject area.

Skills to:

- Identify scientific problems and formulate scientific hypothesis within the study programme's subject area
- Apply research methodologies including modelling tools to conduct his/her work within the thesis subject area with a high degree of independence
- Discuss theories/methods in relation to his/her thesis subject area and the state-of-the-art of the programme's subject area
- Assess the extent to which the production and interpretation of research findings/material depend on the theory/methodology chosen and the delimitation chosen.

EXAMINATION

The thesis is an individual written assignment. The thesis has a length of a minimum of 50 and a maximum of 80 standard pages, excluding references. Students should add a summary to the thesis in English.

The oral examination (defence) consists of 20 minutes oral presentation of the project followed by 30 minutes questions from the examiners.

The grade awarded must reflect an overall assessment of the written thesis and the oral defence.

RE-EXAMINATION

The same as the ordinary exam attempt. For more information, see SDC Thesis regulation 10-steps.

GRADING

For the Danish/international students, grades are given according to the Danish 7 step and the Chinese thesis grading scales.

For the Chinese students, grades are given according to the Danish 7 step grading scale only.

The details of the thesis procedure are described in SDC Thesis Regulations 10 Steps.