SDC
The university partnership
Denmark – China

Course Catalogue Autumn 2022

All courses related to the programmes

Contents

Chemical and Biochemical Engineering

Industrial Reaction Engineering

7,5 ECTS

Course Coordinator: Kim Dam-Johansen (kdj@kt.dtu.dk)

AIM
To provide the students with a fundamental and practically applicable understanding of industrial important types of reactions and reactors that can be used in chemical and biochemical production processes and in pollution control.

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, gas-solid, 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 several of the reactors is expounded together with examples. During the course, 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 to establish mathematical models for the main phenomena
- evaluate calculations for reaction engineering problems 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.

RE-EXAMINATION
Same as the ordinary exam. Passed exam elements will automatically be transferred to the re-exam and cannot be resubmitted.

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

Transport Processes

10 ECTS

Course Coordinator: Peter Szabo (ps@kt.dtu.dk)

AIM
To introduce the participants to the modeling and numerical description of flow, heat and mass transport based on the fundamental equations of change.

CONTENT
Mechanisms for the transport of momentum (flow), energy and mass in chemical and biological systems. The course introduces 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 exam in this course is based on graded reports on one or two projects with a combined weight of 40% and a 4-hour written exam (60%). The number of projects (1 or 2) will be announced at study start. If only one project is specified, a short preliminary report (graded passed/not passed) will be required at the end of the first 3-week period of teaching as a mandatory condition for participation in the written exam.

The report work is estimated to amount to about 2 week's full-time work, with one week's work in each of the two 3-week periods of teaching. The project reports (1 or 2) are limited to 10 pages each, not including a title page. In case of two projects, turn-in of a report on Project 1 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. The exam cannot be passed if any of the part grades for projects (1 or 2) or written exam is "not submitted" or -3 DK scale/39 CN Scale.

RE-EXAM
Grades for projects (1 or 2) carry over from the ordinary exam (total weight 40%), 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

Course Coordinator: John M. Woodley (jw@kt@dtu.dk)

AIM
The reactors used in the bio-industries are designed according to the same general principles as reactors elsewhere in the chemical industry. However, there are some quite specific characteristics of bio-reactions (carried out using fermentation or biocatalysis) which require specialist treatment, such as the complex stoichiometry and thermodynamics. Using a quantitative approach, bio-reactions are analyzed with respect to feasibility and scale-up to produce bio-based chemicals. Biochemistry, microbiology, sustainability, and chemical engineering are all used to obtain a deeper insight into the world of bioreactions and their associated processes.

CONTENT
Role of fermentation and biocatalysis in industrial manufacture of chemicals. Stoichiometry of cellular reactions, degree of redox 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. Two-stage fermentation (microbial biocatalysis). In situ product removal. Process evaluation project.

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

- describe the role of fermentation and microbial biocatalytic 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
- evaluate improvement strategies to enable industrial scale processes.

EXAMINATION
The exam consists of two parts: A process evaluation project (50%) and a written exam (50%).

The process evaluation project (50%) will evaluate a given chemical made by fermentation (or microbial biocatalysis) based on short-cut techno-economic performance and sustainability. The analysis will be used to identify a research and development plan that could enable industrial implementation. The process evaluation project is made in groups of 2 students and includes an oral presentation and a submission of a single written report of around 20 pages.

The written exam (50%) is 4 hours, with aid, 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

Course Coordinator: Manuel Pinelo (mp@kt.dtu.dk)

AIM
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.

CONTENT
This course aims 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
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 pyrolysis. Biogas.
- Other applications: Biomaterials.

EXAMINATION
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. The assessment of the report is individual.
2) a written exam (50%). The written exam is 2 hours and 25 minutes and consists of two parts: a theoretical quiz (25 minutes) and calculations (2 hours). No aids allowed only a simple calculator for the final written exam.
To pass the course, all the three parts of the exam must be passed.

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 two parts: a theoretical quiz (25 minutes) and calculations (2 hours). No aids allowed only a simple calculator for the final written exam.
To pass the course, all the three parts; report, quiz and calculations must be passed.

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

Laboratory Experiments (1. – 3. Semester)

5 ECTS

Course Coordinator: Songgeng LI (sgli@ipe.ac.cn)

AIM
This course is designed to provide advanced experimental facilities at Institute of Process Engineering (IPE) to the students for experimentation skill in different areas of chemical and biochemical engineering,

CONTENT
This course is designed to provide advanced experimental facilities at Institute of Process Engineering (IPE) to the students for experimentation skill in different areas of chemical and biochemical engineering.

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
- Catalyst synthesis and evaluation

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

- collaborate in teamwork 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
The student must 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 grade is based on the average of the six report grades (16.6 % each).

RE-EXAMINATION
The form of re-exam will be the same as the ordinary. However, the re-exam is individual. Passed exam elements will automatically be transferred to the re-exam and cannot be resubmitted.

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

Course Coordinator: Kim Dam-Johansen (kdj@kt.dtu.dk)

AIM
To provide the students with knowledge about front line academic and industrial research in the field of Chemical and Biochemical Engineering.

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
Throughout semester 1, 2, and 3 each student must complete a total of 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. The final evaluation is based on all reports.

RE-EXAMINATION
The re-exam consists of re-submission of reports that are failed in the ordinary exam. Passed exam elements will automatically be transferred to the re-exam and cannot be resubmitted.

GRADING
Passed/not passed

Technology Economics Management and Organization

10 ECTS

Course Coordinator: Birte Holst Jørgensen (bhjq@dtu.dk)

AIM
The general purpose of the course is to qualify the student (1) to analyse an organisation from a strategic, tactical and operational perspective: (2) to define the strategy and the business model of a company; and (3) to understand how engineers contribute to the competitive advantage of a company.

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 a small group report on a fictive case (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.

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

Combustion and High Temperature Processes

5 ECTS

Course Coordinator: Peter Glarborg (pgl@kt.dtu.dk)

AIM
To provide the participants with a fundamental knowledge about combustion and other high temperature processes, including formation and reduction of harmful emissions.

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, particle heating and pyrolysis, and char oxidation.
- use the above tools together with numerical solvers to evaluate and optimise industrial high temperature processes

EXAMINATION
The grade is determined from an overall evaluation of two course exercises (90%) and three problem sets (10%).

RE-EXAMINATION
The same as the ordinary exam. Passed exam elements will automatically be transferred to the re-exam and cannot be resubmitted.

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

Fluidization and Multiphase Flow

5 ECTS

Course Coordinator: Wei WANG (wangwei@ipe.ac.cn)

AIM
This course will provide comprehensive knowledge of fluidization and multiphase flow with fundamentals and applications related to chemical engineering and energy conversion.

CONTENT
This course will provide comprehensive knowledge of fluidization and multiphase flow with fundamentals and applications related to chemical engineering and energy conversion. This includes:

- Fluidization phenomena
- Flow regime transitions
- Bubbling and circulating fluidized beds
- Multiphase flow theories
- CFD models for two-phase flows
- CFD simulation practice
- Application of fluidized beds

LEARNING OBJECTIVES
At the end of the course, the students should be able to:
- understand the flow regime transition of gas-solid flows and state-of-the-art fluidization application
- manage basic calculations and solve practical problems related to fluidization
- have an overview of the numerical modelling approaches
- simulate a lab-scale fluidized bed with CFD software
- design a fluidized bed reactor with preliminary requirement

EXAMINATION
The grade is determined based on an overall evaluation of two course exercises with basic calculations (40%), two assignments with oral presentation (40%), and one CFD course exercise (20%). One final grade is given.

The course 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. The CFD course exercise take the form of simulation of a lab-scale fluidized bed with CFD software package.

RE-EXAMINATION
The re-exam is based on resubmitted exercises/assignments and an oral exam. Passed exam elements will automatically be transferred to the re-exam and cannot be resubmitted.

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

International Food Quality and Health

Food Production Environment andQuality

5 ECTS

Course responsible coordinator
Prof. Biao Huang
Institute of Soil Science, Chinese Academy of Sciences

CONTENT
The course on Food production Environment and Quality mainly introduces two parts of contents. One is the fundamental knowledge on theory of soil science, crop science, and water science related to food production environment and quality. Others are the application of the knowledge, including: (1) the relationship between soil, crop, and water quality and human health; (2) the influence and remediation of human activities on soil, crop, and water quality further food quality; (2) Assessment of environmental risk related to food quality and its management policies.

The course will be divided into 7 modules as follows:
The theme of Module 1 is "Soil science and food environment and quality". It focuses on an introduction to soil types and their distribution and temporal and spatial variability of soil properties and soil major, minor and trace element and their availability.

The theme of Module 2 is "Crop science and food environment and quality", which introduces plant nutrition relevant to soil health, ecological health, human health, Physiological function of plant nutrient elements and relationship with crop quality.

The theme of Module 3 is "Water science and food environment and quality", which focuses on an introduction to food environment and quality issues relevant to the efficient allocation of water resources, water scarcity, water security, water pollution problems and control.

The theme of Module 4 is "Soil, crop, and water and human health", which teaches on the relationships between soil properties and element availability and element uptakes by crops and the relationships between crop and dietary quality and human health.

Module 5, the theme is "Human activities and remediation", which introduces the Impact of fertilization, tillage, moisture regime management, and crop rotation on agro-product quality and human health, heavy metal contamination of agricultural soil, water, and food and human health, and remediation techniques of heavy metal contaminated agricultural soil.

Module 6 teaches the theme of "Environmental risk and human health". It introduces the environmental impact assessment of organic food through comparing to counterpart foods and case studies by life cycle assessment (LCA). Furthermore, the risks in the context of organic production and certification, and risk-based indicator system of organic production will be presented according to Chinese organic regulations and literature review.

Finally, the theme of module 7 is "Environmental management", which focuses on an introduction of certified green food and certified organic food, and management standards and regulations related to soil, water and air quality.

LEARNING OUTCOMES

Knowledge

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

- The basic concepts and theories of soil, water, and crop science;
- The relationship between soil and water quality and food safety;
- The basic measurement methods of soil, water, and crop properties.

SKILLS

The students will be able to:

- demonstrate some field and lab techniques primarily on soil, water, and crop science;
- Statistically analyze and evaluate experimental data
- summarize the data to write reports on food production environment and safety.

COMPETENCIES

Through the course the student is expected to gain the competencies to be able to:

- apply theory and method above mentioned for assessing and managing food quality and health;
- apply principles of experimental design and statistical evaluation of food environment and quality;
- Understand the importance of the interaction between soil, water environment and food quality.

EXAMINATION

The final exam is a 24-hours written exam (100% of the grading). Each student will be presented to 2-3 problems related to the food production environment and food quality in terms of soil, water, and crop science part. The student is expected to choose one problem and write a report with at least 5 pages. In this report, the student should identify and use relevant material from media and other sources and draw on the course curriculum.

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

- master integrate knowledge of food production environment and food quality.
- understand present of issues in relation to food production environment and food quality.
- analyse present and future of key issues.

RE-EXAMINATION

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

GRADING

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

Modern Food Analysis

5 ECTS

Course responsible coordinator
Professor Qinghua Zhang. Research Center for Eco-Environmental Sciences. Chinese Academy of Sciences.
qhzhang@rcees.ac.cn

COURSE CONTENT
This course aims to provide fundamental knowledge of the instrumental analytical techniques and methods used in food analysis together with their main applications in food science research.
Food analysis is the study, development and application of analytical methods and instrumentation for characterizing the properties of foods and their components. All topics covered in the module include information on the basic principles, procedures, advantages, limitations, and applications. General information is provided on regulations, standards, labelling, sampling, and data handling as background for chapters on specific methods to determine the chemical composition and characteristics of foods. Expanded sections on spectroscopy and chromatography are also included. Other methods and instrumentation such as thermal analysis, ion-selective electrodes, enzymes, immunoassays, and other state-of-art techniques are covered from the perspective of their use in the analysis of foods.

LEARNING OUTCOMES
Knowledge
At the end of the course the students will have gained knowledge of:

- Basic principle in food analysis
- Fundamental knowledge of methods used in food analysis
- Fundamental knowledge of the instrumental analytical techniques used in food analysis
- Sampling techniques in food analysis
- Quality assessment and quality control in data analysis

Skills
The students will be able to:

- Solve problems related to food analysis
- Recognize the limitations inherent to particular sampling or analytical procedures
- Outline the theoretical bases underlying methods commonly used for food analysis
- Utilize the mathematical calculations involved in food analysis
- Assess the importance of food composition information to the food industry

Competencies.
Through the course the student is expected to gain the competencies to be able to:

- Apply statistically valid sampling techniques to food materials having widely diverse properties and volumes
- Demonstrate competency in the use of standard techniques of food analysis and the treatment of experimental data
- Apply modern instrumental methods to analyse chemical and physical properties of foods.
- Compare the purposes and methods of food analysis employed in government, research, and industry

EXAMINATION
The students must attend class and submit a 2-page assignment mid-way during the course + perform an oral presentation. The presentation is a 15–20-minute oral class presentation for each student.
During the oral presentation, the student will present a synopsis and perspectives of the assignment and be asked questions. The questions will take a starting point in the assignment and be broadened out to also

cover general topics from the curriculum. Via the assignment and the oral presentation, the student must demonstrate an understanding of the learning objectives of the course. Evaluation is based on an overall assessment of the written and oral presentation.

RE-EXAMINATION
The re-examination consists of a 5-page written essay on a fixed topic plus a 15–20-minute oral presentation. During the oral presentation, the student will present a synopsis and perspectives of the assignment and be asked questions. The questions will take a starting point in the assignment and be broadened out to also cover general topics from the curriculum, to check if the student demonstrate an understanding of the learning objectives of the course.

GRADING
Passed/non-passed.

Food Fermentation and Processing

5 ECTS

Course responsible coordinator:
Dr. Chun You, Professor, Tianjin Institute of Industrial Biotechnology, Chinese Academy of Sciences,
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COURSE CONTENT
The course in Food fermentation is a multidisciplinary course integrating food microbiology, food chemistry, enzymatic and metabolic engineering, food analysis and detection. The aim of the course is to understand a wide range of microbial and enzymatic processes involved in food and ingredient fermentation to achieve desirable properties such as prolonged shelf-life, improved safety, attractive flavor, nutritional enrichment and promotion of health. Furthermore, the course is designed to introduce knowledge about food fermentation with a focus on the latest scientific insights in relation to their desired impacts. Specifically in the course, the topics cover major microorganisms (lactic acid bacteria, moulds and yeasts) involved in food fermentations, their physiological and metabolic properties, and how they are used as starter culture to provide a foundation for the fermented products around the world. The students are expected to understand the knowledge that food fermentation plays roles in improving the nutritional value and human health by producing nutrition, health promoting factors and enzymatic protein.

The major topics in Food fermentation course include:

- General introduction of food fermentation
- Food fermentation and microorganisms
- Food fermentation technology and industrial scale application
- Nutritional and functional properties of fermented food
- Food fermentation and enzymes
- Fermentation food safety and quality control

LEARNING OUTCOMES
The students will become knowledgeable in food fermentation and brewing with a focus on microbiological and technological features for the manufacture of fermented food, and functionality in relation to their desired impact on food quality, nutrition, safety and shelf-life.

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

- The history of food fermentation
- The microbiological and technological features used in food fermentation and their functional properties
- Identity, sources, and physiological characteristics of microorganisms in food fermentation
- Metabolic activities of microorganisms and their influence and role on fermentation food
- Basic requirements and principle of fermentation process and control
- Industrial scale application of fermentation and brewing technology
- Advantages of fermented food
- Food grade fungi deliver/express important enzymes
- Major risk factors associated with food fermentation

Skills:
The students will be able to:

- Demonstrate skills at a basic level related to the understanding the process of food fermentation
- Point to suitable methodologies for fermented parameter and process control
- How to characterize fermented foods
- Improve the safety of fermented foods

Competencies:
Through the course the student is expected to gain the competencies to be able to:

- Apply principles of food fermentation related microorganisms
- Apply principles of industrial scale application of fermentation and brewing technology
- Understand and reflect upon the importance of food safety and quality control

Submission of a report is mandatory for attending the final exam. The report will be written in groups of 3-4 students and be 10-15 pages, double line spacing (completing this will also qualify the student for the re-exam). The report will be evaluated on a pass/ not-passed basis. In the case that a report is not passed, the report needs to be edited for the students to get pass, so they can attend the final exam. The report does not form a part of the final grade but qualify the students for the final exam.

EXAMINATION
The final examination is a 2-hour open book written examination (internet not allowed).

RE-EXAMINATION
Students that do not qualify to participate in the ordinary exam must resubmit the mandatory report before qualifying for the re-exam. This report is individually written. The re-exam will be in the same form as original exam.

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

Microbial Food Safety andHygiene

7.5 ECTS

Course responsible coordinator
Jørgen Leisner, Associate Professor, Section of Food Safety and Zoonoses, Dpt. Veterinary and Animal Sciences, University of Copenhagen, e-mail: jjl@sund.ku.dk

COURSE CONTENT
The course introduces students to key concepts regarding both theoretical aspects and analytical methods within the areas of microbial food safety and hygiene. The course is initiated by an overall introduction to microbial food safety in relation to Western and Chinese traditional and modern foods. The microbial composition of different foods and contamination and growth/survival of microbial pathogens will be covered. The course will subsequently describe methods for assessing hygienic quality of foods and methods for detecting and tracing microbial pathogens including antibiotic resistant variants. These aspects will be dealt with theoretically but to a limited extent also practically. Further, key concepts within the area of bioinformatics will be introduced that allow analytical use of whole genome sequences for outbreak investigations and virulence and antibiotic resistance of microbial pathogens. Parameters important for survival of microbial pathogens in the environment and food processing facilities, growth and survival in foods will be introduced. Control measures, including the concept of bio preservation, for preventing presence and growth of microbial pathogens in the processing environment and in foods will be covered.
The concept of food control as the mandatory activities necessary to assure the quality and safety of food will be described. Finally, the course will introduce the One Health concept that aims to find efficient solutions to the multifaceted global challenges to human, animal and environmental health including the issue of microbial food safety. This issue focus on zoonoses, emerging foodborne diseases, and health- related problems in relation to drug resistance and composition of the intestinal microbial flora. Systems approaches for effective solutions to the challenges will be presented.

LEARNING OUTCOMES
Knowledge
The student should have knowledge of the basic principles of:
- Overall taxonomy, reservoirs (environment, animals and/or humans), antibiotic resistance and virulence profiles of bacterial foodborne pathogens.
- Biotic and abiotic factors determining contamination, survival and growth of microbial. pathogens in Western and Chinese traditional and modern foods.
- Methodology behind quantitative characterization of microbial compositions of such foods.
- Methodology behind molecular characterization of foodborne pathogens and elucidation of foodborne outbreaks with pathogenic bacteria andvirus.
- Food control
- One Health

Skills
As a result of the course, participants will have acquired the skills:
- To possess overall knowledge of the field of microbial food safety and hygiene.
- To understand the principles, advantages and limitations for traditional and molecular methods for determining microbial contents and detecting microbial pathogens of foods
- To understand the principles, advantages and limitations of cultivation-based, DNA-based and other (e.g. Maldi-TOF) methods for identification and typing of bacterial pathogens as well as characterization of their antimicrobial resistance
- To be able to apply relevant software within predictive microbiology and bioinformatics to model growth of bacterial pathogens and spoilage organisms in foods and to use genomic data for identification and characterization of food-borne microbial pathogens.

COMPETENCES

- Competence to be able to participate in research projects on foodborne microbial pathogens.
- Competence to be able to participate in investigations of foodborne outbreaks.
- Competence to be able to participate in control measures including those covered by a food control approach.
- Competence to be able to participate in One Health interdisciplinary efforts to find efficient solutions to the multifaceted global challenges to food safety through cross-disciplinary research, education and collaboration between relevant institutions and stakeholders.

Submission of a report from theoretical exercise is mandatory for qualifying to attend the final exam. The report will be written in groups of 4-5 students and be 5 pages (completing this will also qualify the student for the re- exam). The report will be evaluated on a pass/ not-passed basis. In the case that a report is not passed, the report needs to be edited in order for the students to attend the final exam. The report does not form a part of the final grade but qualify the students for the final exam.

EXAMINATION

The final examination is a 4-hour written examination with no aids allowed except for dictionaries. During the written examination, the students will meet a combination of multiple choice- and essay questions. For each question, it will be indicated how it contributes to the grade.

The purpose of the examination is to assess the student's ability to:

- Understand and explain the fundamentals of microbial food safety and hygiene.
- Describe the basic principles behind cultivation based and molecular methods to assess microbial composition of foods and to identify and characterize foodborne microbial pathogens.
- Answer the teaching objectives in the lecture plan.
- Solve a case with a foodborne outbreak.

RE-EXAMINATION

Students that do not qualify to participate in the ordinary exam must resubmit the mandatory report before qualifying for the re-exam. This report is individually written. The re-exam will be in the same form as original exam.

GRADING

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

Food Quality, Perception and Eating Behaviour

7.5 ECTS

Course responsible coordinator
Professor and science team leader, Derek V. Byrne. derekv.byrne@food.au.dk
Assistant Professor, Barbara V. Andersen. barbarav.andersen@food.au.dk
Aarhus University, Department of Food Science, Team: Food Quality Perception and Society

COURSE CONTENT
The objectives of the course are to teach the students the basic principles of sensory theory and practice in relation to food quality assessment and consumer preferences. Moreover, it is a key objective of the course to give students a practical and applicable view of sensory and consumer science through group projects carried out during the course period.

The course will be structured in a holistic manner starting with an introduction to human sensory perception with focus on physiological and psychological foundations of sensory function. This part of the course introduces the anatomy, physiology and functions of taste and smell, cenesthesis and sensory interactions. Next, moving into how sensory science is important in the consumer realm, the students will become familiar with key objective and subjective sensory methods. In this part of the course, the students will in practice work with discrimination and descriptive tests as well as preference and acceptance tests. Finally, the course covers an introduction to the analysis and interpretation of sensory and consumer data. The overall course perspective is a cross-cultural view emphasising East-Western differences in quality perception and food behaviour

LEARNING OUTCOMES
Knowledge
- At the end of the course the students will have gained knowledge of:
- The different human senses and psychological concepts
- The basic anatomy and functioning of the human senses
- Methods for measurement of sensory properties
- Quality assessment in industrial practice
- Different theories within experimental psychology and consumer behaviour
- Cross-cultural consumer preferences and behaviour

Skills
The students will be able to:
- Demonstrate skills at a basic level related to the understanding of Food Quality Assessment methods and sensory analysis.
- Point to suitable methodologies utilized to investigate food quality and sensory properties of food products.
- Design and conduct sensory experiments for discriminative and descriptive sensory testing.
- Statistical analyse and evaluate sensory data, as well as linking sensory and consumer data.

Competencies
Through the course the student is expected to gain the competencies to be able to:
- Apply principles of sensory and consumer testing methodology.
- Apply principles of experimental design and statistical evaluation of sensory and consumer data.
- Understand and reflect upon the importance of the interaction between consumer choice behaviour and sensory properties of food products for successful new product development.

EXAMINATION

The exam consists of two parts: a written part and an oral part.

The written part consists of submitting a report. The report must follow pre-provided guidelines. The report must be 10 pages and made as a group work of 2-3 participants on a chosen subject within the course content. The exact subject will be agreed with the course responsible. After submission, each student will individually attend an oral exam. The report is necessary for attending the oral exam.

During the oral exam, the student will present a synopsis of the report (5 min) and be asked questions. The questions will take a starting point in the report and be broadened out to also cover general topics from the lectures. The total examination time of each student is approximately 20 min including the presentation (5 min), individual questioning (10 min) and decision for the grade by the examiner and censor (5 min).
The final grade will be based on the written and oral performance combined.

RE-EXAMINATION

In case of re-examination e.g., if the group does not hand-in the report according to deadline or if one or several students in a group or a whole group does not pass the exam (based on the written and oral performance combined), individual reports should be handed in prior to the re-exam. The report will be 5 pages on a chosen subject within the course content. The exact subject will be agreed with the course responsible. A synopsis of the report will be presented at an oral re-exam (5 min) and followed by questions on topics related to the report and the general course content (10 min). The final grade will be based on the written and oral performance combined

GRADING

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

Master thesis

60 ECTS

Course responsible coordinator
Professor and science team leader, Derek V. Byrne. derekv.byrne@food.au.dk Assistant Professor, Barbara V. Andersen. barbarav.andersen@food.au.dk
Aarhus University, Department of Food Science, Team: Food Quality Perception and Society

COURSE CONTENT
The objective of the thesis is to demonstrate and document the student's ability to phrase, examine, analyse and process issues, within a food quality-, health- or marketing relevant delimited subject. The content of the thesis must be settles according to the procedure in "SDC Thesis Regulations, 10 steps".

The thesis is a 60 ECTS point experimental thesis, where the student specialises within of the modules included in the compulsory course program: Food quality, Food safety & risk management, Food & economic chain management, Food business & marketing or Nutrition & health. The thesis addresses a student-developed problem-formulation, preferably of particular industrial interest, which the student investigates via selection and application appropriate scientific theories and methods in an experimental study. The experimental part involves design and analysis of a research study, which preferably is conducted in a food industry environment to allow experience with solutions to food industry relevant issues. Alternatively, the study will be conducted at a university. In the thesis, the findings will be presented, discussed and evaluated in relation to relevant scientific literature.

During the work with the thesis, the student will be assigned a Danish and a Chinese supervisor and potentially a supervisor from food industry. The supervisors contribute with academic and methodological guidance. A thesis contract will be prepared, which will be approved with signature by supervisors and the student and send to the SDC office. The contract includes information about the topic, subject delimitations, a plan for supervision, submission deadline and potentially a confidentiality agreement between the food industry and the student and academic supervisors. Though the thesis can involve a food industrial supervisor, the thesis will be evaluated solely on academic grounds.

LEARNING OUTCOMES
Knowledge
At the end of the course the students will have gained knowledge about:
- Scientific problems within the study programme's subject modules
- A suitable combination of methodologies/theories based on highest international research for use in his/her work with the problem formulation

Skills
The students will be able to:
- Substantiate the idea of conducting experimental work/producing 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
- 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, considering the topic and the subject area

- Discuss and communicate the research based academic, food industry and social significance of the thesis, based on ethical principles

Competencies
Through the course the student is expected to gain the competencies to be able to:
- Independently take responsibility for own professional development and specialization
- Master research-based work
- Solve complex problems and carry out development assignments in a work context

EXAMINATION
Submission of a written master thesis is mandatory for attending an oral defense and must follow the procedure in the "SDC Thesis Regulations, 10 steps". The report will be a maximum of 100 normal pages written in English with a short English summary. A normal page for written submission is 2400 characters. To calculate normal pages, text is included, but not the front page, table of contents, bibliography, appendix, figures, and models. Deadline for submission of the written master thesis is given in the "SDC Thesis Regulations, 10 steps".

For Danish and International students to receive the UCAS grading the rule provided in "SDC Thesis Regulations, 10 steps" must be followed.

At the oral defence, the student will present the project (30 minutes). Then the Thesis Defense Panel will initiate a dialogue about the thesis and ask questions to the student for up to 30 minutes, after which the grade is determined and communicated to the student.

In assessment of the thesis, emphasis is placed on the academic content, but the student's spelling and wording skills are included in the assessment. Quality and independence in the design of own studies will be included in the overall assessment. The quality of data collection, analysis and evaluation will also be included in the overall assessment. A total grade will be awarded for the dissertation and the oral defense. Subsequently a written evaluation will be prepared.

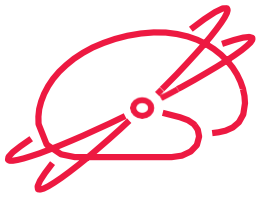
RE-EXAMINATION
Re-exam will be the same as the ordinary exam.

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



10 ECTS

Basic Neuroscience

Course responsible coordinator
Denmark: Jens R Nyengaard, Professor, MD, DMSc, Core Center for Molecular Morphology, Aarhus University Hospital, jrnyengaard@clin.au.dk
China: Zhiheng XU, Professor, Institute of Genetics and Development Biology, Chinese Academy of Sciences, zhxu@genetics.ac.cn

Aim
The objective of this course is to provide the students with knowledge of the general aspects of Neuroscience. Topics will include physiology (in relation to the central and peripheral nervous system), neuroanatomy, neurophysiology, neurotransmission, movement and sensation, neuropharmacology, neuroimaging, brain plasticity and stem cells. These topics will combined provide the background knowledge needed for the following advanced courses in the program neuroscience and neuroimaging.

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 signaling of neurons and glial cells, both in the developing, mature, and diseased nervous system
- Basic human neuroanatomy
- Basic aspects of neurotransmission, movement and sensation
- Introduction to various types of neuroimaging
- Basic aspects of brain plasticity and stem cells
- 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 and identify neuroanatomical structures from brain images and illustrations
- Identify neural structures of importance for major brain diseases
- Be able to 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

Competencies
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
- Be able to 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

CONTENT AND PERSPECTIVE
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 signaling pathways, as well as an introduction to the electrical and receptor-neurotransmitter mediated signaling between neurons and other cells in the CNS.

MODULE STRUCTURE AND TEACHING APPROACH
Lectures and theoretical exercises. See lecture plan for details.

ASSIGNMENT AND EXAMINATION
Assignments
During the semester the students will be subjected to four hand-in assignments, these will be completed at a set time during class. Each of the assignments will be assessed by the responsible teacher. These assignments will be distributed throughout the course and the two assignments with the highest score will contribute to the final grade of the course, each accounting 10%. Thus, the assignments combined will account for a total of 20% of the final grade. The dates of the class assignments will be announced in the beginning of the semester along with the course curriculum. All assignments are individual written assignments where the student is not allowed to use any aids.

A minimum of two hand-in assignments must be submitted before attending the final exam.

EXAMINATION
The final exam is a 4-hour written examination, where no aids are allowed. The final examination will count for the remaining 80% of the final grade of the course. 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. One final grade is awarded, combining the scores of the 20% hand-in assignments and the 80% final examination.

RE-EXAM
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

8 ECTS

Course coordinators:

China: Chencan QIAN, Assistant Investigator, Institute of Biophysics, CAS, qianchencan@gmail.com
Denmark: Maciej Plocharski, Associate professor, Department of Health Science and Technology, Aalborg University, mpl@hst.aau.dk

Aim
The aim of this course is to provide the student with a basic foundation in signal processing techniques commonly encountered in biomedical applications.
The course covers topics from digital signal processing and analysis. First, the foundations about signal, system, and noise are introduced, followed by basic tools for stochastic signal processing in both time and frequency domains. Then some advanced topics of special interest in neuroscience are visited. The course is concluded with image processing methods, with special emphasis on techniques relevant for the analysis of neuroimaging data.

Relevant mathematical concepts are introduced when necessary for understanding the signal processing methods.

LEARNING OBJECTIVES
Knowledge
At the end of the course the students will have gained knowledge of:
- Statistical properties for signals and noises
- Linear system theory
- Basic signal processing methods in both time and frequency domains
- Model-based approaches for stochastic signal processing
- Multivariate methods
- Basic image processing techniques in two and three dimensions

Skills
During the course the student will have obtained skills in order to:
- Generate simulated data with specified statistical properties.
- Characterize and visualize a given signal or system.
- Analyze signals using both time and frequency domain methods.
- Analyze stochastic signals using model-based approaches.
- Analyze 2D and 3D images using basic image processing techniques.
- Design a signal processing system to meet a performance specification.
- Evaluate the results of different methods.

Competencies
The student is expected to gain the following competencies through the course:
- Familiar with the intuitions behind the basic building blocks of signal processing.
- Analyze and reflect on particular problems and identify relevant techniques for solving the problems.
- Provide concise description of solution strategies.
- Interpret and analyse digital signals and images.
- Appreciate new techniques developed in the research literature.

Student requirements
Knowledge and some practical experience with trigonometry, vector-algebra, derivatives, and integrals.
Students are expected to have experience with data handling and programming in Python.

EXAMINATION
The written examination will be in the format of problems to be solved using Python. In addition, essay questions may be formulated. The exam content will reflect the content of the course. Each problem / question will be indicated how it contributes to the total grade. Duration of examination: 4 hours. All aids are allowed including dictionaries, textbooks and a computer for solving problems. Internet connection is not allowed. No phones are allowed (not even used as a calculator).

RE-EXAM
Will be in the same form as original exam.

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

Introduction to Scientific Computing

2 ECTS

Course Coordinators:

China: KONG Yazhuo, Professor, institute of Psychology, Chinese Academy of Sciences, kongyz@psych.ac.cn
Denmark: Kristoffer L. Nielbo, Associate Professor, Centre for Humanities Computing Aarhus, Aarhus University, kln@cas.au.dk

Aim

The aim of this course is to provide the student with a basic foundation in scientific computing. After the course the student is able to write simple algorithms, including loops, functions, and conditional statements, and to apply them to efficient analysis of neuroscientific data. The Python programming environment, which is used for signal and image processing in subsequent courses of the education, is introduced through practical exercises.

LEARNING OBJECTIVES

Knowledge

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

- Scientific programming with Python, the Anaconda distribution, and Jupyter Notebooks
- The concepts of data types ad data structures, in numerical and text form
- Syntax of for modular programming with Python, including functions, scripts, and modules
- loops, control flow and boolean logic

Skills

During the course the student will have obtained skills in order to:

- Create and manipulate number sequences and multidimensional arrays
- Apply the concepts of size and dimension to create and index into multidimensional arrays
- Visualize data using 2D and 3D plotting functions
- Use logical operators and tests for logical indexing and conditional program flow
- Write nested loops and branches of the appropriate type for a specific task
- Create and select elements from character arrays, cells, and structure variables and differentiate between them
- Read, write, and save files and explain the difference between different file types
- Identify the type and dimensionality of new data

Competencies

The student is expected to gain the following competencies through the course:

- Recognize strengths of Python as a scientific programming and visualization environment
- Implement algorithms in computer code, which manipulate data and visualize results

Student requirements

Basic concepts of mathematical logic (comparisons and truth value). Computer literacy: files and folders; basic hardware components such as disk and memory storage. Python/Anaconda installed and able to run (English version).

EXAMINATION

Submission of an individual portfolio, demonstrating completion of exercises worked on during the course. Pass/Fail grading. Internal censor. The portfolio will be jupyter notebook format including Python scripts and outputs created by the scripts. The scripts are written during the course exercises. Working in groups is encouraged, but assignments are submitted individually at the end of the course.

RE-EXAM

Submission of a new individual portfolio, demonstrating completion of exercises. The student will have 1 week to finish the portfolio.

GRADING
Passed/non-passed.

Molecular imaging of brain function and structure

5 ECTS

Course Coordinators:
China: Dr. WANG Yingjie, Institute of High Energy Physics, Chinese Academy of Sciences, wangyj@ihep.ac.cn
Denmark: Søren Baarsgaard Hansen, senior physicist, Department of Nuclear Medicine & PET-centre, associated professor, Aarhus University, soerehse@rm.dk

AIM
The objective of this course is to give a comprehensive introduction to molecular imaging of brain function and structure using mainly positron emission tomography (PET). The course will cover all aspects of molecular imaging from design and production of radioligands, design and functioning of various types of scanners, data processing, tracer kinetics, and data interpretation. Examples will include imaging of brain function like cerebral blood flow, cerebral metabolism, neurotransmission and neurodegeneration for research and clinical diagnostics of major neurological and psychiatric diseases like e.g., Alzheimer's disease, Parkinson's disease, drug addiction, ADHD, brain cancer, and stroke.

The course will provide the necessary skills for basic use of molecular imaging in neuroscience research projects.

LEARNING OBJECTIVES
Knowledge
The student will gain knowledge about:
- Chemical and physical principles for design and production of radiotracers for molecular imaging
- Design and functioning of imaging equipment for PET, SPECT and autoradiography
- Data acquisition, processing, kinetic modelling and data interpretation
- Neurovascular coupling and its regulatory mechanisms for blood flow, oxygen consumption and glucose metabolism
- Basic properties of ligands used to map neurotransmitter systems
- Examples of imaging of brain function and structure in the normal and diseased brain of human subjects and animals

Skills
At the end of the course the student will be able to:
- Reflect on the physical limitations and advantages of radioisotope imaging (PET and SPECT) compared to other imaging techniques
- Design and optimize advanced protocols for best data quality
- Select a suitable ligand to image a specific biological process
- Perform kinetic analysis and interpretation of data from PET studies

Competencies
The course enables the student to:
- Work independently with basic analysis and interpretation of PET data with relation to a scientific question
- Contribute with essential knowledge about PET as a member of an inter-disciplinary research team
- Give advice regarding assessment and selection of optimal imaging method and equipment suitable for various clinical and scientific purposes
- Educate health professionals and others about basic principles of PET imaging

Student requirements
Basic knowledge of calculus, physics, signal processing (e.g. FBSP course). Basic knowledge of neurobiology from BNS course.

Module structure and teaching approach
Lectures and theoretical exercises (48-54 classes).

ASSIGNMENT AND EXAM
4-hour written examination. For each question it will be indicated how much it contributes to the exam. No aids, except calculator.

RE-EXAM
Same format as original exam.

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

Electrophysiology of Cognition

5 ECTS

Course coordinators:
China: Zuxiang Liu, Associate Professor, State Key Laboratory of Brain and Cognitive Science, Institute of Biophysics, CAS Beijing; zxliu@bcslab.ibp.ac.cn
Denmark: Leo Tomasevic, Research Fellow, The Danish Research Centre for Magnetic Resonance (DRCMR), Copenhagen University Hospital Hvidovre; leot@drcmr.dk

AIM

The study of cognition is the study of the thought processes that underlie the overt and covert behaviours of animals and humans. Cognitive functions, e.g., attention, memory, emotion and decision making, arise from and depend on the electrical signalling of neurons in the brain.
Interactions between excitatory and inhibitory cell populations lead to the emergence of a rich repertoire of dynamically varying network activity states that are measurable and quantifiable using electrophysiological observations.

The course introduces key elements of cognitive neuroscience from the perspective of measurements of population synaptic activity in brain networks. A common feature of empirical electrophysiological recordings is that they are detected at the same time scale that cognition evolves on: milliseconds.
A central aim of the course is to enable the student to identify neuroscience research questions that are approachable using electrophysiological recording techniques. To this end, we begin by constructing a model that explains how synaptic activity is reflected at different spatial scales of observation, from intracortical local field potential (LFP) recordings in animals to electro- and magnetoencephalography (EEG and MEG) measurements made on the surface of the human head. The common features between scales are emphasized to enable the student to integrate knowledge from different observation techniques. The event-related response framework for the study of neurocognitive processes is introduced, and subsequently applied in hands-on laboratory exercises using EEG. Core concepts of cognition are thus introduced in parallel with the techniques and paradigms used to study them. Students become familiar with a selection of both canonical EEG responses and common artefacts in computer exercises during which the recorded datasets are analysed.

The course lays the foundation for conducting neuroimaging research into the electrophysiological substrates of neurotypical cognitive functions, as well as dysfunctions caused, e.g., by disease and ageing.

LEARNING OBJECTIVES

Knowledge

- Formulate the biophysical origins of electrical signals at multiple spatial measurement scales in the brain, and contrast their physiological interpretations.
- Identify features of neocortical structure and function that lead to measurable electric and magnetic fields outside the human head, and contrast EEG and MEG in terms of their ability to inform on the sources underlying the measured fields.
- Summarize characteristic features of neurocognitive brain functions and discuss canonical ways in which electrophysiological responses shed light on them.
- Explain the emergence of oscillatory population activity dynamics in brain networks and summarize their hypothesized functional roles in cognition.

Skills

During the course the student will have obtained skills to:

- Apply the event-related response framework to the study of human cognition.
- Identify artefactual M/EEG signal components and apply relevant signal processing tools for the mitigation of their effects on measures-of-interest.
- Process M/EEG recordings and extract data features that address physiologically or cognitively motivated questions.

Competencies

The student is expected to gain the following competencies through the course:

- Outline strategies for design, implementation, interpretation and adequate reporting of an event-related electrophysiology experiment.
- Reflect on ways to quantify experimental electrophysiological data in order to address a cognitive research focus.
- Disseminate published literature and offer principled interpretation of results obtained using electrophysiological techniques to study cognition.

EXAMINATION

Oral examination.

Questions are drawn from a pool of known topics. No preparation, but personal notes may be reviewed during the short preparation period between assignment of question and presentation (2 minutes). No aids are allowed during presentation, though the drawn question may be consulted during the examination. Total duration 30 minutes, including student presentation, examiner questioning, and assignment of the final grade.

RE-EXAM

Will be in the same form as original exam.

GRADING

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

Thesis

60 ECTS

Time frame
3rd and 4th semester

Module coordinator team
China: Rong Xue, Professor, Institute of Biophysics, CAS Beijing Denmark:
Kim Ryun Drasbek, Associate Professor, CFIN, Aarhus University

AIM
The SDC Master's Degree in Neuroscience and Neuroimaging is concluded by a Master's 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 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 defense).

LEARNING OBJECTIVES
Knowledge
During the study the student will:
- Obtain extensive knowledge and understanding in the research topic of the Master's 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 research community as well as non-specialists

Competencies
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

Module structure and teaching approach
Independent work in a research laboratory along with theoretical studies of the topic. The majority of the research must be carried out in China preferably in Danish-Chinese research collaborations. It must be guided and supervised by a Chinese and a Danish university professor affiliated with the SDC. The Chinese supervisor must be an approved SDC Master's supervisor in the neuroscience and neuroimaging program. The Danish supervisor must be on the list of approved Danish supervisors. The supervisor team has to be approved by the Chinese and Danish HEPs.

LITTERATURE
Individual

Necessary steps for the master thesis

A master thesis contract signed by both supervisors have to be submitted to the SDC within the deadline set by the SDC.

For the Chinese UCAS degree, the student must perform an Opening Speech.

Neuroscience and Neuroimaging Symposium
The annual SDC Neuroscience and Neuroimaging Symposium takes place during the students 3rd semester. It is mandatory for students to participate in the symposium as a part of their master thesis.

ASSIGNMENT AND EXAM
Written thesis and oral examination.

The written report should contain the same sections as a scientific paper. Please include a section on method optimization 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. The student will give a 45 minutes oral presentation of the project, followed by 45 minutes of questions from examiners.

Chinese students:
Examiners: Chinese supervisor, Danish supervisor, external censor. Chinese students will be graded according to the Danish grading scale only.

Danish/International students:
Before the defense, the thesis will be assessed and approved for UCAS grading, by a UCAS Thesis Review Panel of Chinese experts.

Examiners: Chinese supervisor, Danish supervisor, external censor and for the Chinese grading also Review Panel of Scientific experts.

GRADING
For the Danish degree, one single grade is awarded combining the performance in the written thesis and the oral defence, according to the Danish 7-step grading scale.
For the Chinese degree, the Danish/International students will be assessed according to the UCAS grading procedure on the 4-step thesis grading scale.

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 serves as a broad introduction to the overall themes and conceptual framework of the programme. Students are provided with an introduction to the most important features and characteristics of the range of societal and economic systems addressed in the programme. This includes introductions to the key theories and concepts of the state, political systems, economic development strategies, socioeconomic systems and corporate governance. The course also discusses and illustrates how to conduct comparative studies in the social sciences.

Students integrate 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 assignment is comparative analysis related to the issues discussed in the course.

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

EXAMINATION
The exam is comprised of a written assignment. Students 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 coordinator. The assignment must not exceed 10 standard pages when written as individually, 15 pages when writing in pairs and 20 if writing in a group of 3. This includes tables and footnotes, but not front page, bibliography, and appendices.

The assignment should demonstrate the student's 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
- present independent and persuasive analyses.

RE- EXAMINATION
The same as the ordinary exam. 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 point grading scales.

Research Methods

7.5 ECTS

Course coordinator:
Johannes Kabderian Dreyer (jodreyer@ruc.dk)
Maj Grasten (mlg.mpp@cbs.dk)

CONTENT
The course provides the student with the skills required to conduct different types of research and apply research methods in projects.

The student is introduced to basic concepts and frameworks in social science research methods and how to design and conduct qualitative as well as quantitative research. The course is separated in two parts, each with a specific focus on qualitative research and quantitative research. Each part ends with a partial examination.

The focus of the course is on understanding the necessary steps involved in doing research: formulating research questions, research design, data collection, data analysis, and drawing inferences. The goal for the student is to be acquainted with a range of the most important and commonly used research methods in the social sciences. This enables the student to select research designs and methods appropriate for a particular research objective and gives students a sufficient understanding of a set of methodologies, which are crucial to designing and executing research projects that demonstrate high standards of analytical validity.

The course provides the student with understanding in the following main areas:
- how to match research questions with research designs and data collection methods
- how to select the most appropriate research design
- 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

LEARNING OBJECTIVES
At the end of both parts of the course, the student can:
- 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 questions
- perform rudimentary analyses using different methods
- master the use of the R software at a level that allows students to conduct their own research projects

EXAMINATION
The examination is divided in two partial examinations, one for the quantitative method part of the course and one for the qualitative part. There will be one final grade based on the average of the two grades. The average of the two partial examinations will be rounded up to the nearest mark for the final grade.

- The exam for the quantitative part is a 15-minute individual oral exam based on a written group project of 5 pages. 5 additional pages are permitted as appendix.
- The exam for the qualitative part is a 24-hour individual written exam. The assignment must be 7 pages and should not exceed 10 standard pages (including tables and footnotes but not references).

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 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. However, if one part of the partial examinations has been passed, this grade will automatically be transferred to the re-exam, and the re-exam will in this case only consist of the failed partial exam element.

GRADING

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

Science and Innovation Policy

7.5 ECTS

Course Coordinators:
Maja Horst (majho@dtu.dk)
Alan Irwin (ai.ioa@cbs.dk)

CONTENT
The course explores some of the most important themes, trends and issues regarding science and innovation policy world-wide. It offers an interdisciplinary perspective, bringing together historical, sociological and policy approaches in particular. The course combines a presentation of background material covering broader subjects such as the emergence of 'big science' with a more specific treatment of contemporary topics, including the science and innovation system, the public management of research, and responsible innovation. The course will additionally provide a comparative viewpoint on the public management of science across several nations, including developments in China, Denmark, and the USA.

Active student participation will be strongly encouraged. Students will be asked to prepare small projects, which build towards the final written assignment.

Assessment is based on a written individual student assignment. This should focus on a specific case of science and innovation policy from one or more national/regional setting. The assignment should present the case, link it to course material (e.g., main theoretical perspectives or thematic discussions within the field of science and innovation policy), and present both analytical and policy-relevant conclusions. Support for the student assignment will be provided throughout the course.

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

- demonstrate and synthesize knowledge about main trends, concepts and discussions within science and innovation policy
- identify significant patterns of development across different nations (specifically, China, Denmark and the USA).
- analyse and explore some of the main policy challenges and dilemmas as they relate to this field.
- apply knowledge about science and innovation policy to one selected case and be able to reflect upon the larger implications of this case.

EXAMINATION
Aids: all available material

Prerequisites for examination: It is strongly recommended, but not required, that students participate in all class activities and submit short exercises preparing for the assignment.

The examination comprises an individual written assignment. The topic for the assignment is to be selected by the student and agreed in advance by the course coordinators. Students should select a particular case within science and innovation policy. They should explain the central issues within this case, making appropriate connections to the larger themes and concepts introduced during the course. They should then present both analytical and policy-related conclusions on this case. The assignment must be at least 8 pages and should not exceed 10 standard pages (including tables and footnotes but not references).

RE-EXAMINATION
The same as the ordinary examination.

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

Organisation and Management

7.5 ECTS

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

CONTENT
The course provides students with an understanding of the dominant contemporary theories of organisation and management, which offer explanations to key organizational challenges emanating from the institutional environment, sector and industry differences, organizational structure, and strategy.

The course consists of two parts:
Part 1) introduces the course and how we can define an organization based on classical organization theories. This part of the course takes point of departure in organizational design and explores how different designs can help organizations address challenges. Based on this, the course moves to discuss similarities and differences between public and private organizations. Finally, core organizational behaviour theories are introduced to enable students to understand theories about culture, teams, and leadership.

Part 2) introduces and explores concepts, approaches and theories related to understanding organizations in relation to their external environment represented by institutions, business partners, government, and general stakeholder groups. Recognizing the global nature of organizations and management, this part particularly focuses on management and strategy of organizations that operate across borders. Institutional imprint on organizations and organizational agency, the value of social and political networks, optimal governance modes of cross-border business operations, and managing corporate social responsibility are among topics covered in this part of the course.

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 in different institutional settings and sectors
- explain advantages and disadvantages of different organizational strategies related to managing external contingencies
- Understand and analyse organisational change and internal dynamics

EXAMINATION
The exam is a 20-minutes oral exam.

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
Course coordinator: Duncan Wigan (dw.ioa@cbs.dk)

For this course, students have three options:

1. Research based internship
2. Research based project
3. Electives

RESEARCH BASED INTERNSHIP

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 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-minute 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 point grading scales.

RESEARCH BASED PROJECT

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/or providing solutions to the defined problem
- identify and discuss practical implications of the project
- work independently on a study with scientific rigor

EXAMINATION

The examination is an individual 45-minute 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 point grading scales.

ELECTIVES

Please follow the rules and regulations concerning electives at SDC.

Innovation Management

Contemporary Theory of Innovation and Innovation Management

7,5 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

as a prerequisite to participate in the exam, a written assignment is prepared by the students in groups (recommended group size is 4-5 members). It is performed during the module period. The assignment is not graded, must feedback is provided. The prerequisite exam must also be passed to participate in the re-exam.

EXAMINATION
Individual written exam. The exam is a 3-hour written exam with all aids incl. PC with 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.

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.

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 scientificparadigms.
- 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.

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

7,5 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

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 research 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.
- 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.

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 research 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.

Nanoscience and Technology

Unifying Concept in Nanoscience

15 ECTS
Course Coordinator: Tue Hassenkam, tue.hassenkam@sund.ku.dk

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

- Describe Nano science as a concept.
- Understand central concepts in Nano science (e.g., Quantum mechanics, molecular forces on nanometre range).
- Understand fundamental operating principle, use and limitations of central tools in nanoscience, which cover:
    - Explaining concepts of high-resolution microscopy (e.g., AFM, SEM, and TEM).
    - Explaining concepts of bottom up/top-down fabrication of nano scale devices.
    - Explaining concepts in molecular electronics, (e.g., OLED, OFET, and thin film devices).
    - Explaining differences between biological and artificial membranes
    - Listing and identifying properties of nanomaterials such as graphene, carbon nanotubes, nanowires, quantum dots, small metal clusters and nanoparticles.
    - Relating concepts on the different properties of bulk material versus nanomaterials.

Skills
Apply the above knowledge for evaluating and calculating nanoscale system properties and behaviour.

Competencies

- Read and analyse 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.

To qualify for the exam, the student must present two research articles during the course.

EXAMINATION
To qualify for the oral part of the exam, the student must first pass the written part of the exam: hand-in 3 written assignments during the course and write a 15-page essay on a chosen topic.

Essay (33%), assignments (33% Split between 3 assignments) and oral exam (34%) at the end of exam.

The oral exam is 30 minutes, no aids, no preparation time

RE-EXAMINATION
Same as ordinary. The assignments and essay must be passed before the oral re-exam. Passed exams will be transferred to the re-exam.

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

Nanobiotechnology

5 ECTS
Course Coordinator: Daniel Otzen, dao@inano.au.dk

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 nanobiotechnology:
- General overview over basic biotechnological and nanobiotechnological concepts.
- Self-assembly of proteins, peptides and other biomolecules
- Artificial enzymes, organelles and cells
- (Biological) Nanobots
- Nanotoxicology
- Nanotechnology in infectious disease treatment
- Omics

Knowledge
At the end of the course, the students should be able to:
- Describe basic concepts in cell biology
- Describe the self-assembling properties of proteins, peptides lipids and nucleic acids
- List and describe synthesis and properties of different organic polymers
- Describe the use of unnatural amino acids to modify protein properties
- Explain how supramolecular molecules can function as catalysts
- Describe concepts and challenges within artificial cells, organelles and microreactors
- Explain concepts, challenges, and techniques within the toxicology of nanomaterials
- Describe the use of nanotechnology in infectious disease treatment
- Describe the application of omics (genomics/transcriptomics/proteomics/bioinformatics) in nanobiotechnology

Skills
Apply the above knowledge to evaluate and characterize nanobiotechnological systems.

Competencies
Read and analyse nanobiotechnology literature, present and evaluate this work in a concise manner, and write a reflective self-consistent essay on it. Write and evaluate specific nanobiotechnology concepts, techniques, and literature reviews.

EXAMINATION
Report/essay based on the experimental exercises must be completed before the written exam.
Written exam (three hours, with all aids except internet). The exam consists of questions from all five fields from the teaching. The course grade is based both on the report (30%) and the written exam (70%).

RE-EXAMINATION
Same as ordinary examination. The report/essay must be completed before the written re-exam. Passed exams will be transferred to the re-exam. Re-examination will be converted to oral examination in case of less than five students: 30 min. oral exam, no aids, no preparation time.

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

Nanocharacterisation

10 ECTS

Course Coordinator: Morten Foss, foss@inano.au.dk

CONTENT

In this course students will learn the basic physical principles that underlie several 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 experimental exercises followed by a compulsory written report/essay based on a subset of the techniques introduced.

LEARNING OBJECTIVES

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

Knowledge

- Describe and explain the physical principles and concepts of several essential methods for nanocharacterisation.
- List, select and apply these methods to obtain specific information from given experimental systems.
- Describe strengths and weaknesses of the methods.

Skills

- Apply the acquired knowledge about characterization techniques to evaluate and design specific experimental systems.
- Analyse experimental data obtained by the techniques.

Competencies

- Analyse and understand data in scientific literature based on the experimental methods.
- Choose and evaluate specific techniques for given experimental systems.
- Write reports based on specific experimental methods.

EXAMINATION

Report/essay based on the experimental exercises must be completed before the written exam.

Written exam (three hours, without aids). The course grade is based both on the report (25%) and the written exam (75%).

RE-EXAMINATION

Re-examination format as for ordinary examination. The report/essay must be completed before the written 3-hour re-exam. Passed exams will be transferred to the re-exam.

In case of less than five students, the re-examination will be converted to 30 min. oral exam, no aids, no preparation time.

GRADING

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

Thesis (3. Semester)

60 ECTS

Course Coordinator: Per Hedegård, hedegard@nbi.ku.dk

CONTENT
The aim of the thesis work is to demonstrate that the student can work on a high theoretical level and in a systematic manner apply scientific methods to problems within nanoscience that are theoretical or practical in nature. The thesis must demonstrate competence working with scientific theories and methods within a specified subject of nanoscience. The subject must have a complexity and an extent that allows for it to be completed in course of two semesters. The thesis may be theoretical or theoretical/practical in nature. Students may establish a partnership with a company or an organization with the purpose of identifying and solving problems within nanoscience using scientific procedures and methods. The students will be provided with guidance during the thesis, having a Danish as well as a Chinese supervisor.

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 based on 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 an individual written assignment.

Students should add a summary to the thesis in English.

The examination (defence) is oral, based on the thesis. It consists of the thesis presentation followed by a dialogue between the student and the examiners that make up the Thesis Defence Panel. The oral

examination lasts 60 minutes (incl. assessment) where the student has approx. 30 minutes for presenting. The grade awarded must reflect an overall assessment of the written thesis and the oral defence. The assessment is made by the Thesis Defence Panel, which includes an external examiner.

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.

Life Science Engineering and Informatics

Introduction to Omics Oriented Life Science

5 ECTS
Course Coordinator: Peter Kristensen, Associate Professor, Aalborg University, Section for Biotechnology, pk@bio.aau.dk.
Zhihua Zhang, Professor, UCAS, zhangzhihua@big.ac.cn

CONTENT
The course "Introduction to Omics Oriented Life Sciences" will provide the students with a unified vocabulary and a common theoretical foundation, allowing them to engage in the studies of living organisms with various omics tools. Also, the students will critically review scientific literature, allowing them to identify solid and problematic conclusions based on scientific literature. The students will present scientific papers and will receive feedback on the presentations from other students and the teacher, allowing them to build competencies in presenting scientific findings. The students will also be given a historical insight in the field of life sciences, with a special focus on scientist trailblazing the Omics era.
A brief introduction to some of the most fundamental techniques in genomics and proteomics will be given, with the aim to provide students with a generalized overview, allowing them to progress to in deeper introductions of specific areas.

LEARNING OBJECTIVES
The student who has met the objectives of the course will be able to:

Knowledge
- Identify, classify, and account for chemical properties of macromolecules (DNA, RNA and protein)
- Account for the process and regulation of replication, transcription, protein synthesis and protein degradation
- Describe the importance and functions of RNA in cell fate determination, development, and also diseases.
- Describe the basic components the genome and their structures, including their basic units, organization, as well as topological and 3D architecture.
- Understand information contained - and outline the methods used - in genomics.
- Describe the concept of metagenomics, and outline the methods used in study metagenome.
- Describe the main post-translational modifications on macromolecules and how it influences activity, such as epigenetic and enzyme activity.
- Describe the concept of epigenetics, e.g., posttranslational modifications in core-proteins(nucleosomes), modification of nucleic acids (DNA and RNA).
- Describe and understand the information obtained by qualitative and quantitative proteomics and outline the methods used.
- Outline major global omics data-centers and understand the importance of curation in developing high-quality databases.

Skills
- Discuss historical aspects forming the foundation of the state-of-the art technologies used to study complex systems in life sciences, e.g., DNA sequencing, mass spectrometry.
- Discuss the importance of protein-protein, protein-RNA, protein-DNA interactions, and the whole interactome as a complex system and outline the methods used to study these.
- Describe and understand the forces of mutation and selection in shaping codon usage bias and outline the methods used.
- Describe the forms of molecular evolution (positive selection, negative selection, and neutral mutation) and understand how to derive selective pressure from molecular sequences.

Competences
- Outline the use of bioinformatics tools in various Omics studies.

- Critically review and present scientific literature

EXAMINATION

Oral exam. The total exam time is 50 minutes for preparation, oral exam and evaluation and grading.

The student will draw a question and have 25 minutes to prepare for the oral exam. This portion of the exam is with all aids. The oral examination will take 20 minutes and is without aids. The exam will conclude with 5 minutes for the evaluation and grading.

RE-EXAM

Same as the ordinary exam.

GRADING

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

Analytical biochemistry and sample preparation for Omics

10 ECTS

Course coordinator: Ulrik Kræmer Sundekilde, Assistant Professor, Aarhus University, Food Science, uksundekilde@food.au.dk

CONTENT
An Omics investigation is inevitably preceded by sample enrichment and purification based on the biochemical and/or physico-chemical properties of the group of molecules to be analysed. This purification is crucial, because an omics experiment should only assay a defined group of molecules (e.g. DNA but not RNA); from a technical point it is important that samples do not contain impurities that can spoil instrumentation. Quite different purification concepts are required, because the groups of molecules subjected to an omics study are highly diverse. This course will give theoretical and experimental insight into various enrichment and separation techniques employed in omics studies and outline the requirements for sample purification prior to the actual omics analysis.

LEARNING OBJECTIVES
The student who has met the objectives of the course will be able to:

- Explain the principles behind analytical techniques for sample preparation
- 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.

Knowledge
The students will acquire knowledge on the theory behind methods used for separation and purification of RNA, DNA, proteins, peptides and metabolites, including methods based on affinity, hydrophobicity, polarity, charge and size:

- Describe the central physico-chemical properties of nucleic acids, peptides/proteins, carbohydrates and lipids that is central for analysis and enrichment.
- 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

Skills
Through laboratory exercises, the students will acquire skills in practical laboratory work:

- 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
- Purification of sub-cellular organelles

Competences
The students will acquire competences that will enable them to include sample preparation and biochemical knowledge as an integral part in designing omics experiments, as well as competences in presenting data

Prerequisites for examination: Mandatory participation in Laboratory exercises.

EXAMINATION
4-hours written exam; all aids except internet access.

RE-EXAM
Same as the ordinary exam.

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

Central Techniques in Omics

10 ECTS

Course lead: Allan Stensballe, Associate Professor, Aalborg University, Medicine and Health Technology, as@hst.aau.dk

CONTENT
Biosciences in the post genome era depends on investigating molecular changes with large-scale technologies. This course aims to build basic understanding of the technologies and methods used to characterize and detect variations in genome, transcriptome, proteome, and metabolites of humans, animals, plants and microorganisms, and to provide students with knowledge sufficient for evaluating the specific strengths, weaknesses and possibilities of basic methods for characterizing biological systems at the molecular level.

The course will contain both theoretical and experimental approaches to the following techniques:

- Mass spectrometry technology (Instrumentation, Electrospray ionization, Maldi-TOF, ion optics, mass analysers and operation)
- Protein id and characterization in Proteomics and Metabolomics. Interpretation of data including post-translational modifications.
- Protein and metabolite quantification (LC-MS/MS, SRM and MRM methods)
- Array technology
- Advanced Imaging (EM, MALDI Imaging)
- NMR based metabolomics
- Next generation DNA sequencing
- RNAseq based transcriptomics
- microRNA technology

LEARNING OBJECTIVES
The student who has met the objectives of the course will be able to:

- Read, understand, explain, and critically evaluate methods and data from primary research articles using the following omics methods:
- Protein identification by Maldi-TOF based peptide mass fingerprinting
- Protein id by ESI-MS/MS
- Metabolite id and quantification analyses by Mass spectrometry
- Protein quantification by Mass spectrometry
- Discovery based comparative proteome mapping
- Hypothesis based (targeted) comparative proteome mapping
- Selected reaction monitoring MS (SRM)
- Proteogenomic data integration.
- Mapping of posttranslational modification of proteins
- Microarray based transcriptome mapping
- Next-generation based transcriptome mapping
- Genome sequencing
- evaluate and reflect on the shortcomings of the specific methods and technologies chosen to describe specific biological systems in original research articles suggest alternative approaches to those presented in original scientific literature
- Plan experiments, interpret raw data, critically evaluate data quality and integrate data across the following omics technologies:
- Protein identification by Maldi-TOF based peptide mass fingerprinting
- Protein id by ESI-MS/MS
- Protein quantification by Mass spectrometry
- Discovery based comparative proteome mapping
- Hypothesis based (Targeted) comparative proteome mapping
- Selected reaction monitoring MS (SRM)

- Mapping raw instrument data against reference genome data
- Microarray based transcriptome mapping
- Next-gen based transcriptome mapping
- motivate the choice of experimental methods and approaches for describing and investigating specific biological problems
- evaluate strengths and limitations of various statistical methods
- explain the overall theoretical principles behind the statistical methods introduced during the course
- account for the preconditions, assumptions and limitations in the individual steps of the statistical analysis
- independently perform a basic analysis of the various omics data using R

EXAMINATION
An individual written assignment to be completed in 48-hours.
The assignment is a maximum of 5 pages (font size 11, normal margins) and includes short answers, computational, and essay questions.

RE-EXAM
Same as the ordinary exam.

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

Bioinformatics and Systems Biology

5 ECTS

Course coordinator: Dali Han, Associate Professor, UCAS, handl@big.ac.cn

CONTENT
Bioinformatics is today essential for almost all branches of life sciences. For instance, the advent of Next Generation Sequencing (NGS) technologies has transformed how biological research is being performed and Whole human genomes can today be sequenced cost effectively and rapidly providing unprecedented possibilities for investigating human traits, evolution and diseases. Similarly, whole bacterial communities and their interplay with the environment can be studied, unravelling novel enzymes and organisms. As these experiments produce massive amounts of data, skills with bioinformatics and large data supercomputing are crucial for analysis. The aim of the course is to give the students a good knowledge of the NGS technology and steps for sequence data analysis as well as a background to bioinformatics in general and an introduction to biological data science.

The course content is structured in 4 main themes.

Introduction to bioinformatics
An introduction to the basics of bioinformatics including the electronic data formats for storing information about biological macromolecules, such as DNA, RNA and proteins, as well as an introduction to publicly available sequence and structure databases such as GenBank, UniProt and PDB. The theme will provide students with knowledge of a number of new methods for molecular structure and sequence analysis.

Introduction to NGS
A solid introduction to NGS and NGS data processing and the relevant corresponding tools. Students should be able to understand and apply this information to practical uses, such as screening large segments of sequenced DNA extracted from wide-ranging clinical or environmental samples.

Biological Data Science
Main computational tools to load, analyze, visualize, and model biological data, such as PCA methods, linear and logistic regression, clustering, and basic Machine Learning..

Applied Bioinformatics
The students will work on case studies where Bioinformatics and Biological Data Science are used to solve relevant scientific problems involving biological and clinical data

LEARNING OBJECTIVES
The student who has met the objectives of the course will be able to:

- break down real-world data problems
- recognise patterns in data and generalize from them
- search for sequence and structure data from the publicly available databases, such as GenBank, UniProt and PDB
- generate and critically evaluate DNA and peptide alignments
- query sequence databases using alignment-based methods (BLAST) and critically evaluate the results
- explain basic concepts of machine learning and data science
- parse (read and extract) (bioinformatics data) files for needed information.
- Understand and operate with common formats for representing DNA and protein sequence data
- explain the applications of the different NGS technologies, including the weakness and strengths of the approaches, learn to implement the steps involved in a general NGS data analysis

EXAMINATION
written assignment + oral defense

An individual written assignment to be completed in 24-hours, followed by an oral defense.
The assignment must be between 5 and 10 pages and covers the entire course including exercises and theoretical questions.

The oral defense takes 30 minutes including questioning and grading. For the oral defense, the student will go through their assignment and there will be general questions about the course content.

RE-EXAM
An oral re-examination of 30-minutes covering the whole course.

GRADING
A single grade will be assigned given according to the Danish 7 step and the Chinese 100 points grading scales

Thesis (3. Semester)

60 ECTS

Course responsible: Danish HEP Ling Ding, Associate Professor, DTU, lidi@dtu.dk and Yang Yungui, Professor, UCAS ygyang@big.ac.cn

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.

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 IO 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 IO Steps.

Water and Environment

Hydrology, Freshwater Ecology and Biogeochemistry (Module 1)

15 ECTS

Course Coordinator: Denmark: Torben Linding Lauridsen, Senior Scientist, Aarhus University, tll@bios.au.dk
China: Wu Qinglong, Professor, Nanjing Institute of Geography and Limnology – NIGLAS, qlwu@niglas.ac.cn

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 introduces the different components of the hydrological cycle, their governing physical equations, the measurements, and sensors used, and relevant modelling approaches used to estimate those components, with emphasis on novel data sources. The course is structured around three main topics:

- Land- atmosphere interactions with the study of atmospheric water and precipitation, evaporation, and actual evapotranspiration.
- Surface processes describing soil water infiltration, rainfall runoff processes and river routing.
- 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. 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 modelling 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 consists of:

- 3 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 modelling 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

Course Coordinator: Kristian Koefoed Brandt, Associate Professor, Copenhagen University, kkb@plen.ku.dk

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 consists of:
- 3 group 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

Course Coordinator: Kristian Koefoed Brandt, Associate Professor, Copenhagen University, kkb@plen.ku.dk and Professor Tao Liang, UCAS, liangt@igsnrr.ac.cn

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. Ideally, the thesis has a length of a minimum of 50 and a maximum of 80 standard pages, excluding references. A SDC "standard page" includes 2400 type devices incl. blanks. Tables and figures (including headings and table/figure text) count as 800 characters each regardless of size/length. In determining the number of standard pages, the front page and references are not included. 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 IO-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 IO Steps.