

SDC

The university partnership
Denmark – China

Course Catalogue Spring 2020

All courses related to the
programmes



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Chemical and Biochemical Engineering

Green Chemical Engineering

5 ECTS

CONTENT

- Introduction to green chemical engineering
- History of green chemical engineering
- Catalysis in green chemical engineering
- Green chemical engineering in organic synthesis
- New green materials
- Green materials design

LEARNING OBJECTIVES

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

- understand the basic concept of green chemical engineering and state of the art of research and application.
- carry out basic approaches of design catalysts for application to green chemical engineering.
- make the preliminary design of a green process.

EXAMINATION

2 course assignments of 4-6 pages each are to be solved individually. The final marks are given based on the marks of the course assignments (50 % each).

RE-EXAMINATION

The same as the ordinary exam.

GRADING

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

Process Design – Principles & Methods

10 ECTS

CONTENT

The course will be divided into two parts.

The first part will deal with introduction to process design principles, the stages of the process design life cycle and the preliminary design steps (flow sheet synthesis, equipment sizing/costing, economic evaluation, scheduling of batch operations, distillation sequences, and pinch analysis).

The second part will deal with conceptual design (advanced process synthesis (such as heat integration, heat exchanger networks, reactor networks, reaction-separation sequences, and solvent selection), equipment selection, and flow sheet optimisation).

LEARNING OBJECTIVES

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

- make design related decisions.
- use knowledge to solve practical engineering problems.
- collect and assess missing data and information from the open scientific literature.
- work in groups.
- use computer aided tools.
- generate and screen alternatives.
- verify and analyse simulation results.
- formulate process design problems and to develop systematic solution strategies.
- apply chemical engineering principles learned from other courses.
- apply "green" or environmental issues in process design.

EXAMINATION

Evaluation of exercises/design project report plus oral presentation of design project and minor take-home exam problems.

RE-EXAMINATION

The same as the ordinary exam.

GRADING

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

Coatings Science and Technology

5 ECTS

CONTENT

The course will give a broad perspective on polymers and coatings. Course contents are: basics of polymers, molecular weight, mixtures and blends, crosslinking chemistry (acrylics, polyurethanes, epoxy and alkyds), mechanical and thermal properties of polymers, corrosion, electrochemistry, anticorrosive coatings, basics of coatings, crosslinking in coatings, solvents, latex, rheology, pigments, pigment dispersion, exterior durability, intumescent coatings, insulation coatings, blade coatings, coating failures and degradation, coatings specification, testing, and inspection.

LEARNING OBJECTIVES

To provide the students with a basic knowledge on coatings and polymers used in coatings. The course focus is on understanding and principles (as opposed to systematically going through specific coating ingredients).

A student who has met the objectives of the course will be able to:

- Determine polymer molecular weight distributions from average molecular weights
- Draw phase diagrams for polymer melts/mixtures and determine miscibility of systems
- Estimate suitable solvents for different polymers
- Explain crosslinking mechanisms
- Determine the effect of various parameters on the mechanical and thermal properties
- Estimate solvent properties and analyze rheological phenomena in coatings
- Characterize pigments and pigment dispersion
- Set up simple rate models for coatings behaviour
- Identify types of corrosion/corrosion mechanisms
- Understand the fundamentals of electrochemistry
- Classify methods used for corrosion prevention
- Select the coatings for protection against corrosion and deterioration of industrial structures
- Understand common coating degradation mechanisms
- Explain and identify common coating failures
- Select relevant coatings standards and test protocols
- Do basic coating system specifications for the heavy industry
- Identify common surface preparation and application techniques

EXAMINATION

4-Hour written exam. All aid, without internet.

RE-EXAMINATION

Oral exam. The student(s) who attend(s) the re-exam will draw one question from a pool of ten questions. Questions related will be asked. The students do not know the questions beforehand and the questions will be based on the topics taught in the course. The total evaluation is 15 minutes.

No aids are allowed.

GRADING

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

SDC Green Challenge

5 ECTS

CONTENT

This course will provide the students with an opportunity to use their knowledge obtained from the SDC MSc Program in Chemical and Biochemical Engineering to identify an energy or environment related challenge in China or Denmark, to develop a concept addressing the challenge, and to evaluate the feasibility of the concept with respect to technology, economy and sustainability.

LEARNING OBJECTIVES

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

- identify and analyse an energy or environment related challenge in China or Denmark.
- conceive chemical and biochemical engineering solutions.
- develop a solution concept to the point where the feasibility of the concept can be decided.
- evaluate the technical, economic and sustainable aspects of the solutions.
- present the results to non-specialists and participate in scientific/non-scientific discussions.

EXAMINATION

The students will work in teams of four students. Each team must:

- 1) participate in the GRØN DYST at DTU, including submitting of abstract and presentation to the conference.
- 2) complete a report for the developed project for GRØN DYST. The report is expected to be 10-30 pages and be submitted at the end of the course.

The course is evaluated based on the report (50%) and an individual presentation of the GrønDyst project at the oral exam (50%). The duration of the presentation is 2 minutes (same as the final presentation of GrønDyst), followed up by a discussion/question session of 5 minutes.

Evaluation: pass/not pass, internal examiner.

RE-EXAMINATION

The re-exam consists of re-submission of the report and an individual oral exam following the same rule as the ordinary exam.

GRADING

The course is evaluated according to pass/non-pass.

Summer School in Unit Operations

7,5 ECTS

CONTENT

1-week theoretical study, 3-week experiments and half-week visits to companies and chemical plants.

In the 1-week theoretical study, the students will be introduced to core theory in Unit Operations, such as liquid and gas flow, absorption and distillation columns, drying, extraction, pumps, filtration, mixing, and heat transfer. The students will carry out five individual theory exercises.

In the 3-week experiments, in groups of two, the students perform and report on four exercises within the following areas: flow in pumps, pipes and fittings, flow through particle beds, heat transmission, distillation, absorption, extraction, filtration, membrane filtration, centrifugation, drying, evaporation/crystallization, agitation.

LEARNING OBJECTIVES

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

- understand the core theory in unit operations.
- apply theory to practical experimental problems.
- analyse results and formulate conclusions concerning the quality and applicability of the results and to draw consequences for the process operation, plant design and functionality of the components.
- operate process units incl. data acquisition systems and measuring equipment in pilot scale size.
- explain the design of processes.
- recognise technical components on real life plants.
- identify and explain practical tasks concerning sampling and measuring techniques.
- make a report on an experimental job in an organised way, which makes it easy to read and understand calculations on conclusions.

EXAMINATION

The course is evaluated based on the five individual theory exercises (25%) and the four reports (in a group of two students) on experiments (75%). The reports must be done according to a report writing guide provided by the teacher.

RE-EXAMINATION

The re-exam consists of re-submission of theory exercises and/or reports specified by the teacher based on the results of the ordinary exam,

GRADING

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

SDC Research Immersion

7.5 ETCS

CONTENT

Through participation in a research project in a shorter period of time, the student will try to answer a question or solve a problem, which is connected to the work of the supervisors. The student will gain knowledge within a topic related to the research area of the Department of Chemical & Biochemical Engineering, while gaining insight into how the scientific method is put into practice to solve a given problem. The student will also gain general competences, e.g. the ability to participate in constructive mentor-mentee relationships and the ability to communicate science – in writing as well as orally.

Participation in a research project in collaboration with supervisors. The supervisors can be professors, researchers, postdocs or PhD students at DTU Chemical Engineering. The exact content of the project will be further agreed upon with the supervisors. The project must be communicated in a final, written report.

LEARNING OBJECTIVES

A student who has met the objectives of the course will be able to:

- work in a focused and strategic manner to retrieve scientific literature.
- extract information from scientific articles of relevance to a scientific project.
- critically evaluate his/her own and others experimental designs.
- plan, carry out and finalise a project under tight time constraints.
- communicate the results of a scientific project in a report that could be shaped like a scientific article.
- constructively participate in a student-supervisor relationship.
- explore and analyse relevant technologies for solving the given problem.

EXAMINATION

The course is evaluated based on a final, written report by individual student.

RE-EXAMINATION

The same as the ordinary exam.

GRADING

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

Note: This course is only offered to SDC students who have taken a laboratory course in unit operations at DTU Chemical Engineering during bachelor study.

Thesis (4. Semester)

30 ECTS

The MSc thesis in the CBE programme must abide by the 'SDC Thesis Regulations, 10 steps'. The following special CBE rules describe CBE specific interpretations, limitations, and approved extensions.

The MSc thesis in the CBE programme is a 30 ECTS thesis. The MSc thesis is the final assignment of the programme. The objective of the MSc thesis is to give students the opportunity to apply the knowledge they have acquired in an independent way on a larger project that concludes with a written report. The thesis must document skills in applying scientific theories and methodologies to a clearly defined academic topic. The Heads of the Educational Programme (HEPs) must approve that the MSc thesis falls within the technical and scientific field of the programme.

The MSc thesis must be written in English and it must include an abstract.

The MSc thesis may be undertaken in collaboration with a company.

Each of the student must have a Chinese supervisor and a Danish supervisor. For assignment of supervisors, 'SDC Thesis Regulations, 10 steps' must be followed. Both supervisors must regularly follow the progress of the thesis.

CONTENT AND LEARNING OBJECTIVES

The content of the thesis must be settled according to the procedure in 'SDC Thesis Regulations, 10 steps', steps 3 and 5. The thesis content is part of the SDC thesis contract. The thesis may contain a combination of experimental work, fieldwork, theoretical studies, synthesis, modelling and analysis. All thesis must include elements of literature studies and criticism. In addition, the thesis contains the following overarching learning objectives:

A graduate of the MSc programme in Chemical and Biochemical from SDC:

- can identify and reflect on technical scientific issues and understand the interaction between the various components that make up an issue.
- can, on the basis of a clear academic profile, apply elements of current research at international level to develop ideas and solve problems.
- masters technical scientific methodologies, theories and tools, and has the capacity to take a holistic view of and delimit a complex, open issue, see it in a broader academic and societal perspective and, on this basis, propose a variety of possible actions.
- can, via analysis and modelling, develop relevant models, systems and processes for solving technological problems.
- can communicate and mediate research-based knowledge both orally and in writing.
- is familiar with and can seek out leading international research within his/her specialist area.
- can work independently and reflect on his/her own learning, academic development and specialisation.
- masters technical problem-solving at a high level through project work, and has the capacity to work with and manage all phases of a project – including preparation of timetables, design, solution and documentation.

Submission of project plan must follow the procedure in 'SDC Thesis Regulations, 10 steps'. However, Step 5 must be completed no later than 1 month after the beginning date, and the thesis contract must include a project plan. In the project plan, the student is also to take into account the overarching learning objectives listed above. When submitting the thesis, the student is to enclose a separate document presenting the original project plan and a revision of the same, where appropriate. In addition, the document is to include a brief auto-evaluation of the project process.

Project deadline.

The project deadlines are given in 'SDC Thesis Regulations, 10 steps'.

Assessment

In assessment of a MSc thesis, the quality of the academic contents will carry the most weight. The students writing abilities will also count, though this will be weighted slightly less, while spelling will carry little weight.

The MSc thesis is evaluated based on a report and an oral defence. The report and the oral defence will be evaluated as a whole. The oral defence of the MSc thesis must follow the procedure in 'SDC Thesis Regulations, 10 steps'.

RE-EXAMINATION

The re-exam must follow the procedure in 'SDC Thesis Regulations, 10 steps'.

GRADING

For the Danish/international students, grades are given according to the Danish 7 step and the Chinese 4 step 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.

Innovation Management

Product Design and Development

7.5 ECTS

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

CONTENT

The aim of the module is to provide the students with a systematic process, a set of tools and methods that will enable them to understand how design ideas may evolve into innovative solutions to marketplace needs, wants and desires.

The creation of a new product or service is not a simple process. It takes in various organisational levels, numerous functional areas, dispersed geographies and requires unique skills and competences of the individuals involved in it. This course combines the perspectives of marketing, design and operations. In addition to focusing on the design and development phases a product goes through, the course also addresses a more general view of the appropriate attitude to design and innovation in today's fast changing global business environment.

LEARNING OBJECTIVES

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

- gain knowledge and understanding of characteristics of successful product design and development.
- grasp what it takes to create a new product or service and what are fundamental design techniques in demand methodologies that support this process.
- develop ability and confidence in adopting, evaluating and implementing design techniques and methodologies in various domestic and international organisational settings in both manufacturing and service environments.

EXAMINATION

Group oral exam based on the literature from the reading list and a written assignment.

- The assignment is prepared by the students in groups (recommended group size is 4-5 members). The assignment is performed in the course of the module period and constitutes 30 per cent of the grading.
- The oral exam is 25 minutes per student (incl. grading). The oral exam constitutes 70 per cent of the final grade.

RE- EXAMINATION

Individual oral examination based on a written assignment. The project is an individual written mini-assignment of 10 standard pages. The oral exam 25 minutes per student (incl. grading).

GRADING

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

Innovation Systems and Government-Business Relations

5 ECTS

Course coordinator: Roman Jurowetzki, Assistant Professor, Aalborg University (roman@business.aau.dk)

CONTENT

The aim of the module is to provide students with knowledge of theories of innovation systems and how companies are embedded in and can take advantage of such systems. Technology is seen as the key driver in most frameworks and thus technological development and its impact on socio-economic change are at the core of this course.

The module will have a special focus on government-business relations, including policies of innovation promotion and university-business relations, and on how new technologies are developed in such an interaction context.

The module will present contemporary theories of innovation systems in different perspectives (Global, National, Regional, Sectoral, Technological) and will illustrate their interplay with innovation at business- and organizational levels. Innovation systems will furthermore be analysed from a policy perspective, in order to support the development of innovation systems.

While the focus will be on innovation system variants, we will also explore several ecosystem frameworks (i.e. business, innovation, knowledge, entrepreneurial ecosystems) that have been prominent within the business- and management literature.

The course will have a considerable amount of practical elements, where we will explore different techniques for system mapping and analysis, such as qualitative event analysis, network analysis and various data mining techniques.

LEARNING OBJECTIVES

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

- analyse and reflect on the concept of innovation systems and apply it at different analytical levels.
- conduct analysis and evaluation of innovation systems' development, dynamics and opportunities for change through policy formulation.
- understand and reflect on innovation management strategies within an innovation system perspective.
- account for and explain the roles of government in business activities of firms.
- understand and critically assess different strategies that businesses can pursue in relation to governments.

EXAMINATION

The course is evaluated through a portfolio of evaluation forms: two individual mini-assignments performed during the course (20 per cent of the overall grade each), a group assignment performed during the course period (10 per cent of the overall grade) and an individual essay (50 per cent of the overall grade) on one of stipulated topics written in the time frame of one week. The length of the essay is 10-15 standard pages. The number of pages includes the text and tables while references and annexes are excluded.

RE- EXAMINATION

The examination is based exclusively on an individual essay with an extended length of 15-20 standard pages

GRADING

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

Globalisation and Innovation

5 ECTS

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

CONTENT

The aim of the module is to give students knowledge on theories of economic globalisation in general and specific theories of internationalisation of companies focusing on the internationalisation of value chain activities in general and innovation activities in particular.

The focus of the module is on the internationalisation of innovation/R&D and how global innovation networks are organised and managed in an intercultural context. Furthermore, a special attention is given to the subject of managing knowledge and intellectual property rights in a global context.

Teaching comprises lectures, seminars and cases. Furthermore, the theoretical elements of the course are linked to practical action through a written group assignment that is performed throughout the course.

LEARNING OBJECTIVES

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

- understand and reflect on the major dimensions, stages, drivers and meanings of globalisation.
- understand and reflect on how companies fit within the context of globalization and organise their value chain activities across borders.
- critically ponder and synthesize internationalisation theories in relation to their value chain activities in general and innovation/R&D activities in particular.
- use tools and techniques needed for organising innovation activities on the global scale.

EXAMINATION

Individual oral examination based on a written assignment and the literature from the reading list.

- The assignment is prepared in groups (recommended group size is 4-5 students). The assignment length requirements are 10-15 standard pages. The assignment is performed in the course of the module period and constitutes 30 per cent of the final grade.
- The oral exam is 25 minutes per student (incl. grading). The oral exam constitutes 70 per cent of the final grade.

RE- EXAMINATION

Individual oral examination based on a written assignment. The project is an individual written mini-assignment of 10 standard pages. The oral exam 25 minutes (incl. grading).

GRADING

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

Business Models Innovation

12.5 ECTS

This includes Semester Project II

Course coordinator: Christian Byrge, Associate Professor, Aalborg University (post@christianbyrge.com)

CONTENT

The aim of the module is to provide students with insights into the concept of business models and how to design and implement business models as well as how to design and implement original, unique and innovative business models. Furthermore, the module is set out to provide the students with contemporary creativity approaches for enhancing creativity in the entrepreneurial team and for the entrepreneurial individual. A concrete case related to innovation, business modelling and creativity is used to experiment on and discuss the development of business models.

LEARNING OBJECTIVES

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

- understand and reflect on business models, innovation and its underlying assumptions.
- understand and practice contemporary approaches for enhancing creativity and how to apply creativity methods in teams and for individuals.
- link business model theories to innovation and creativity practices and use tools for business model innovation.

EXAMINATION

The examination in this course is integrated with the examination in *Semester Project II* and an overall grade will be given. For examination regulations please see *Semester Project II*.

Semester Project II

12.5 ECTS

This includes the course Business Models Innovation

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

CONTENT

The aim of the module is to further develop (from Semester Project I) the students' skills in working problem-oriented in groups and solve real-life innovation problems.

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 2nd 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 Business Models 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 II. 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 assignment is prepared in groups (recommended group size is 4-5students). 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. There will be questions from the entire course curriculum.

RE- EXAMINATION

Individual oral examination based on a written assignment. The project is an individual written mini-project of 10 standard pages. 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.

Thesis (4. Semester)

30 ECTS

Course coordinator: Dmitrij Slepnirov, Associate Professor, Aalborg University (ds@business.aau.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 innovation management that are theoretical or practical in nature. The thesis must demonstrate competence working with scientific theories and methods within a specified subject of innovation management. The subject must have a complexity and an extent that allows for it to be completed in course of one semester.

The thesis may be theoretical or theoretical/practical in nature. Students may establish a partnership with a company or an organisation with the purpose of identifying and solving problems within management of innovation 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

After having completed the Master's thesis, the student must be able to:

- identify and define a complex and relevant innovation management problem (theoretical or theoretical-practical in nature) with important practical (policy and/or strategic) implications and potential for theoretical contribution.
- identify and apply relevant theories that can be used for building a conceptual framework for the analysis of the identified innovation management problem.
- identify and compare relevant scientific methods and prepare a design for selection, collection and analysis.
- develop solutions and demonstrate implications based on the findings of the analysis
- work independently and assume academic responsibility for the learning that the project has resulted in.
- demonstrate competence of and skills in scientific writing and oral presentation of the thesis and its findings.

EXAMINATION

The thesis is an individual written assignment.

The thesis has a length of a minimum of 60 and a maximum of 100 standard pages, excluding executive summary, references and annexes. 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).

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

Re-take examinations are subject to the same regulations as the ordinary exam. For more information, see SDC Thesis regulations 10 steps.

GRADING

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

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

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

Life Science Engineering and Informatics

Molecular genetics and epigenetics

5 ECTS

CONTENT

The course will provide the students with the skills to understand and explain the basic molecular architectures of plant and animal genomes as well as the basic mechanisms that regulate genome functions. Furthermore, the course will provide the students with the ability to understand and discuss principles of molecular genetics including an insight into and the use of methods to identify complex traits and disease genes.

- The organisation of plant and animal genomes
- Identification and characterization of DNA sequences, genes and molecular genetic variation
- Molecular methods used to map Mendelian and complex traits
- Basic mechanisms in genetic regulation of genome function
- Basic mechanisms underlying epigenetic phenomena, including DNA methylation, chromatin modification, RNA methylation and noncoding RNA
- Reading, understanding and oral presentations of scientific papers

The teachings are scheduled continuously over eight weeks with two to four sessions per week. The teaching comprises lectures, discussion, student presentations and exercises.

LEARNING OBJECTIVES

By the end of the course, the student is expected to have the skills to:

- explain the architecture of plant and animal genomes.
- discuss the mechanisms that regulate the functions of the genome.
- discuss the principles of molecular genetic methods and the techniques used to identify complex traits and disease genes.
- explain principles and mechanisms underlying epigenetic phenomena.
- critically read, understand, and orally present scientific papers.

EXAMINATION

25 minutes oral exam including assessment. Students will be given 5 minutes to prepare answers for the questions, which they will draw randomly, and then given 20 minutes for oral presentation.

RE-EXAMINATION

Re-exam will follow the same format.

GRADING

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

Central techniques in Omics

9 ECTS

CONTENT

Biosciences in the post genome era are a technology driven field. Progress depends on investigating molecular changes with large-scale technologies. This course aims to build basic understanding of the technologies and methods used to characterise 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 individual basic methods for characterising biological systems at molecular levels.

The course will provide the students with skills to understand, explain and select the relevant basic methods for characterising biological systems by large-scale molecular mapping methods. The students will develop the skills to evaluate the strengths and shortcomings of specific technological approaches currently available for describing genome, proteome, transcriptome and metabolome changes in biological systems. The competences achieved are appropriate for preparing the students for designing their own experimental approaches for their final master projects.

Content and perspective:

- Mass spectrometry technology (Instrumentation, Electrospray ionization, Maldi-TOF, ion optics, mass analysers and operation)
- Practical introduction to 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 applied in omics
- Advanced Imaging in omics (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:

- 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.

By the end of the course, the student is expected to have the skills to be able to:

- evaluate strengths and limitations of individual central technologies for structural and quantitative analyses of DNA, mRNA, proteins and metabolites from biological samples.
- evaluate the quality of data from proteome, genome, transcriptome and metabolome analyses as presented in original scientific literature.

- 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.
- motivate the choice of experimental methods and approaches for describing and investigating specific biological problems.

Learning outcome from the theoretical part:

Being able to read, understand, explain, and to evaluate critically the methods and information 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

Learning outcome from the laboratory part:

Being able to plan experiments, interpret raw data, critically evaluate data quality and to 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.

EXAMINATION

One exam consisting of two parts: 2-hour closed book written exam followed by 3-hour open book written exam. Only one grade is given and both parts must be passed to pass the course.

RE-EXAMINATION

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

7 ECTS

CONTENT

Bioinformatics is today essential for almost all branches of life sciences, as data generation has become more accessible globally. For instance, the advent of Next Generation Sequencing (NGS) technologies has transformed how biological research is being performed and today almost all biological fields use the technology for innovative discoveries. 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 basic handling of the Unix command line for handling large data sets, knowledge of the NGS technology and steps for sequence data analysis as well as a background to bioinformatics in general and an introduction to systems biology.

This course introduces elementary Unix, basic programming principles and good programming practices. The Unix introduction covers basic commands, file manipulation and input/output redirection. The idea is to equip the student for handling common bioinformatics file formats and forming a good basis for the computer exercises, which are integrated with the lectures.

The student will get an introduction to the most commonly used bioinformatics databases, such as Genbank, PDB, UniProt and SwissProt and work with bioinformatics algorithms such as BLAST, PSI-BLAST and pairwise- and multiple alignment. Weight-matrix based methods will be introduced and how to search using weight-matrices.

An introduction to broader topics such as network biology and metagenomics informatics will also feature on the course to provide a vision for the breadth of omics data and how their utilisation leads to impact.

LEARNING OBJECTIVES

A student who has met the objectives of the course will be able to:

- work from the Unix command line for handling data and operating tools.
- use basic programming skills to extract and analyse data.
- demonstrate insight in structured problem solving.
- break down real-world data problems.
- recognise patterns in data and generalize from them.
- parse (read and extract) (bioinformatics data) files for needed information. Understand and operate with common formats for representing DNA and protein sequence data.
- 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 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.
- give a basic introduction to network biology and metagenomics informatics.
- explain basic concepts of machine learning.
- understand B and T cell epitopes, and MHC presentation with bioinformatics applications.

- cooperate in groups and communicate results.

EXAMINATION

Active participation: Most sub-courses are designed with exercises involving hands-on work and/or answering questions based on content taught in the classroom. These are evaluated, and comprise a final grade according to sub-course weight (see below). All sub-courses must be passed to pass the full course.

GRADING

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

The sub-courses and respective assessment criteria and weighting are listed below:

Module 1 - Introduction to programming, 25% of the final grade.

Covering the basics of the Python programming language along with introducing basic programming principles and good programming practices. Various looping and control structures, built-in data and container types (lists and dictionaries), regular expressions and more advanced data structures are covered. Additionally, a basic introduction to awk for command line manipulation of data. Examples from programming will focus on parsing and manipulating data files including bioinformatics file formats. A large part of the course is spent on computer exercises, which are integrated with the lectures. Intense classroom teaching will be tightly woven in with exercises conducted in class and as homework.

Module assessment: All exercises are done individually and will be assessed. Students will have exercises every day, which will be graded and together give a combined grade for this module.

Module 2 - Introduction to bioinformatics, 20% of the final grade.

The lectures introduce the students to the basics of bioinformatics including the electronic data formats for storing information about biological macromolecules, such as DNA, RNA and proteins, as well introduce them to publicly available sequence and structure databases such as GenBank, UniProt and PDB. The section will provide students with knowledge of a number of new methods for molecular structure and sequence analysis. Second half of each lecture day includes hands-on sessions of computer exercises, where the methods are learned through practical use. Module assessment: Based on the completion of the daily exercises, which include searching data, running different tools and based on the results replying to the questions included in the exercises. These exercises are to be completed in the class or at home.

Module 3 – Introduction to NGS and Metagenomics, 10 % of the final grade.

The aim of this module is to give a solid knowledge of NGS and NGS data processing, the microbiome concept and methods for analysing metagenome data. 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 environmental samples (in microbiome samples in particular). Furthermore, it is a goal that the students learn to formulate scientific questions in relation to the microbiome that can be addressed by advanced metagenomics analysis and integration with other data types related to the micro biome (association analysis).

Module assessment: Students are asked to work on exercises/assignments. Answers have to be handed in and will be evaluated.

Module 4 – NGS-2, 10 % of the final grade.

This module builds on module 3 – Introduction to NGS. Here the student will be introduced to NGS methods aimed at the analysis of gene regulatory networks, both at the transcriptional and post-transcriptional level.

Students will learn about Transcription Factor-DNA interactions, mRNA expression, micro-RNAs. They will be introduced to the methods currently used for studying such mechanisms and molecules and how these data can be used to understand the genetic events involved in various stages of life.

We will also learn introductory notions of network biology and graph theory, by which gene and/or protein interactions can be studied in a systems-wide manner.

Finally, two practical examples of projects in which these methods are used will be discussed.

Module assessment: Students will be evaluated on a combination of short questions, short exercises and the analysis of a paper (in the form of targeted questions relative to such paper)

Module 5 – Machine Learning and Immunology, 15 % of the final grade.

Basic knowledge of machine learning concepts: training and evaluation, cross validation will be discussed. Application to simple cases (HMM profiles of proteins). Fundamentals of adaptive immunity: B and T cell epitopes, MHC presentation. Training of neural networks for predicting MHC presentation from experimental data. Usage of the tools in a real-case example (vaccine case study)

Module assessment: Combination of short questions (50%), and a written report on the vaccine case study (50%).

Module 6 - Integrative Systems Biology and Human Genetics, 20 % of the final grade.

This module will focus on Integrative Systems Biology and Applied Human Genetics. Current bioinformatics usage in medical genetics, interspersed with application of methods learned in previous weeks. Students will learn about genome-wide association studies along with some disease-insight, further learn about analysis of RNA-seq biobank data, its combination into functional genetics approaches, eQTL and allelic imbalance. Students will then learn about the application to drug discovery (mendelian randomisation) as well as drug response stratification. Finally, the students will be introduced to one-at-the-time personal genetics and how to analyse their own genome.

Module assessment: The students will be assessed using a combination of assignment evaluation and multiple choice tests.

RE-EXAMINATION

A written re-examination covering the whole course. This examination will be conducted in a single 4-hour session that comprises evaluation of all the modules. Each module will contribute to a different weight in the final evaluation (weights specified below). The written examination shall be a combination of a) programming exercises, b) multiple choice questions and c) descriptive questions. The exam is without aids.

Biostatistics

3 ECTS

CONTENT

Sophisticated statistical methods for analysing omics data are increasingly employed to deal with the complex data sets from the high-throughput experiments. With statistical tools, scientists generate testable hypotheses and draw the scientific conclusions supported by data. This course aims to build a basic understanding of the theoretical and practical aspects of various biostatistical concepts and analytical methods commonly used in the omics field. It focuses on the concepts of experimental design, qualitative and quantitative analysis of data, and statistical inferences. The course also aims to provide the students with knowledge sufficient for evaluating the specific strengths, weaknesses and possibilities of individual statistical methods as well as the capability to read articles on the subject critically. In addition, this course will provide a hands-on tutorial on analysing data with R, the most important statistical tool in the academy.

Content and perspective

- Descriptive statistics
- Introduction to probability
- Introduction to hypothesis testing (for two groups of numbers)
- Introduction to multiple hypothesis testing
- Introduction to analysis of variance (ANOVA)
- 2 by 2 contingency table
- Linear regression
- Correlation
- Principal component analysis (PCA) and cluster analysis
- Statistical power
- Data transformation
- Data visualisation

LEARNING OBJECTIVES

Knowledge

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

- explain the overall theoretical principles behind the statistical methods introduced in the course.
- evaluate strengths and limitations of various statistical methods.
- account for the preconditions, assumptions and limitations in the individual steps of the statistical analysis.
- apply reasonable statistical methods in analysing empirical data.
- independently perform a basic analysis of the various omics data using R.

Skills

By the end of the course, the student is expected to have the skills to:

- explain the basic principles underlying statistical methods.
- evaluate strengths and limitations of various statistical methods for data analysis.

- use R language to perform statistical tests.

EXAMINATION

Final exam are two reports based on the use of statistics in 2 hypothetical research projects. The grade of each report will count as 50 % of the final grade. The student describes how they solve a given biostatistics assignment in two omics areas. Details on the individual assignments will be discussed during the exercises. Each report should consist of between 3 pages and 5 pages (excluding references). A report must contain the following sections: a) introduction and description of assignment; b) overview of the student's procedure to solve the task; and c) evaluation of results and conclusion."

RE-EXAMINATION

The Re-examination will have the same format as the ordinary exam but a new topic must be chosen.

GRADING

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

Applied Omics in Food and Veterinary Sciences

5 ECTS

CONTENT

The omics disciplines are strongly in demand in the sectors of food, agriculture, biotechnology and applied microbiology. In these areas, omics represent a largely underexploited potential of technologies with great promise to advance developments to gain insights at the molecular level into e.g. quality of foods, feed and raw materials, nutritional values, probiotics, crop plant breeding, processes in food production, biotechnology and fermentation and food ingredients. The use of omics techniques is rapidly implemented in these fields of fundamental and applied research with anticipated huge benefits involving also development of dedicated emerging omics tools.

The course aims to provide a broad knowledge of the use of omics in food science concerned with cereals, vegetables, probiotic bacteria, livestock, meat and dairy products. It will provide background to the technical sub-disciplines of proteomics with reported application in the various areas of food and agricultural sciences. It focuses on the experimental design from sample preparation to qualitative and quantitative analysis of data.

Case stories will be selected to cover various thematic including also functional properties of key proteins involved e.g. 1) uptake and metabolism of prebiotic oligosaccharides by probiotic bacteria from the human gut, 2) redox control systems in cereals and microbes in relation to food biotechnology, 3) quality of selected foods. The course also aims to provide the students with knowledge sufficient for proposing research strategies to address objectives to be pursued in the areas of food and agricultural sciences and to evaluate the specific strengths, weaknesses and possibilities of individual experimental plans and projects as well as the competence to critically read articles on the subject.

Content and perspective

- Lectures on relevant techniques in proteomics
- Introduction to the area of food and agricultural sciences
- Description of case stories on "omics" in probiotics bacteria
- Description of case stories "omics" in crop cereals for functional properties and quality
- Description of case stories "omics" in livestock, vegetables, other raw materials
- Description of case stories "omics" redox-active processes in lactic acid bacteria and cereal crops
- The discovery chain from "2D spots to 3D structures" and "omics"-based identification of key proteins
- Production using recombinant techniques and characterization of key proteins in cereals and probiotics
- PULs gene clusters (PULs = polysaccharide utilization loci) in probiotic bacteria, "omics" and phylogenetic analysis
- Future perspectives

LEARNING OBJECTIVES

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

- evaluate strengths and limitations of selected relevant experimental plans in the area of food and agricultural proteomics.
- explain the possibility of integration of "omics" techniques for individual food and agricultural raw materials and products.
- account for the preconditions to provide experimental design to achieve given objectives.

- independently present a critical account of the application of “omics” in a selected theme within food and agricultural sciences.

Module structure and teaching approach

The course will run over three weeks intensively, with up to eight hours per day. Teaching comprises lectures, discussion, group work on 3-4 selected topics, student presentations with students as opponents.

EXAMINATION

Assignment and exam

Final exam is held at the end of the course based on the report (15-30 pages) made as group work (3-4 participants) on a chosen subject (one out of 6) within the course content, individual oral presentations of the report (15 or 20 min for the group, which is composed of 5 min for the students individually) and a defense (10 min individually) of the subject chosen for the report and the course content. The questions at the exam will take a starting point in the report and cover also general topics from the lectures as well as the journal clubs. Total examination time of each student is thus 30-35 min inclusive the group presentation and decision for the grade by the examiner and the external examiner. Internal censor.

RE-EXAMINATION

Re-examination is a 3 hour written exam in the form of an essay addressing a theme within the topic. The re-exam is with all aids.

GRADING

Assignments (project report) and oral defense will be graded with one final grade using the 7-step grading scale/100 points.

Nanoscience & Technology

Nanoelectronics

5 ECTS

Course responsible:

CONTENT

. The course will cover the following areas: concepts in electron transport, current flow in nanostructures, mesoscopic electron transport, the quantisation of charge, and conductance and their consequences for transport, Landauer (transmission) formalism. The chosen examples will include quantum wires, low dimensional semiconductor structures, quantum dots, graphene, carbon nanotubes, molecular transistors, and other timely subjects in nanoelectronics. One session will be devoted to nanofabrication.

The course also includes two laboratory experiments:

- Measurement of the Quantum Hall effect and Shubnikov de Haas oscillations in a two-dimensional electron gas at low temperatures (4 Kelvin).
- Fabrication (or measurements) of graphene quantum dots.

The experimental results are to be analysed in context of the theory presented in the course and summarised in reports written in groups of 3-4 students.

We aim at giving a phenomenological introduction to selected topics in the physics of nanostructures. The general theme is current flow (electron transport) in (low-dimensional) nanoscale structures, where quantum effects are expressed clearly. The basic formalism, key concepts and real experiments will be discussed, rather than complete theoretical treatments, which are covered in other courses. The students will be provided with the background for understanding a wealth of recent experiments in the field which ranges from quantum Hall physics, single-electron transport through "artificial atoms" in semiconductor structures to real "molecular transistors" based on single molecules. In addition to the purely scientific interest, these phenomena are also of technological importance in nanoelectronics and potential future applications in quantum information processing.

LEARNING OBJECTIVES

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

- demonstrate understanding of the basic formalism and the key concepts within electron transport.
- describe the differences between transport in bulk materials (metals, semiconductors) and nanostructures.
- explain the most prominent consequences of quantum effects in electron transport through nanostructures (limited to the contents of the course).
- describe the functionality of selected nanoelectronic devices based on these principles.
- differentiate between various regimes of mesoscopic electron transport.
- sketch the key elements in realising an electron transport experiment on a nanostructure.
- identify the relevant physical parameters in such an experiment, e.g. the essential length scales, energy scales, characteristic temperatures, quantized units etc.
- carry out experiments on simple experimental setups for measurements of nanodevices.

- know basic low-temperature techniques for measuring of nanodevices.
- apply theory from the course on experimental data to extract relevant parameters.
- write a report presenting relevant theory, experimental results and analysis.
- differentiate between ideal theoretical quantum phenomena and measurements under less ideal conditions.
- present clearly the phenomena reported in a research article within the field of experimental electron transport in nanostructures (in the following referred to as "the article").
- differentiate between the essential information and technical details in the article.
- reproduce and discuss the main features and trends in graphical representations of transport data.
- relate the findings to the theory treated in the course.
- relate or contrast to relevant examples (e.g. other articles) known from the course in order to demonstrate a broader understanding of the field.
- evaluate critically the article's conclusions to the extent that the background for this discussion has been treated in the course.

EXAMINATION

Oral examination (approx. 30 min), 10-12 minutes presentation based on one of experiments (A or B) followed by a discussion on other topics covered in the course.

RE-EXAMINATION

The same as the ordinary exam. The re-exam will be held as the ordinary exam, experiment (A or B) must be completed before re-exam.

GRADING

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

Synthesis and Fabrication

10 ECTS

Course responsible:

CONTENT

The course will be taught on the basis of recent reviews on the state-of-the-art nano-assembly and top-down/bottom-up nanofabrication. The student will learn different chemical methods used in construction of functional molecules and in surface and polymer modification as well as lithographic procedures for nanofabrication.

Throughout the course, the students will...

LEARNING OBJECTIVES

Nanomaterials are fabricated by utilising modern chemistry design, technology and techniques. The student will be made familiar with these synthetical techniques, chemical/physical methods to characterize the nanomaterials and enable their applications.

A student that fully meets the requirements of the course should be able to:

- Fabrication of self-assembled monolayers (ZMW)
- Single-molecule devices (ZMW)
- Organic electronics: OLED, OFET, OSC (ZMW)
- Novel nanoporous materials (BHH)
- Graphene, Chemical GO (BHH)
- Graphene, CVD, properties, characterization, application in devices (YQL)
- Polymer (RS)

EXAMINATION

Oral exam (60%) and assignments (40%). To qualify for the exam, students have to hand in all four assignments

RE-EXAMINATION

Re-exam same as ordinary. Assignments must be completed before re-exam.

GRADING

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

Bionanomaterials

5 ECTS

Course responsible:

CONTENT

The aim of this course is to provide the students with background knowledge on bionanomaterials based on the assembly of nucleic acid, peptide and protein. To introduce the latest achievements in basic research and potential applications.

This course will go through themes such as: Self-assembly of biological molecules. Design and assembly principle of DNA and RNA nanostructures: build 3D nanostructures with controlled size and geometry. DNA based organic synthesis. Modification of nucleic acids nanostructures with various functional elements. Nucleic acids based imaging probes and drug delivery system. Artificial molecular devices. Construction of peptide assembly nanostructures. Protein assembly nanostructures. Peptide assembly based nanomaterials. Biomedical application of peptide based nanomaterials. Disease associated peptide and protein assembly.

LEARNING OBJECTIVES

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

- describe the basic concept of DNA and RNA nanotechnology; explain and compare different strategies to assemble DNA nanostructure; design DNA nanostructures with provided software relate models of designed nanostructures to fabrication of nucleic acids nanomaterials; explain the strategies to assemble metal nanoparticle for plasmonic study and encapsulate drug molecules for therapeutic purpose.
- read and give a short presentation of a scientific paper within the subject area, understand the basic concept of peptide and protein assembly.
- understand the interaction mechanism between peptides in peptide and protein assembly; describe the possible aggregation pathways in peptide assembly; explain the strategies to design peptide assembly nanostructures for biomedical applications.
- expose the above goals in a scientifically correct language.

EXAMINATION

A three day take-home assignment in the form of an essay. All students will be evaluated by their class performance/presentations and final essay scores.

RE-EXAMINATION

The re-examination is the same as ordinary.

GRADING

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

Business Innovation and Entrepreneurship

5 ECTS

Course responsible:

CONTENT

Taking into consideration that more natural sciences graduates will work in companies in real business contexts or start building new businesses as their career choices, this course will provide an introduction to main concepts and theories related to innovation, organisation, and entrepreneurship.

How to organise and manage technological activities is an important part of a high-velocity global market. To keep competitive advantage in such a dynamic global market, companies and organisations are required to change and develop continuously, i.e. work with innovation. On the other hand, to take advantage of the new global and technological opportunities, the existing firms reorganise to become more entrepreneurial which involves the spotting, developing, and pursuing of business opportunities, by creating innovative projects inside the companies.

The main subjects covered are:

- The concepts of innovation, entrepreneurship, and organisation.
- Organisation structure and design.
- Leadership and Intrapreneurship.
- Innovation project and management.

The course comprises lectures, cases, discussions and students' active involvement, and consists of three parts:

- The basics of innovation, entrepreneurship and organisation.
- Leadership, entrepreneurship and business model.
- Innovation project management.

For each part, there will be 3-4 sessions of teaching, for each session there will be three teaching hours. The students are required to read and reflect on the literature and proactively engage in class discussions.

LEARNING OBJECTIVES

By the end of the course, the students are expected to relate nanotechnology knowledge and knowledge learned from this course to:

- understand and explain the concepts and principles of innovation, and identify different types of innovations.
- understand the concept of entrepreneurship, and be able to identify nanotechnology related business opportunities.
- design their own business models and organisations for new businesses.
- understand basic tools of project management, and apply to their own nanotechnology related innovation projects.

EXAMINATION

Individual written essay on the topic: Business innovation and entrepreneurship in a nanotechnology perspective.

Format:

- Min 5 pages, max 10 pages (including references, tables, and figures)
- The student is expected to formulate a problem, and use theories/frameworks/concepts learned in class to help explain/solve the problem.

RE-EXAMINATION

The re-exam will be held as the ordinary exam.

GRADING

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

Nano Energy Materials

5 ECTS

Course responsible:

CONTENT

This course sets out to explore:

- Description of fundamental concepts in the synthesis, physical properties, and applications of nanoenergy materials.
- Crystal structures and bonding in solids.
- Short introduction to X-ray diffraction and its use for analysis of crystalline materials.
- Interpretation and use of phase diagrams.
- Defects.
- The electrical and magnetic properties of solids and nanoparticles. Emphasis will be placed on relations between structure and properties.
- Surface energy of nanoparticles.
- Nucleation and growth theory.
- Nanoparticle interaction and synthesis methods.
- Applications of nanomaterials for energy applications.

LEARNING OBJECTIVES

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

- explain basic nucleation and growth theory.
- explain nanoparticle interactions.
- relate surface physics and chemistry to nanoparticle morphology.
- relate nanoparticle morphology and size to its properties.
- explain the interrelationship between band structure and properties.
- explain basic phase diagrams and relate it to phase transformations in materials.
- explain the fundamental concepts of the following technologies, and the role and benefits of nanomaterials: thermoelectrics, photovoltaics, magnetic materials, supercapacitors, batteries, hydrogen storage materials.
- express the concepts above verbally in a scientifically clear, correct and engaging language.

EXAMINATION

Written exam: 3-hour written exam + mandatory weekly assignments

RE- EXAMINATION

The re-examination is the same as ordinary..

GRADING

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

Neuroscience and Neuroimaging

Magnetic Resonance Imaging

5 ECTS

CONTENT

Basic MRI covers the basic principles of magnetic resonance (MR) imaging and some research methods. This includes spin dynamics in a magnetic field, interaction of magnetization by radiofrequency pulses, principles of MR imaging using magnetic field gradients, relaxation of magnetization and contrast in images. The most important applications of MR will be introduced. These include angiography and blood flow measurement, perfusion and diffusion assessment and functional MRI. Besides, examples of the clinical use of MR imaging will be given.

LEARNING OBJECTIVES

Knowledge

The student should have knowledge of the basic principles of:

- magnetic dipole moments in a magnetic field.
- image formation.
- obtaining contrast in MR images.
- using MRI for various physiological measurements.
- clinical MRI.

Skills

- Possess overall knowledge of fundamental MRI and the clinical use of MRI.
- Understanding of which kind of research problems for which MR can be used.
- Understanding of the limitations of MR.

Competences

- Competence to be able to participate in research projects using MRI.
- Competence to be able to participate in evaluation of MR scanners for equipment purchasing.

EXAMINATION

Submission of small report from practical exercise is mandatory for attending the exam. The report will be written in small groups, and should typically be 5-10 pages. (Completing this will also qualify the student for the re-exam.)

Written examination. Combination of multiple choice and essay questions. For each question, it will be indicated how it contributes to the grade. Four hours. No aids except dictionaries. Internal censor.

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

- understand and explain the fundamentals of MRI.
- answer the teaching objectives in the lecture plan.
- describe applications of MRI in the clinic and research.

- describe basic principles of MR based angiography, diffusion, perfusion.
- know and describe safety issues.

RE-EXAMINATION

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.

Pattern Recognition and Predictive Modelling in Neuroscience

5 ECTS

CONTENT

The aim of this course is to introduce pattern recognition and predictive modelling techniques and enable students to statistically analyse complex data sets as typically encountered in neuroscience. The course introduces topics in unsupervised and supervised learning beginning with presentations of unsupervised learning techniques such as k-means cluster analysis mixture models, as well as dimension reduction techniques. Within supervised learning, in addition, PRPM covers basic and advanced regression models for continuous and binary outcomes including penalized regression and support vector machines. The course emphasizes techniques for model training and assessment as well as variable selection.

Student requirements

Knowledge and competence within mathematics equivalent to the Mathematics course in the master's program. Basic knowledge in biostatistics (ANOVA, regression).

LEARNING OBJECTIVES

Knowledge

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

- understand mathematical and statistical principles in cluster analysis, mixture models expectation maximization, latent variable models, dimension reduction, regularised regression, support vector machines, classification, and model assessment and selection .
- critically reflect on theoretical and practical strengths and shortcomings of the approaches.

Skills

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

- apply unsupervised and supervised learning techniques particularly within neuroscience research.
- identify relevant techniques to solve particular problems, and discuss strengths and weaknesses of different approaches.
- concisely account for solution strategy and analysis results, as necessary for publication in scientific journals or prototyping machine learning algorithms.

Competences

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

- independently develop analysis strategies and apply combinations of statistical methodologies to solve research-based problems within neuroscience.
- become proficient in novel techniques (not covered in lectures) by studying and critically reviewing research articles.

EXAMINATION

Oral examination of the learning objectives. 20 min preparation. 20-minute examination including a 15-minute presentation by the student and 5 min. for questions. All aids allowed during preparation, only 1 sheet of notes from preparation during exam. External censor

The purpose of the exam is for the student to be able to:

- define and explain fundamental concepts within statistical learning.
- explain and apply clustering methods and mixture distributions.
- explain and apply linear and non-linear techniques for dimension reduction.
- explain and apply basic and advanced regression models and classification techniques for high-dimensional data.
- explain and apply central concepts within model evaluation, model selection and variable selection.
- identify and apply the methods introduced in the course for analysing data and discuss the advantages and disadvantages of the chosen methods.

RE-EXAMINATION

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.

Neuroscience in a Clinical Perspective

5 ECTS

CONTENT

This course builds upon the knowledge obtained in BNS with a focus on clinical perspectives of neuroscience and the methods used (e.g. EEG & other neurophysiologic methods as well as PET, autoradiography and radiochemistry). Although we may be interested in very basic questions about neuronal behavior or the optimization of MR coils, then in the end much of the research in neuroscience have implications for patients at some point. Similarly, patients have through various injuries and diseases helped neuroscientists to gain a better understanding of how the brain works, whereby, knowledge about patients also may help researchers in basic research. The goal is a broad introduction to various clinical aspects and the students will be given an introduction to common psychiatric disorders (e.g. affective disorders - unipolar (depression) and bipolar (manic-depressive); schizophrenia; OCD; addiction, etc.). In addition, the course also touches neurodegenerative diseases (e.g. Parkinson's and Alzheimer's diseases) and developmental disorders (e.g. Autism). In addition, students are introduced to neuropsychological issues following brain injury and how patient assessment is done and what rehabilitation and treatment perspectives are available.

Recommended student requirements

Knowledge equivalent to Basic Neuroscience, Fundamental Biomedical Signal Processing and Medical Imaging Techniques.

LEARNING OBJECTIVES

Knowledge

The course will enable the student to understand and reflect on:

- Central neuroscience topics related to both normal brain function and neuropsychiatric disorders.
- How neuroanatomy and transmission affects mental functions
- Basic features and applications of several important methodologies in clinical neuroscience such as assessment, symptoms, treatment, including general neuroscience methods

Skills

During the course, the student will acquire skills in:

- Basic insights into examination and assessment.
- The molecular basis of mental function in health and disease with particular focus on serotonergic, noradrenergic, and dopaminergic mechanisms.
- The behavioral disturbances affected by these neurotransmitters e.g. in neurodegenerative, psychiatric, and neuropsychological disorders from a biopsychosocial perspective.
- Identifying treatment perspectives of the described disorders.

Competences

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

- Select and certify the most suitable methodologies for studying neurological, psychiatric, and neuropsychological disorders.
- reflect on the cause of behavioural disturbances and propose research solutions.
- Have a basic foundation to critically review scientific publications dealing with neurological, psychiatric, and neuropsychological diseases.

- combine molecular, anatomical and signalling knowledge to gain insight and suggest research approaches in the study of diseases of the brain.

EXAMINATION

The exam is a 2-hour written multiple-choice examination without aids. For each question, it will be indicated how it contributes to the grade. Internal censor.

RE-EXAMINATION

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.

Magnetoencephalography and Electroencephalography

5 ECTS

CONTENT

Synaptic signalling between neurons generates electric currents that are associated with electric and magnetic fields strong enough to be recorded non-invasively on the surface of the human head using electro- (EEG) and/or magnetoencephalography (MEG), respectively. MEG and EEG provide instantaneous and continuous information on human brain function. To fully appreciate their strengths and weaknesses, as well as their relationship to each other, considerable effort must be made to understand the complex relationship between measured M/EEG signals and the spatial-temporal configuration of their (bio)physical generators in the brain.

Such insight is not only key to correct interpretation of measurements, but also required for building a physiologically motivated model from which estimates of cortical source locations can be obtained. In order to successfully apply M/EEG to a neuroscientific question, and to relate published M/EEG literature to studies employing contemporary tomographic neuroimaging techniques, subtleties of instrumentation and practical challenges of data collection must be appreciated. To this end, we will provide students with the opportunity to perform hands-on laboratory exercises involving steps from preparation to acquisition and quality assurance. Even the most careful acquisitions result in datasets containing artefacts—signal components of both biological and non-biological origin that overshadow the (often subtle) neuronal responses of interest. Students are introduced to a selection of both canonical responses and common artefacts in computer exercises during which the recorded datasets are analysed.

The event-related paradigm is the workhorse of M/EEG-based scientific inquiry, and is therefore covered in detail in the context of sensory- and task-evoked responses. The extraction of quantifiable indices of brain function in both health and disease using the on-going, spontaneous fluctuations of M/EEG recordings is also briefly touched upon. The aim of the course is to provide students with a solid foundation from which to develop a deeper understanding of the study of human brain electrophysiology using state-of-the-art techniques and experimental paradigms.

LEARNING OBJECTIVES

Knowledge

Successful completion of the course will enable the student to:

- describe the biophysical model of the generators of the electric and magnetic fields that are measurable from outside the human head.
- characterise the coupling of EEG and MEG measurements to these fields, and the fundamental limitations on the signal information content imposed by physics.
- discuss method and parameter choices for obtaining spatially resolved estimates of current sources in the brain.

Skills

During the course, the student will learn to:

- 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 a physiologically or cognitively motivated question.

Competences

After the course, the students can:

- outline strategies for design, implementation, interpretation and adequate reporting of an event-related M/EEG experiment.
- reflect on ways to quantify experimental M/EEG data in order to reveal aspects of the underlying brain function.
- disseminate published literature and offer principled interpretation of results.

MODULE STRUCTURE AND TEACHING APPROACH

Lectures, group work and in-class presentations, M/EEG laboratory exercise (data collection), guided hands-on data viewing and analysis (in-class computer exercises).

EXAMINATION

30 min. oral examination. No aids.

Internal censor.

- Structure: random assignment of a known question, student presentation, examiners question, determination of grade.
- No aids during presentation or examination, but personal notes may be reviewed during short preparation period between assignment of question and presentation (1-5 minutes). Cell phones and internet access are not allowed.

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.

Integrative Neuroimaging

5 ECTS

CONTENT

Neuroimaging techniques are capable of probing physiology and function at molecular, cellular and system levels, in animal models and humans. However, each imaging modality has its unique strength and inherent limitations. Moreover, most imaging modalities are correlative in nature, precluding causal inferences. The aim of the Integrative Neuroimaging Course is to give the students the possibility to gain experience in the rapidly advancing field of multimodal imaging. The students will learn about when, why, and how to combine different imaging modalities. The course will provide the students with a "multimodal imaging framework" which will help them to critically interpret literature within the field and to optimally plan scientific projects in the field of brain imaging.

During the course, the following topics will be covered in overview lectures or exercises:

- Introduction into the concepts behind integrative multimodal imaging
- Introduction to standard neuroimaging analysis tools
- General analysis techniques useful for integration of modalities
- Integration of electrophysiology (EEG/ERP/MEG) and functional MRI
- Introduction to transcranial brain stimulation (TMS, TDCS) and deep brain stimulation
- Combining EEG and TMS/TDCS
- Neurostimulation and neuroimaging: TMS & fMRI, offline and online
- Integration of MR-related techniques: structural MRI (sMRI) and diffusion weighted MRI (DWI)
- Combining sMRI and functional MRI (fMRI)
- Combining DWI & fMRI
- Integrating DWI and TMS
- Integration of MR-based techniques with positron emission tomography

Recommended student requirements

Basic knowledge of the major brain mapping techniques (structural and functional MRI, diffusion sensitive MRI, PET, EEG, MEG)

Basic experience with Matlab, MRI and EEG data analysis software

LEARNING OBJECTIVES

Knowledge

By the end of the course, the student will have:

- Acquired in-depth knowledge about how the combined use of brain mapping modalities can help overcome modality-inherent weaknesses and to maximize the modality-specific scientific potential.
- Knowledge on standard analysis tools including statistical parametric mapping, analysis of event related potentials and unsupervised decomposition with applications in multimodal neuroimaging.
- Basic knowledge about how to model multimodal imaging data.
- Knowledge on how to critically review own and published multimodal results.
- The ability to understand, reflect over and explain how to best integrate two imaging modalities.
- Acquired knowledge to be able to identify neuroscientific questions that can best be studied with an integrative neuroimaging approach.

Skills

The student will be able to:

- design a multimodal neuroimaging study: Identify the most relevant neuroimaging techniques, choose the most appropriate analysis tools and discuss strengths and weaknesses of different approaches.
- explain how to incorporate interventional approaches (TMS, TDCS) in brain mapping studies.
- explain the technical and computational challenges of multimodal integration.
- use and understand standard tools for analysis of neuroimaging data.
- co-register multimodal imaging data and integrate data sets acquired in different imaging modalities for subsequent analysis.
- evaluate the choice of method for multimodal integration.
- evaluate and choose the most appropriate neurostimulation techniques and protocols.
- account for solution strategy and analysis of results, as necessary for publication in scientific journals.
- disseminate knowledge about integrative neuroimaging and discuss related professional and scientific topics with both peers and non-specialists.

Competences

This course provides the students with the capacity to:

- overview complex experimental situations that require the integration of two imaging modalities.
- plan and pursue interdisciplinary cooperation with researchers using complementary imaging modalities.
- develop new ideas on how to improve multimodal integration and implement novel applications for integrative neuroimaging.
- acquired knowledge to be able to identify neuroscientific questions that can best be studied with an integrative neuroimaging approach.

EXAMINATION

The exam is a 7-day take home assignment.

The evaluation of the course is based on a written report. At the end of the course, students are presented with a research paper. The students are to write a report including a short summary and a discussion/review of the paper.

The extent of this written report should be no more than four pages, excluding illustrations, references, tables and figures. The students should attempt to integrate the knowledge obtained during the course in the evaluation of the research.

The following questions may serve as inspiration during preparation of the report:

What is the central question that the paper addresses?

What are the hypotheses?

What are the main results?

How can the results be interpreted?

Are there technical aspects, which may hamper or limit the interpretation of the results?

What multimodal imaging techniques are used in the paper or how can multimodal imaging techniques help in addressing the research question?

Which experiments may help address the research question?

Does the paper make a significant contribution to the field?

Evaluation will be based on internal censorship.

RE-EXAMINATION

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.

Advanced Neuroimaging (elective)

5 ECTS

CONTENT

The course aims to give a comprehensive understanding of two important imaging modalities for neuroscience, MRI and PET. The emphasis will be on physical aspects including the relationship between design of key hardware components, signal processing and the quality of the final image data acquired. The course will provide the necessary skills for using MRI and PET in neuroscience.

Student requirements

Basic knowledge of Calculus, Physics, signal processing, and MRI. An understanding of basic medical imaging techniques. English language proficiency.

LEARNING OBJECTIVES

Knowledge

The student will gain knowledge about:

- theoretical description of spin dynamics, magnetisation, and interaction between field and tissue.
- design of magnet coil, gradient coil, RF coil, RF components in the RF transmission and receiving pathways.
- imaging methods for spectroscopy, contrast weighing, fast imaging, fMRI, ultra-high field MRI.
- principles and methods for production of PET tracers.
- design of detectors and other key hardware components for PET scanners.
- PET data acquisition, corrections, image reconstruction, and performance assessment.

Skills

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

- reflect on the physical limitations and advantages of MRI and PET.
- perform data analysis and processing of data from MRI and PET studies.
- design and optimise advanced MRI and PET protocols for best data quality.

Competences

The course enables the student to

- contribute with essential knowledge about MRI and PET as a member of an inter-disciplinary research team.
- interpret data from MRI and PET relative to a scientific question.
- give advice regarding assessment and selection of optimal MRI and/or PET equipment suitable for various clinical and scientific purposes.

EXAMINATION

30 min oral examination without preparation time in one MRI topic and one PET topic drawn from a pool of at least 10 known topics.

RE-EXAMINATION

Same format as original exam

GRADING

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

Advanced Neuroscience (elective)

5 ECTS

CONTENT

The objective of this course is to provide the student with a broad knowledge of current approaches for the study of neural function and behaviour.

The student should get an understanding of information processing in synapses, neurons and microcircuits; understand the experimental approaches used in analysing the neurophysiological basis of behaviour in intact animals, and understand the use of animal models in the study of neurological disease. The course includes a wide variety of animal model systems used in neuroscience research, and techniques for genetic manipulation in both invertebrate (e.g. *C. elegans*, *Drosophila*) and vertebrate models. The students should be able to critically read and present the current literature, and discuss the function and structure of neuronal circuits in relation to animal behaviour. This course provides an up-to-date knowledge of the neural basis for indirect measurements of global brain function such as PET and fMRI. As such, it provides insights useful when designing and interpreting experiments in human brain scanning studies. The course provides examples of genetics, signal processing, neural modelling and physiology used in the study of neural function in health and disease.

Recommended student requirements

Knowledge and understanding of basic neurobiology, physics, mathematics and signal processing, and electrophysiological and optical imaging methods, commensurate with a level at or above that which is the objective of the basic 1st. and 2nd.semester courses in neuroscience and neuroimaging. English language proficiency.

Module structure and teaching approach

Each subject will be covered by one original paper and possibly one review in double-lessons. One or two students (working as a team) will present the original paper (15 minutes), followed by a general discussion. In the second lesson a review may be presented by another student or by another pair of students (also 15 minutes presentations). Alternatively, only the original paper will be presented, and the review is expected to be read by the students in preparation. Both original papers and reviews will be used in the examination. Teachers will be from Chinese and Danish Universities affiliated with SDC. The teacher's role is primarily to guide the presentations in class, and to provide feedback.

All students are expected to actively participate in class. The course coordinators will (before the start of the course) allocate published papers/reviews for the students to present. It is a prerequisite for attending the oral exam that the student has presented two papers, one of these must be an individual presentation (to mimic the exam situation).

LEARNING OBJECTIVES

Knowledge

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

- demonstrate knowledge and understanding of molecular, genetic and physiological methods for measuring and manipulating brain function and behaviour.
- demonstrate an understanding of the strengths and limitations of the different animal models on the basis of their physiological and pathophysiological relevance, and understand how to select the best animal model(s).
- demonstrate knowledge and understanding of the molecular, dendritic, cellular and circuit organization and physiology of the CNS in relation to the behavioural requirements and evolutionary adaptations of the organism.

Skills

During the course, the student will obtain the ability to:

- evaluate results derived from experiments performed in animals in neuroscience research.
- argue for the relative merits of the above methods, and suggest new developments of methods and new physiological experiments.
- identify relevant animal models and experimental approaches to address a particular neuroscientific question.
- find, evaluate and present relevant current scientific literature.

Competences

By the end of the course the students have acquired the capacity to:

- critically understand modern molecular, cellular and behaviour-testing methods in relation to the analysis of neural information processing and brain function in health and disease.
- perform independent as well as in team work, trans-disciplinary scientific projects using a variety of physiological methods for the analysis of brain function.
- analytically evaluate his/her own and general knowledge and understanding of brain function, and indicate avenues for further improvements.

EXAMINATION

Exam format: Oral examination based on the papers/reviews presented during the course.

Examiners: Teachers from the course.

The exam duration will be 35 minutes (followed by 5 minutes for evaluation). The first part (15 minutes) consists of a paper presentation by the student, followed by 20 minutes of discussion.

Each student will be assigned a paper for presentation 48 hours prior to the examination. During the 48 hours, the student is expected to produce an exam-PowerPoint presentation of the paper. The exam-paper will not be the same as the one(s) the student has presented in class during the course, but will be one of the papers presented by other students during the course.

When evaluating the exam, it is important that the student has shown the ability to present the paper in a concise fashion, using effective presentation techniques. The main emphasis is on the ability to extract the important points of the paper, to argue why things have been included in the exam-presentation, to evaluate the paper in a critical fashion, and to put the findings and conclusions of the paper into a wider context, for instance based on the course literature and material found by the student.

RE-EXAMINATION

Will be in the same form as the original exam.

GRADING

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

Cognitive Science (elective)

5 ECTS

CONTENT

The students will be introduced to cognitive science emphasising the functional aspects of the human brain that govern everyday behaviour, such as; attention, memory, problem solving, etc. The course is based on a number of lectures in combination with student participation in workshops and exercises. Here the students will conduct small behavioural experiments, typical relating to some of the classical studies in cognitive science (e.g. visual search (Treisman & Gelade, 1980), the serial positioning curve (Glazer and Cunitz, 1966) in free recall, etc.). The overall goal is to give the course participants a thorough introduction to cognitive science and behavioural methods.

Recommended student requirements

An understanding of the content covered in the courses BNS and NNPN. A basic knowledge of the major imaging techniques (structural and functional MRI, diffusion sensitive MRI, PET, EEG, MEG). English language proficiency.

Module structure and teaching approach

Combined lectures, with student activities. The student activities can take the form of small behavioural experiments that may provide the empirical data for one of the two final synopsis papers, classroom presentations, as well as group work.

LEARNING OBJECTIVES

Knowledge

During this course, the student will obtain:

- knowledge about the historical roots and foundation of cognitive science.
- knowledge about specific cognitive functions (e.g. memory, attention, emotions, etc.).
- knowledge of behavioural experiments that can provide the basis for further neuroscientific enquiries.

Skills

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

- disseminate theoretical knowledge about cognitive science and experimental results.
- conduct behavioural experiments investigating human cognition.
- devise, design, and set-up simple behavioural experiments within cognitive science.

Competences

The course provides the student with the ability to:

- critically review scientific publications dealing with topics relating to cognitive science, and cognitive neuroscience more broadly.
- select suitable methodologies for studying cognition.
- reflect behavioural test designs and propose research solutions.

EXAMINATION

The exam is an oral synopsis exam. Examiners will be Teachers from the course.

By 9 am the day before the exam, the student must hand in two synopsis papers, one theoretical and one empirical, the maximum size of a synopsis is three pages each (times new roman, pt. 12, 1.5 line spacing). The topics should not be too overlapping and needs to be approved by the course coordinator before the final exam. A synopsis is a short academic text, based on the course literature, and may include supplementary literature chosen by the student.

The oral part of the exam is 30 min. The student will enter the examination room and choose one of the two synopsis papers at random, which will be the basis for the exam. Then the student will have 7 min to make a brief presentation, followed by an examination based on the chosen synopsis (approximately 7 min) and the broader course curriculum (approximately 7 min), leaving the remaining time for the examiner and censor to discuss the final grade and give feedback.

RE-EXAMINATION

Will be in the same form as the original exam.

This is a new oral synopsis exam, based on new topics that are not too overlapping with previous chosen topics (for specifics on format please cf. to the above section), and these need to be approved by the course organiser before a re-examination.

GRADING

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

Public Management and Social Development

Business and Global Governance

7.5 ECTS

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

CONTENT

This course provides students with an introduction to the global context in which public and private actors operate and seek to realize goals.

The course addresses theories within International Political Economy and introduces students to the main international political economic processes and international organisations that condition the environment in which public and private actors operate. Students are expected to deploy and evaluate these theories against detailed cases drawing on both the Chinese and European arenas.

Key issue areas covered in the course include, not exhaustively, international finance, production, trade, law, taxation and the environment. We explore which actors and organisations are important in these issue areas and the political economic processes of which they are comprised.

Students submit research papers at the conclusion of the course based upon the issues covered in the course. There will be guidance provided on developing research questions and seminars running parallel to classes are used to assist students in building the research paper and reflect upon content.

LEARNING OBJECTIVES

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

- recognise, describe, classify and deploy analytically key theories and theoretical traditions in international political economy.
- identify central processes, institutions and actors in the global political economy and how these processes, institutions and actors impact on the constitution of the international political economy.
- use this basic knowledge to formulate and respond persuasively to research questions about the international political economy.

EXAMINATION

Individual research report (10 standard pages) based on a self-chosen topic. The research question is to be based on topics covered during the course.

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.

Comparative Policy Processes

7.5 ECTS

Course coordinator: Edward Ashbee (ea.dbp@cbs.dk)

CONTENT

The aim of this course is to introduce and explore different theoretical frameworks that can be used in undertaking a comparative study of policymaking processes. These include power-based approaches, structural explanations of policymaking, and institutionalist theories, as well as advocacy coalition and rational choice models. The course's coverage of these will incorporate an evaluation of the methodological challenges that arise when seeking to operationalise them. The course will at the same time consider the specific issues that arise when seeking to look at - and compare - policymaking processes in different time-periods or countries.

LEARNING OBJECTIVES

Following the successful completion of the module, participants should be able to:

- identify and assess the criteria to be used in comparing public policymaking processes across different national settings.
- identify, analyse and evaluate key concepts, models and theories in the study of policymaking processes and the assumptions that underpin them.
- relate core concepts, models and theories to empirical evidence.
- identify and assess the key methodological issues that arise when particular approaches to policymaking processes are operationalised.
- identify and assess the major contemporary challenges facing policymakers in different countries, settings and sectors.
- undertake a comparative theoretical and empirical study of policymaking processes based upon structured and coherent forms of argumentation.

EXAMINATION

The exam will be an individual assignment (10 standard pages) based upon a question or questions set by the teaching staff. The question(s) will draw upon the classes and the readings, and the assignment will be assessed on the basis of the learning objectives for the course.

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.

Social Innovation and Entrepreneurship

7.5 ECTS

Course coordinator: Kai Hockerts (kho.msc@cbs.dk)

CONTENT

The course aims to help students understand processes underlying social innovation in areas such as for example the voluntary sector, microfinance, or fair trade.

The course introduces students to various theories with regard to social innovation. Students gain hands-on experience with the practice of business plan writing, applying the theoretical knowledge acquired.

Students are expected to identify a real-world opportunity in the form of an innovation that will create charitable or societal benefits, being developed in either the public or private sector. They will be required to "transfer" that idea into the real world. This means developing a mission statement in which the intended social impact is identified clearly.

Furthermore, students are required to identify and describe a business model, determining relevant market segments, income strategies, and financing models. This content will then be assimilated into a specific business plan. The course will be completed with the students presenting their business plans/opportunities.

LEARNING OBJECTIVES

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

- discuss distinctions between different theories of social innovation.
- explain how these theories link to social performance.
- define which variables impact the social performance of social enterprises.
- apply theories to the analysis of social entrepreneurship in a wide range of cases.
- apply class room learning to a specific real-world example in regard to which a business plan is prepared and defended.

EXAMINATION

A mini project (i.e. the business plan) is prepared in groups of 3-5 students (max 10 standard pages per project). The mini project (business plan) is the basis of an individual oral defence.

The grading is based on an overall assessment of both the business plan submitted in writing and the oral defence – with an emphasis on the latter.

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.

Comparing Social Policies: Welfare States in Theory and Practice

7.5 ECTS

Course coordinator: Kristian Kongshøj (kongshoj@dps.aau.dk)

CONTENT

This course introduces basic theoretical and empirical perspectives on welfare states and the various ways of meeting social needs in different social systems.

The course includes theories and methods of policy analysis and their application to policy development and institution building in the welfare area.

Furthermore, the course elaborates on various challenges to welfare states all over the world. In many countries, these challenges have been reinforced by economic crisis. This adds to a long list of challenges for mature as well as for new welfare states: ageing populations, migration, poverty, new social risks, changing family patterns, social cohesion, etc.

The aim of the course is to compare these challenges across different social systems and welfare regimes. It examines the drivers of change as well as constraints on change in terms of path dependence and institutional complementarity. It addresses how possible solutions vary with the different combinations of social actors and institutions in the environment: states, markets, families, voluntary associations, social partners, and corporate social responsibility.

LEARNING OBJECTIVES

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

- undertake an in-depth comparative analysis on a selected topic within social policy.
- conceptualise and analyse the effects of different welfare state arrangements on social equality, economic efficiency and political stability.
- conceptualise and analyse challenges to the welfare state emanating from social risks and different forms of social change in different settings.
- identify, discuss and evaluate solutions suggested to the kind of welfare challenges covered in the course.

EXAM

Individual research report (10 standard pages) based on a self-chosen topic. The research question is to be based on topics covered during the course.

Reports will be graded on the basis of student's ability to:

- identify and elaborate on a research question relevant to the course and the learning objectives.
- select and substantiate theories, concepts and empirical data of relevance to the research question.
- carry out an analysis of the research question with chosen theories, concepts and empirical data.
- critically reflect on results and analysis, including the implications of the chosen method, data and theories.

RE-EXAM

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.

Thesis (4. Semester)

30 ECTS

Course responsible: Duncan Wigan (dw.dbp@cbs.dk)

CONTENT

The thesis addresses a student-developed problem statement, which is relevant to the programme. It should demonstrate that the student is able to formulate and delimit a research problem, and that the student can design and carry out an inquiry suitable to the problem at hand by:

- presenting, discussing and evaluating social science literature relevant to the problem.
- selecting and applying appropriate social science theories and methods.
- compiling and analysing suitable empirical data.

Based on this students should be able to draw substantiated conclusions and discuss the quality of thesis findings.

The thesis can be done in collaboration with an organization, focusing on a topic of particular interest to that organisation. However, the thesis is evaluated solely on academic grounds.

The student will be provided with guidance during the thesis, and will have a Danish as well as a Chinese supervisor.

LEARNING OBJECTIVES

After having completed the master's thesis, the student should be able to:

- formulate, delimit and operationalise a research question in an area of relevance to the programme.
- select, apply and critically discuss relevant theories and scientific methods.
- collect, deploy and critically discuss relevant empirical material.
- persuasively justify the analysis and assess the strengths and weaknesses of the thesis.

present the results of the analysis in a logically coherent, structured and linguistically adequate manner, both written and orally.

EXAMINATION

The thesis is an individual written assignment. The length of the thesis is 60-80 standard pages.

Students must include a summary to the thesis in English.

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

The duration of the oral examination is 60 minutes including grading. The student has maximum 12 minutes to do a presentation of the thesis.

The grade awarded reflects 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

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

A revised version of the thesis can be based on a new or revised subject.

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.

Water and Environment

Statistics, Modelling and Global Change (Module 3)

15 ECTS

CONTENT

The objective of this course is to provide students with knowledge and tools to:

- understand and apply frequently used data analysis and statistics, which are necessary for their future work and research.
- understand and - through simulation models - quantify the interactions between climate forcing, land use, water resources and surface water quality.
- understand and quantify the processes of carbon and nitrogen flows in ecosystems (soils, plant communities and animals) and the resulting effects on greenhouse gas emissions.
- understand and apply GIS-based geospatial analysis for geospatial ecology and environmental geographical analysis at small to large spatial scales.

The course comprises a combination of out-of-class and in-class activities, including lectures, theoretical exercises and computer exercises. Computer exercises will be based on topics and case-studies presented at lectures.

LEARNING OBJECTIVES

After completion of the course, the students should be able to

Knowledge

- understand the logic underlying commonly used statistical procedures, including regression models and analysis of variance
- identify relevant tools and models that can quantify how climate forcing (e.g., CO₂, temperature, precipitation and irradiance) and land use influence water resource availability and surface water quality
- describe and explain the effects of climate variability and climate change on biodiversity and ecosystem functioning at different spatial scales (ranging from plant, ecosystem to global)
- describe and explain theory from geospatial ecology, and to apply it to global change problems
- describe and explain general methodological approaches and their problems in GIS-based geospatial data handling and modelling, as well as spatial statistical analysis

Skills

- apply frequently used data manipulation and statistical procedures, such as regression models, analysis of variance and graphical presentations
- apply and demonstrate the use of eco-hydrological models for river basin water resources management and scenario simulations
- be able to quantify measures for reducing greenhouse gas emissions from agriculture and forestry with respect to efficiency, including the accounting of possible side effects on the environment and ecosystem services
- apply tools and statistical analysis for GIS-based geospatial data handling relating to geospatial ecology and environmental geography

Competences

- collect, handle and analyse datasets at small to large spatial and temporal (time) scales, in relation to describing and understanding river basin dynamics, geospatial ecology and global changes.
- asses, discuss and propose how various management scenarios may influence water resources and water quality.
- describe and discuss measures for adapting managed and natural ecosystems to climate change and describe the possible consequences of such measures.
- asses and discuss the methodological approaches used in GIS-based geospatial data handling, modelling as well as spatial statistical analysis.

EXAMINATION

The exam is a 3-hour written multiple choice exam with 40 questions of equal weight.

No aids. Only calculator is allowed at the exam.

RE-EXAMINATION

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

GRADING

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

Integrated Water Management and Legislation (Module 4)

15 ECTS

CONTENT

The objectives of the module are to:

- train the students to be skilled in how external nutrient reduction affects streams, lakes and reservoirs in different climate zones.
- provide a basic understanding of physico-chemical and biological restoration methods for streams and lakes/reservoirs.
- understand basic concepts of crop water relations, water productivity and strategies for efficient water and nutrients (mainly N and P) management in agro-ecosystems.
- provide an overview and understanding of water legislation, policy and planning in China and the EU.
- provide a basic understanding of urban water systems, and how nature-based approaches to current freshwater challenges may contribute to climate resilience and sustainable urban development.

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

Freshwater Ecosystem Management

- Basic introduction to the effects of reduction in nutrient loading to streams, lakes and reservoirs in different climate zones. Included are the effect on nitrogen and phosphorus cycling and retention; response of primary producers and consumers, water quality issues.
- Basic introduction to physico-chemical and biological lake/reservoir restoration methods, including methods that reduce internal loading in lakes/reservoirs and reinforces a shift to a clear-water state (biomanipulation).
- Basic introduction to stream restoration methods, including effects of re-meandering stream, that improve the physical variations in streams and reduce plant harvesting.

Agricultural Water and Nutrients Management

- Water dynamics in the soil-plant-atmosphere continuum (SPAC).
- Water balance in the field, crop water productivity and irrigation strategies.
- Plant nutrition functions, plant nutrient deficiency diagnosis.
- Soil fertility concepts, turnover of N and P in soil and effect on plant nutrient availability.
- Fertilization strategies and farming systems, methods to improve nutrient use efficiency, reduce N and P losses, improve crop yield and quality.
- Modelling water, N and P dynamics in the soil-plant systems and losses to the environment.

Water Legislation and Policy

- General introduction to water legislation in China and the EU
The challenge of sustainable management – why do we need to regulate the use of resources?
The institutional set-up and main pieces of water legislation in China as part of the evolving national water policy with a particular view to water quality
The institutional set-up in the EU and the main elements of EU water policy and legislation with a particular focus on the EU Water Framework Directive and integrated water resource management

- Water Policy and Implementation
Policy instruments in general: Command-and-control-regulation, economic instruments, information/voluntary instruments. Pros and cons.
Implementation. Potential difficulties in fulfilling policy aims; potential obstacles during the implementation process – for instance at target group level and organisational level?
Water policy instruments– lessons from Europe. Primary focus will be on European experiences with economic policy instruments in water (currently analysed in a European Union research project called 'EPI Water'). Evaluation of environmental policies.
- Water Planning
Spatial planning principles and water management.
Top-down and bottom-up approaches in water management.
Management challenges in common-pool resources (such as water).
Comprehensive cross-sectorial planning - policy integration in relation to water management.

Urban Water Management

- General introduction of urban water systems, challenges and trends in solutions, including water supply and treatment systems, urban drainage and conventional stormwater management.
- Stormwater quantity conveyance, detention and retention; stormwater quality, control and re-use options.
- Ecosystem services; non-conventional stormwater management; aquatic ecological restoration in inland urban lakes.
- General introduction on what a city is, urban development and how to manage transitions towards sustainable development.

The teachings of all sub-modules comprise lectures, theoretical exercises and project work in combination with visits/tours to ongoing projects on urban water and agricultural water and nutrients management. The topics of the theoretical exercises run in parallel with the topics presented in the lectures. Each project is done in groups of students and is presented as a report and an oral presentation.

LEARNING OBJECTIVES

Following the successful completion of the course, the students will be able to describe, structure, explain, integrate, apply and critically evaluate:

- how lakes/reservoirs and streams respond to nutrient loading reduction in different climate zones.
- methods applied for reducing the nutrient loading to surface.
- waters including the fate of nutrients.
- methods that can be used to speed up recovery of lakes/reservoirs and to improve ecosystem quality of lakes and streams.
- summarise, explain, analyse, critically discuss, and generalise based on primary literature (scientific papers) in the field.
- describe, explain, integrate relevant environmental data from restoration and management case studies, as well as critically discuss limitations.
- understand the basic concepts of crop water relations and water dynamics in the soil-plant-atmosphere continuum.
- analyse crop water productivity and to evaluate water-saving irrigation strategies.
- describe the biological and chemical processes affecting plant availability of N and P in fertilisers, manures and other soil amendments used in agriculture.
- describe crop nutritional physiology, nutrient function and the effects of fertilization and soil fertility management on crop yield and quality and losses to the environment.

- understand and explain the main legal principles governing the management of water resources in their own jurisdictions and make some comparisons with other jurisdictions in both China and the European Union.
- identify relevant legal, policy and planning mechanisms in water management and use relevant materials in problem-solving.
- comment critically on the legislation, policy and plans relevant to a particular problem of water resources management that was the focus of the assignment, e.g. by comparing law and policy with the experiences in the European Union.
- analyse urban water systems and their current challenges based on literature, open source data and interviews, including urban water supply and storm water management systems, urban water quality and treatment technologies.
- understand urban water management and urban development, including the role of green infrastructure and green technologies, and apply this knowledge for suggesting environment friendly solutions for urban water issues.
- understand the concept of urban ecosystem services, and apply it to assess the conventional water systems versus potential alternative water systems.

EXAMINATION

The exam comprises

- two assignments during the course, where each assignment will account for 15% of the grade
- a written 3- hour examination which accounts for 70 % of the grade. No aids allowed

The two assignments are group assignments with individual oral presentation and questions. Each group consists of 3-4 members, and the topics are fixed. 2-4 standard pages.

Beside these two assignments, a third assignment has to be completed and submitted as a pre-requisite for taking the written examination.

The written examination is a 3-hour written presence examination based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the full module.

No aid is allowed.

RE-EXAMINATION

The re-exam is a 4-hour written presence examination based on short questions related to the learning objectives, requiring short text answers and/or calculations. The questions cover the full module.

No aid is allowed.

GRADING

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