AALBORG UNIVERSITET

Semester Description of Study Programme at Aalborg University

Semester description for 2nd semester, Master in Biomedical Engineering and Informatics, Spring 2019

Semester details
School of Medicine and Health
Study board for Health, Technology and Sports Science
Curriculum for the Master´s program in Biomedical Engineering and Informatics

Semester framework theme
This should include an elaborated description in a prose form of the focus of the semester, activities implemented to fulfil the competence objectives and the thematic(s) of the semester. In other words, the semester description includes the "framework theme" that the students will be exposed to during the semester. The role of the semester and its contribution to students' academic progression should also be described.

The 2nd semester on the Master in Biomedical Engineering and Informatics will focus on biomedical topics with a clear scientific and clinical relevance. The understanding of biomedical signals and information will be addressed in a clinical relevant context using modeling methods and/or biomedical system design and development methods. The students will acquire competencies in planning and carrying out a research project within the scope of the semester theme – Biomedical (information) systems.

Semester organisation and time schedule
This must be a short description the of the different activities of the semester, their mutual connections and the way in which they support each other and also support students in reaching their goals; such activities may be study trips, internship periods, project modules course modules, including laboratory activities, cooperation with external stakeholders, possible cross-disciplinary cooperation relations, any guest lectures and other events.

Activities on this semester include a 15 ECTS project and three elective 5 ECTS courses, totaling 30 ECTS.

The 15 ECTS project is carried out in groups of 4 students. Two weeks before semester start, project proposals are made available to the students in Moodle. On the day of semester start the semester coordinator will give a welcome and an introduction to the semester. This is followed by course presentations by the course lecturers (course responsible) and by presentations of the project proposals by their proposers. The students must then form groups of 4, primarily based on their project preference. The semester coordinator will support the group formation process.

Three elective courses (5 ECTS each) must be selected from a total of 5 available courses (described below). Focus of these courses are within physiological and information modeling, (advanced) signal and image processing, and new health care technology. The courses will introduce new methods, frameworks and technology that are particularly relevant for the project on this semester and generally relevant for the two final semesters. The three courses must be elected on the first day of the semester as part of group formation process.

Two semester group meetings are scheduled – one in February and one in March. At the meetings, the students will receive relevant information and provide feedback to the semester coordinator on courses and projects. The semester coordinator and the semester secretary are present at the meetings. Course responsible and supervisors may attend.

A status seminar is planned halfway through the semester – please refer to the Study board policy.
Dates for handing in the project and for exams will become available in the beginning of the semester.

Semester coordinator and secretariat assistance
Names of anchor person (teaching staff), course coordinator, semester coordinator (or similar title) and secretariat assistance provider(s).

Semester coordinator: Lars Pilegaard Thomsen, lpt@hst.aau.dk, Department of Health Science and Technology
Semester secretary: Melanie Rosendahl, rosendahl@hst.aau.dk, School of Medicine and Health
Student representative: Please check semester details on Moodle.

Module description (description of each module)

Module title, ECTS credits (and possibly STADS code)
Biomedical (information) systems / Medicotekniske (informations) systemer
15 ECTS project module

Location
Master, Biomedical Engineering and Informatics, 2nd semester
Study board for Health, Technology and Sports Science

Module coordinator
The academic staff member responsible for the organisation and execution of the module.
The module leader may be the same person as the semester coordinator. If a person responsible for exam is pointed out, please state name and e-mail address here.

Semester coordinator: Lars Pilegaard Thomsen, lpt@hst.aau.dk, Dept. of Health Science and Technology

Type and language
Module type (e.g. study subject module, course module, project module etc.)
Language of instruction.

Project module. All communication/instructions on this semester will be in English. In the presence of non-Danish-speaking members of a project group, the project report is written in English. The report can take the form of either a monograph or a scientific paper with additional work sheets.

Objectives
Description of the content and objectives of the course as regards learning objectives of the students in the module. This comprises a transcript of the knowledge, skills and competences described in the study regulations and curriculum. Reference can be made to elaborations on semester Moodle site.

From Curriculum:

To learn to apply and evaluate scientific methods in modelling and/or design of biomedical systems or clinical information systems based on a realistic clinical or scientific problem.

Students who complete the module:

Knowledge
- have gained knowledge of at least one of the areas: Signal processing and image analysis, Pattern recognition and decision support, Clinical information systems, Sensory-motor control and rehabilitation systems, and Physiologic modeling
- understand knowledge within the selected area(s) and is able to reflect on a scientific basis on this knowledge

Skills
- are able to independently plan and carry out a research study on basis of a given problem
- are able to apply scientific methods and tools to research within the chosen area of knowledge
- are able to choose scientific theories and methods within the chosen area of research
- are able to communicate problems, methods and results within the scientific area, in writing
- are able to discuss professional and scientific problems with peers

Competences
- are able to function in a project with a high level of complexity and which requires new solutions
- are able to take responsibility for their own professional development

Academic content and conjunction with other modules/semesters
A brief and general description of the academic content of the module as well as the basis and motivation for the module; i.e. a brief review of the content and foundation of the module.
The intention is to provide students with an overview of each module and to create understanding of the module in relation to the semester and the entire programme.

The project can contain collection of empirical data and execution of experiments with humans and will typically incorporate modeling methods, advanced processing and/or system design and development.

Scope and expected performance
The expected scope of the module in terms of ECTS load. This comprises number of teaching hours, exercises, preparation time, travel activity (if applicable) etc.

The expected student work load is 15 ECTS corresponding to 450 hours of work per student. This includes all aspects of project work including supervisor meetings, literature reading, experimental work, data analysis, report writing, preparation of project presentation.

Participants
Indication of the participants in the module, particularly if they include several year groups, programmes or another type of co-teaching.

Participants are students in the 2nd semester Master in Biomedical Engineering and Informatics.

Prerequisites for participation
Description of the prerequisites for students' participation in the course, i.e. previous modules/courses in other semesters etc. The overall intention is to emphasize the coherence of the programme. This may be a transcript of the text in the study regulations and curriculum.

The participants must actively participate in the 1st semester Master in Biomedical Engineering and Informatics according to the curriculum.

Module activities (course sessions etc.)

Supervisors for this project module are from the Department of Health Science and Technology (HST). Co-supervisors may come from other departments, institutions, hospitals and companies. In their supervision, besides a strong focus on fulfilment of the learning goals from the curriculum, supervisors are expected to encourage a discussion with the students regarding their forthcoming exams.

The students are expected to work in close collaboration with their project supervisor. Any projects matters related to confidentiality, IP, ethics, legal issues, etc. must be respected by both students and supervisor. Please attend to the information made available by the study board regarding confidentiality, found here (only in Danish).

Examination

We refer to webpage concerning exams at www.smh.aau.dk. Please refer to point 4.2 in Examination Policies and Procedures and to the video on project exam.

Module description (description of each module)

Module title, ECTS credits (and possibly STADS code)
Elective 2a: Advanced signal processing / Avanceret signalbehandling
5 ECTS

Location
Master, Biomedical Engineering and Informatics, 2nd semester
Study board for Health, Technology and Sports Science

Module coordinator
The academic staff member responsible for the organisation and execution of the module.
The module leader may be the same person as the semester coordinator. If a person responsible for exam is pointed out, please state name and e-mail address here.

Johannes Jan Struijk, jjs@hst.aau.dk, Department of Health Science and Technology.

Type and language
Module type (e.g. study subject module, course module, project module etc.)
Language of instruction.

This is a course module and the language of the course is English.

Objectives
Description of the content and objectives of the course as regards learning objectives of the students in the module. This comprises a transcript of the knowledge, skills and competences described in the study regulations and curriculum. Reference can be made to elaborations on semester Moodle site.

From Curriculum:

Students who complete the module:

Knowledge
- have knowledge about different tools for joint-time-frequency analysis
- demonstrate understanding of the trade-off between time and frequency resolution in the analysis of a non-stationary signal
- can explain the relationships between time-frequency and wavelet analysis
- have knowledge about adaptive filtering and multivariate signal processing
- can identify different nonlinear tools that can be applied to analyse biomedical signals
- have knowledge about methods for estimation of features from biomedical signals

Skills
- can reflect on the choice of appropriate time-frequency distributions suitable to different biomedical problems
- can design wavelets for multi-resolution analysis of signals with specific biomedical applications such as filtering
- can evaluate appropriate adaptive filters suitable for the problem to solve
- can apply multivariate tools for classification and feature space reduction
- can analyse and describe nonlinear analysis methods
- can analyse and describe the frequency content of a biomedical signal with respect to time
- can handle de-noising of biomedical signals using various techniques such as wavelet and adaptive filters

Academic content and conjunction with other modules/semesters
A brief and general description of the academic content of the module as well as the basis and motivation for the module; i.e. a brief review of the content and foundation of the module.
The intention is to provide students with an overview of each module and to create understanding of the module in relation to the semester and the entire programme.

After a strong theoretical understanding of the principles behind different techniques applied for stochastic processes and especially for stationary signals in the first semester, this course on advanced signal processing provides analytical tools for analyzing non-stationary processes. The core element of the course is the combination of time and frequency analysis for biomedical signals. Furthermore, the course teaches the students the concepts of adaptive filters and multivariate analysis.

Scope and expected performance
The expected scope of the module in terms of ECTS load. This comprises number of teaching hours, exercises, preparation time, travel activity (if applicable) etc.

The course is 5 ECTS which approx. equals a student work load of 150 hours. The course will contain 10 lectures (2 hours) followed by exercises (2 hours) with assistance from the lecturer. There are additional two slots (8 hours) allocated in the timetable for the students to work on the mini-project. It is expected that the student will use approx. 62 hours on preparation for the lectures and exercises (without supervision) and approx. 32 hours for exam preparation (including finalizing the mini-project). During the mini-project, students are given biological signals to be analyzed and must write a short report.

Participants
Indication of the participants in the module, particularly if they include several year groups, programmes or another type of co-teaching.

This is an elective course for 2nd semester master program in Biomedical engineering and informatics. The number of participants varies from time to time.

Prerequisites for participation
Description of the prerequisites for students' participation in the course, i.e. previous modules/courses in other semesters etc. The overall intention is to emphasise the coherence of the programme. This may be a transcript of the text in the study regulations and curriculum.

A prerequisite for understanding this course is sufficient knowledge in basic signal processing and knowledge about Fourier transform. Although not mandatory, knowledge on stochastic processes and stationarity makes understanding this course easier.

Module activities (course sessions etc.)

Activity - type and title	Planned instructor*	Learning goals from Curriculum
3 Lectures and exercises activities covering the following topics : **Time-Frequency distributions:** • Short Time Fourier Transform • Wigner-Ville Distribution • Cohen's class time-frequency distributions • Other distributions	Federico Gabriel Arguissain	Have knowledge about different tools for joint-time-frequency analysis, Demonstrate understanding of the trade-off between time and frequency resolution in the analysis of a non-stationary signal, Have knowledge about methods for estimation of features from biomedical signals, Can reflect on the choice of appropriate time-frequency distributions suitable to different biomedical problems, Can analyze and describe the frequency content of a biomedical signal with respect to time,
3 Lectures and exercises activities covering the following topics : **Time-Scale Analysis:** • Lifting techniques. • Continuous and Discrete Wavelet transform	Johannes Jan Struijk	Have knowledge about methods for estimation of features from biomedical signals, Can explain the relationships between time-frequency and wavelet analysis, Can identify different nonlinear tools that can be applied to analyze biomedical signals,

• Filter bank and wavelet packets		Can design wavelets for multi-resolution analysis of signals with specific biomedical applications such as filtering, Can handle de-noising of biomedical signals using various techniques such as wavelet and adaptive filters.
2 Lectures and exercises activities covering the following topics : **Multivariate Analysis:** • Independent component analysis • Blind source separation	Susan Aliakbaryhosseinabadi	Have knowledge about adaptive filtering and multivariate signal processing, Can apply multivariate tools for classification and feature space reduction Can analyse and describe nonlinear analysis methods
2 Lectures and exercises activities covering the following topics : **Adaptive Filters:** • Estimation theory • Wiener Filter • Kalman Filters	Bo Geng	Have knowledge about adaptive filtering and multivariate signal processing, Can evaluate appropriate adaptive filters suitable for the problem to solve,
Mini-projects: Problem-based analysis of real biological signals. Self study (2 last slots)	Johannes Jan Struijk	Can reflect on the choice of appropriate time-frequency distributions suitable to different biomedical problems

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Examination Advanced signal processing / Avanceret signalbehandling

The exam is an individual oral exam. The total exam duration is 20 minutes including assessment. At the exam one examiner (course responsible) and an internal assessor (course teacher) will be present. Oral examination is chosen since topics of the module are conceptual and focus on biomedical applications and the student's understanding of how the advanced methods can be applied.

The examination starts with the student giving a five minutes presentation of the application of the methods used in the mini project followed by questions from the examiner. The last part of the exam is based on questions related to an additional learning outcome.

The student is allowed to bring notes.

We refer to webpage concerning exams at www.smh.aau.dk.

Module description (description of each module)

Module title, ECTS credits (and possibly STADS code)
Elective 2b: Image analysis and computer vision / Billedbehandling og computer vision
5 ECTS course module

Location
Master, Biomedical Engineering and Informatics, 2nd semester
Study board for Health, Technology and Sports Science

Module coordinator
The academic staff member responsible for the organisation and execution of the module.
The module leader may be the same person as the semester coordinator. If a person responsible for exam is pointed out, please state name and e-mail address here.

Maciej Plocharski, mpl@hst.aau.dk, Department of Health Science and Technology.

Type and language
Module type (e.g. study subject module, course module, project module etc.)
Language of instruction.

Course module in English.

Objectives
Description of the content and objectives of the course as regards learning objectives of the students in the module. This comprises a transcript of the knowledge, skills and competences described in the study regulations and curriculum. Reference can be made to elaborations on semester Moodle site.

From Curriculum:

Students who complete the module:

Knowledge
- have knowledge of basic and advanced image analysis and computer vision methods and concepts
- have knowledge of data driven and model based techniques for analysis of 2D or 3D image data
- have knowledge of optical and tomographic imaging geometry
- have knowledge of linear and non-linear techniques for solving inter-subject and intra-subject image registration problems
- have knowledge of geometrical representation of objects in 2D and 3D derived from image data
- have knowledge of statistical and morphological image processing have knowledge of multi-scale techniques

Skills
- are able to apply image analysis and computer vision methods to extract information from the original image data
- are able to apply intensity transformations and image filtering in the spatial and frequency domain
- are able to detect fundamental image features from image data
- are able to apply basic 2D and 3D image segmentation methods
- can solve linear image registration problems

Competences
- are able to demonstrate understanding of the concepts, theories and techniques in the area of image analysis and computer vision
- are able to apply methods on medical image data to extract quantitative and qualitative anatomical and physiological information

Academic content and conjunction with other modules/semesters
A brief and general description of the academic content of the module as well as the basis and motivation for the module; i.e. a brief review of the content and foundation of the module.
The intention is to provide students with an overview of each module and to create understanding of the module in relation to the semester and the entire programme.

The course has a signal processing foundation and extends to image processing and computer vision.
The focus of the course is to provide the students with strong theoretical understanding of the principles, concepts and theories behind various techniques applied for processing of medical images. Furthermore, the students will learn to apply these methods on the medical image data to extract quantitative and qualitative anatomical and physiological information. MATLAB will be used as tool.

Scope and expected performance
The expected scope of the module in terms of ECTS load. This comprises number of teaching hours, exercises, preparation time, travel activity (if applicable) etc.

The course is 5 ECTS which approx. equals an ordinary student work load of 150 hours. The course will contain 11 lectures (2 hours) followed by exercises (2 hours). It is expected that the student will use approx. 75 hours on preparation for the lectures and the following exercises and approx. 31 hours for exam preparation.

Participants
Indication of the participants in the module, particularly if they include several year groups, programmes or another type of co-teaching.

2nd semester students from MSc in Biomedical Engineering and Informatics.

Prerequisites for participation
Description of the prerequisites for students' participation in the course, i.e. previous modules/courses in other semesters etc. The overall intention is to emphasise the coherence of the programme. This may be a transcript of the text in the study regulations and curriculum.

Participation in Digital Signal Processing on 4th semester and in Physics and Clinical Technology on 5th BSc in Biomedical Engineering and Informatics.

Module activities (course sessions etc.)

Activity - type and title	**Planned instructor***	**Learning goals from curriculum**
6 lectures and exercises: • Digital image fundamentals • Intensity transformations and spatial filtering • Edge detection • Image segmentation • Morphological image processing • Blob detection & representation and description	Maciej Plocharski	• have knowledge of basic and advanced image analysis and computer vision methods and concepts • have knowledge of multi-scale techniques • are able to apply image analysis and computer vision methods to extract information from the original image data • are able to apply intensity transformations and image filtering in the spatial and frequency domain • are able to detect fundamental image features from image data • are able to demonstrate understanding of the concepts, theories and techniques in the area of image analysis and computer vision • are able to apply methods on medical image data to extract quantitative and qualitative anatomical and physiological information • have knowledge of statistical and morphological image processing • have knowledge of geometrical representation of objects in 2D and 3D derived from image data

5 lectures and exercises: • Texture analysis and scale space theory • Energy-based segmentation • Image registration and atlas-based segmentation • Model-based segmentation • Object tracking	Alex Skovsbo Jørgensen	• are able to apply basic 2D and 3D image segmentation methods • have knowledge of linear and non-linear techniques for solving inter-subject and intra-subject image registration problems • have knowledge of optical and tomographic imaging geometry • can solve linear image registration problems • have knowledge of data driven and model-based techniques for analysis of 2D and 3D image data-

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Examination in Image analysis and computer vision

The exam is oral.

Both the examiner responsible for the module and an internal assessor are present during the exam. The aim of the oral exam is to verify if the student is able to demonstrate a knowledge and understanding of the basic as well as advanced principles, concepts, and techniques of the curriculum. Each student randomly selects one topic related to the curriculum and starts the examination with a short presentation, followed by supplementary questions from one or both examiners. The student must demonstrate an understanding of the image analysis methods when applied to practical cases, which is addressed during the exercise-sessions in the course module.

Students are examined individually; the exam lasts maximum 20 minutes, which includes the assessment of the student's performance. There is no preparation time, and the students receive the assessment at the end of the examination. Students are allowed to bring their notes on paper for the exam.

We refer to webpage concerning exams at www.smh.aau.dk.

Module description (description of each module)

Module title, ECTS credits (and possibly STADS code)
Elective 2c: Methods and models in clinical information systems / Metoder og modeller i kliniske informationssystemer
5 ECTS course module

Location
Master, Biomedical Engineering and Informatics, 2nd semester
Study board for Health, Technology and Sports Science

Module coordinator
The academic staff member responsible for the organisation and execution of the module.
The module leader may be the same person as the semester coordinator. If a person responsible for exam is pointed out, please state name and e-mail address here.

Kirstine Rosenbeck Gøeg, kirse@hst.aau.dk, Department of Health Science and Technology,

Type and language
Module type (e.g. study subject module, course module, project module etc.)
Language of instruction.

Material and lectures in English, assignments can be handed in in either Danish or English.

Objectives
Description of the content and objectives of the course as regards learning objectives of the students in the module. This comprises a transcript of the knowledge, skills and competences described in the study regulations and curriculum. Reference can be made to elaborations on semester Moodle site.

From Curriculum:

Students who complete the module:

Knowledge
- have knowledge of different types of methods for Information System development (i.e., agile development)
- understand health care system architectures based on message communication and networks
- have knowledge on alternative types of architectural models with specific focus on models and system integration applied in health care
- understand different types of databases and the design of relational databases (including local, distributed, heterogeneous or homogenous databases)
- have knowledge of security, privacy and legislation in health care affecting information system development
- understand performance in clinical information systems

Skills
- can apply appropriate methods in information system development
- can select appropriate architecture for a given context
- can analyse performance issues arising from chosen architectures, databases, and security in health care
- can design a relational database based on a given context and be able to generate queries

Competences
- can evaluate the most appropriate methods and models to design an information system in a given health context

Academic content and conjunction with other modules/semesters
A brief and general description of the academic content of the module as well as the basis and motivation for the module; i.e. a brief review of the content and foundation of the module.
The intention is to provide students with an overview of each module and to create understanding of the module in relation to the semester and the entire programme.

The course, Methods and models in clinical information systems aim to provide the students with an overview of and experience with methods for performing requirement collection, development and evaluation related to clinical information systems. In addition, different state-of-the-art architectural approaches used in health are presented, and the students gain experience in modelling in the context of these different paradigms. This insight forms the basis for achieving the competence of choosing appropriate methods and models for different health context and technical environments.

The course requires basic knowledge about clinical information systems and relation database design. The course gives the foundational knowledge needed to do clinical information system related projects where models and architectures are in focus. Synergy can be achieved when combining with the knowledge of the course "Semantics of clinical information systems", because they together comprise the main challenges of clinical information system research, and the proposed state-of-the art solutions.

Scope and expected performance
The expected scope of the module in terms of ECTS load. This comprises number of teaching hours, exercises, preparation time, travel activity (if applicable) etc.

The course is organized as a mix of theoretical lectures and activity-based lectures (workshop). The course is a 5 ECTS course equivalent to app 150 working hours distributed on 14 confrontations of various kind (lectures, active learning activities, workshops, student presentations). The workload is distributed among the following activities (times are approximated):

- In class activities. 56 hours
  - Lectures and active learning activities including student presentations: 32 hours
  - Workshop: 24 hours
- Student preparation time. 54 hours
  - Readings before lectures: 14x2 hours = 28 hours
  - Preparing written assignments, finishing workshop related work, preparing presentations: 26 hours
- Exam and exam preparation: 40 hours

Participants
Indication of the participants in the module, particularly if they include several year groups, programmes or another type of co-teaching.

Elective course for students at: Master, Biomedical Engineering and Informatics, 2nd semester

Prerequisites for participation
Description of the prerequisites for students' participation in the course, i.e. previous modules/courses in other semesters etc. The overall intention is to emphasise the coherence of the programme. This may be a transcript of the text in the study regulations and curriculum.

The course requires basic knowledge about clinical information systems and relation database design.

Module activities (course sessions etc.)

In the Methods and models course, tree types of activity types are applied:
Lectures: Which are 30-45min presentations including questions from the students

Active learning activities in class: Different activities in class that are closely monitored and instructed. E.g. an exercise demonstrating the efficiency of SCRUM as a system development method or a vision and roadmap session where the students must prioritize, plan and present a health care IT solution in an accelerated process.

Workshop: The workshop consists of students solving a larger assignment that runs through most of the course. The students must develop different IT artefacts for a well-defined health context. The assignment has a written instruction, which is handed out in the beginning of the course, and it is monitored by the instructors mostly in oral discussions or presentations by students to align with the oral exam.

Student preparation time is not explicitly stated in the following plan, but it must be expected before and sometimes after each of the course activities.

Activity - type and title	**Planned instructor***	**Learning goals from curriculum**
Theme one: Requirement for clinical information systems in health care and research. Focus on: Methods for ensuring a clear contribution of medical informatics research Methods for requirement collection in real health care settings (2 lectures, 2 hours of active learning, 4 hours of workshop)	Kirstine Rosenbeck Gøeg	have knowledge of different types of methods for Information System development have knowledge of security, privacy and legislation in health care affecting information system development can apply appropriate methods in information system development
Theme two: Modeling for health care Focus on: Modelling for heterogeneous system landscapes: Networks and distributed systems (2 lectures and 2 hours of workshop) Modelling for big data use cases. Data warehouses using dimensional modelling and noSQL (2 lectures, 4 hours of active learning, 6 hours' workshop) Modelling for semantic interoperability: State-of-the-art standardized Two-level modelling and terminology binding (2 lectures, 2 hours' workshop) Modelling for securing privacy of health information: State-of-the-art secure architectures (2 lectures, 2 hours workshop)	Kirstine Rosenbeck Gøeg and Mark Hummeluhr Christensen	understand health care system architectures based on message communication and networks have knowledge on alternative types of architectural models with specific focus on models and system integration applied in health care understand different types of databases and the design of relational databases (including local, distributed, heterogeneous or homogenous databases) understand performance in clinical information systems can select appropriate architecture for a given context can analyse performance issues arising from chosen architectures, databases, and security in health care can design a relational database based on a given context and be able to generate queries can evaluate the most appropriate methods and models to design an information system in a given health context

Appropriateness of models: (4 hours workshop and 2 hours student presentations to conclude the theme)		
Theme three: Methods for system development in safety-critical domains Methods for managing system and architecture development processes (1 lecture, 3 hours active learning) Methods for evaluating system design (1 lecture, 3 hours active learning)	Kirstine Rosenbeck Gøeg and Mark Hummeluhr Christensen	have knowledge of different types of methods for Information System development can apply appropriate methods in information system development can evaluate the most appropriate methods and models to design an information system in a given health context
Course conclusion: Visions and roadmaps for better e-health (4 hours active learning)	Kirstine Rosenbeck Gøeg	can evaluate the most appropriate methods and models to design an information system in a given health context

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Examination in Methods and models in clinical information systems

The exam is oral, and is partially based on the workshop assignment, in such a way that taking the exam without doing the workshop related work is possible yet difficult. The students receive feedback on their workshop assignment during the course.

At the exam, the student will draw a known exam question. Each will have two parts, so that they are related to the methods and models part of the course respectively. In addition, each question will ask about the application of one of the methods or models presented in class. As such the questions evaluate both the knowledge intended learning outcomes (ILOs) and skill ILOs. The students will elaborate on the answer without further preparation time for 3-5 minutes per question. After each answer, the exam responsible ask detailed and supplementary questions whenever necessary to evaluate the ILOs of the course. The students are prepared for this beforehand because they have had presentation and feedback rounds in class, and they know that method and design choices are in focus. The exam responsible is especially aware of the reasons for method and design choices when listening to the presentation and asking questions, because this is an important Competence-ILO in the course.

Each exam will take 20 minutes including evaluation. The student can choose either Danish or English as exam language. Present during examination, is the student, and internal censor and an instructor from the course (module coordinator).

We refer to webpage concerning exams at www.smh.aau.dk.

Module description (description of each module)

Module title, ECTS credits (and possibly STADS code)
Elective 2d: Rehabilitation and Assistive Technology / Rehabilitering og velfærdsteknologi
5 ECTS course module

Location
Master, Biomedical Engineering and Informatics, 2nd semester
Study board for Health, Technology and Sports Science

Module coordinator
The academic staff member responsible for the organisation and execution of the module.
The module leader may be the same person as the semester coordinator. If a person responsible for exam is pointed out, please state name and e-mail address here.

Federico G. Arguissain, fga@hst.aau.dk, Department of Health Science and Technology.

Type and language
Module type (e.g. study subject module, course module, project module etc.)
Language of instruction.

This course module is given in English.

Objectives
Description of the content and objectives of the course as regards learning objectives of the students in the module. This comprises a transcript of the knowledge, skills and competences described in the study regulations and curriculum. Reference can be made to elaborations on semester Moodle site.

From Curriculum:

Students who complete the module:

Knowledge
- know how disease in the sensorimotor system affects normal movement patterns and other functions of vital importance
- know the effect of aging on the human body (cognitive and sensorimotor aspects)
- know how mental diseases related to aging or injury influence the functionality of the sensory-motor system
- know ergonomics and rehabilitation in relation to the optimization of human performance and for the prevention/rehabilitation of neuro-musculoskeletal injuries and diseases
- know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision
- know cognitive rehabilitation technologies, e.g. rehabilitation of dementia, neglect related to apoplexy, aids for communication
- know technologies for communication between the patient and equipment/tools/surroundings, this includes brain-, tongue-, and eye-computer interfaces
- know the integration of assistive technologies in homes/institutions,
- know ethical aspects in relation to assistive technologies

Skills
- are able to apply knowledge about the functional effects of diseases for the choice of optimal rehabilitation and assistive technologies
- are able to apply knowledge about the effects of aging/injury in order to identify relevant assistive technologies

Competences
- are able to evaluate ergonomics and rehabilitation perspectives using relevant technologies
- are able to evaluate the potential of (new) technologies for their relevance as rehabilitation and assistive devices

- are able to advice people in the health care systems about possibilities in rehabilitation and assistive technologies

Academic content and conjunction with other modules/semesters
A brief and general description of the academic content of the module as well as the basis and motivation for the module; i.e. a brief review of the content and foundation of the module.
The intention is to provide students with an overview of each module and to create understanding of the module in relation to the semester and the entire programme.

Through lectures, lab tours and workshops, this course will provide the student with knowledge and skills within rehabilitation and assistive devices. The student will obtain knowledge of how cognitive and sensory-motor diseases affect an individual and how technology can be used to rehabilitate and assist disabled individuals. The addressed diseases are some of the most frequent and invalidating diseases in the nervous and muscular systems. The technologies addressed in this course range from technologies at research level to technologies currently implemented in the healthcare system.

The course addresses knowledge of basic physiopathology, with a special focus on how this knowledge can be applied to select optimal rehabilitation and assistive technologies. The course *Sensory-motor Control* of 1st semester Master is recommended.

Scope and expected performance
The expected scope of the module in terms of ECTS load. This comprises number of teaching hours, exercises, preparation time, travel activity (if applicable) etc.

The course consists of 150 hours of work and has 14 instances, organized as twenty-three 45-min lectures, three four-hours workshops focused on casework, and two four-hours lab tours. It is expected that the student will use approx. 78 hours on preparation for the lectures and workshops and approx. 35 hours for exam preparation.

Participants
Indication of the participants in the module, particularly if they include several year groups, programmes or another type of co-teaching.

Elective course for students at: Master, Biomedical Engineering and Informatics, 2nd semester

Prerequisites for participation
Description of the prerequisites for students' participation in the course, i.e. previous modules/courses in other semesters etc. The overall intention is to emphasise the coherence of the programme. This may be a transcript of the text in the study regulations and curriculum.

1.d Sensory-motor Control is recommended.

Module activities (course sessions etc.)
Three types of activities are included in the module:

- Lectures: 45-min oral presentations given by a lecturer.
- Lab Tour: a four hour activity in which the students visit the laboratories and get hands on with rehabilitation and assistive technologies. The students will get the chance to use and evaluate the presented technologies.
- Workshop: an four houractivity in which the students, in groups, will be presented with a possible scenario (*case*) that involves a disease / disability. The student groups will have to apply the acquired knowledge about the particular disease / disability to choose an optimal rehabilitation / assistive technology. The student groups will have to make a presentation about their case, in which they will have to argue about their selection criteria, the potential of the chosen technology, etc. After the presentation, they will be provided with feedback.

The structure of the module, including the different activities and the relation to achieving the learning goals will be presented and discussed in detail in the first introduction lecture. Likewise, the exam form and content, together with examples of exercises, will also be addressed.

Activity - type and title	Planned instructor*	Learning goals from Curriculum
Lecture: Introduction to rehabilitation and assistive technology. Demography, ethical aspects in relation to assistive technologies. (1x45 min)	Federico G. Arguissain	• know how disease in the sensorimotor system affects normal movement patterns and other functions of vital importance • know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision • know ethical aspects in relation to assistive technologies
Lecture: robotic prostheses - mechatronics (2x45 min)	Strahinja Dosen	• know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision
Lecture: robotic prostheses – control (2x45 min)	Strahinja Dosen	
Lecture: the cognitive and sensorimotor aspects of aging (1x45 min)	Erika G. Spaich	• know the effect of aging on the human body (cognitive and sensorimotor aspects) • know how mental diseases related to aging or injury influence the functionality of the sensory-motor system
Lecture:tele home-care (2x45 min)	Birthe I. Dinesen	• know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision, • know the integration of assistive technologies in homes/institutions
Lecture: Smart house technology. The integration of assistive technologies in homes/institutions (2x45 min)	Birthe I. Dinesen	
Lecture: cognitive disorders and their rehabilitation (1x45 min)	Federico G. Arguissain	• know cognitive rehabilitation technologies, e.g. rehabilitation of dementia, neglect related to apoplexy, aids for communication • know technologies for communication between the patient and equipment/tools/surroundings, this includes brain-, tongue-, and eye-computer interfaces
Lecture: technologies for communication between the disabled and equipment/tools/surroundings. This includes brain-, tongue-, and eye-computer interfaces. (1x45 min)	Lotte N. S. Andreasen Struijk	
Lecture: rehabilitation through robotics, computer technology and virtual reality systems (2x45 min)	Lotte N. S. Andreasen Struijk	• know cognitive rehabilitation technologies, e.g. rehabilitation of dementia, neglect related to apoplexy, aids for communication • know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision

Lecture: damage of the central nervous system – consequences and rehabilitation (1x45 min)	Erika G. Spaich	• know how disease in the sensorimotor system affects normal movement patterns and other functions of vital importance • know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision
Lecture: functional neuromuscular stimulation for spinal cord injured and brain-injured patients (2x45 min)	Erika G. Spaich	
Lecture: rehabilitation of the auditory and visual functions (2x45 min)	Afshin Samani	• know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision

Lecture: a brief introduction to eye tracking and its application in cognitive loading and fatigue among computer users. (2x45 min)	Afshin Samani	• know ergonomics and rehabilitation in relation to the optimization of human performance and for the prevention/rehabilitation of neuro-musculoskeletal injuries and diseases • know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision
Lecture: prevention & rehabilitation of work-related neuro-musculoskeletal disorders (2x45 min)	Pascal Madeleine	
Lab tour	To be decided among the lecturers	• know existing devices and methods for rehabilitation and aid, e.g. functional electrical stimulation, robots, computer technologies (e.g. biofeedback, virtual reality, augmented reality), smart house technologies, tele-rehabilitation technologies, sensory rehabilitation technologies for hearing and vision • know rehabilitation technologies e.g, aids for communication • are able to evaluate ergonomics and rehabilitation perspectives using relevant technologies • are able to evaluate the potential of (new) technologies for their relevance as rehabilitation and assistive devices

Lab tour	To be decided among the lecturers	
Workshop (Case start)	Federico G. Arguissain	• are able to apply knowledge about the functional effects of diseases for the choice of optimal rehabilitation and assistive technologies • are able to apply knowledge about the effects of aging/injury in order to identify relevant assistive technologies • are able to evaluate ergonomics and rehabilitation perspectives using relevant technologies • are able to evaluate the potential of (new) technologies for their relevance as rehabilitation and assistive devices •
Workshop Students working on their case on their own (self-study). (4x45 min)		
Workshop (Case end) Students' presentation of their case.	Federico G. Arguissain Relevant lecturers for the different cases.	

* All rights reserved for changes during the semester due to e.g. illness, cancellations etc.

Examination in Rehabilitation and Assistive Technology

1. The exam is a written exam made available through the Digital Exam system (DE)
2. During the written exam the individual student must answer a number of questions to demonstrate ability to describe, argue and provide examples based on the knowledge, skills and competencies acquired during the course and related to all types of, but not all, learning outcomes.
3. The exam will consist of one question related to the case they worked with, plus a number of questions related to the learning outcomes in general.
4. The student must bring a personal computer.
5. The duration of the exam is 3 hours.
6. All aids are allowed, but access to internet and communication is not allowed.

We refer to webpage concerning exams at www.smh.aau.dk.

Module description (description of each module)

Module title, ECTS credits (and possibly STADS code)
Elective 2e: Physiologic modeling / Fysiologisk modellering
5 ECTS course module

Location
Master, Biomedical Engineering and Informatics, 2nd semester
Study board for Health, Technology and Sports Science

Module coordinator
The academic staff member responsible for the organisation and execution of the module.
The module leader may be the same person as the semester coordinator. If a person responsible for exam is pointed out, please state name and e-mail address here.

Lars Pilegaard Thomsen, lpt@hst.aau.dk, Department of Health Science and Technology.

Type and language
Module type (e.g. study subject module, course module, project module etc.)
Language of instruction.

Course module in English.

Objectives
Description of the content and objectives of the course as regards learning objectives of the students in the module. This comprises a transcript of the knowledge, skills and competences described in the study regulations and curriculum. Reference can be made to elaborations on semester Moodle site.

From Curriculum:

Students who complete the module:

Knowledge
have knowledge about:
- bioelectric models
- biochemical models
- biomechanical models

With the course both highlighting the similarity of mathematical representation across these type of models, and exemplifying these models with examples from various physiologic subsystems and therapeutic interventions including pharmacokinetics.

Skills
have obtained skills in relation to model construction, simulation, fitting and validation which includes:
- building of compartmental models
- a basic understanding of other model types including finite element modelling
- parameter estimation and numerical optimization
- identifiability and the appropriateness of model complexity
- evaluating the goodness of model fitting – model fitting statistics

Competences
- are able to integrate skills and knowledge from different scientific fields

Academic content and conjunction with other modules/semesters
A brief and general description of the academic content of the module as well as the basis and motivation for the module; i.e. a brief review of the content and foundation of the module.
The intention is to provide students with an overview of each module and to create understanding of the module in relation to the semester and the entire programme.

The course introduces basic and advanced concepts of modeling using examples from three important areas of physiological modeling; bioelectrical, biochemical, and biomechanical. The course provides the student with an overview of how models are constructed and validated and examples of application, using both research-oriented and commercially available models. Furthermore, the fundamental mathematical disciplines required for optimization of models and construction of finite element models will be presented as well as application of these methods within the three before mentioned areas.
MATLAB, COMSOL and AnyBody will be used as tools during exercises.

Scope and expected performance
The expected scope of the module in terms of ECTS load. This comprises number of teaching hours, exercises, preparation time, travel activity (if applicable) etc.

The course is 5 ECTS which approx. equals an ordinary student workload of 150 hours. The course will contain 13 lectures (2 hours) followed by exercises (2 hours). It is expected that the student will use approx. 68 hours on preparation for the lectures and exercises and approx. 30 hours for exam preparation. During the course work, preparation and exam preparation the students are expected to achieve the competence of being able to integrate skills and knowledge from different scientific fields.

Participants
Indication of the participants in the module, particularly if they include several year groups, programmes or another type of co-teaching.

2nd semester master students from Biomedical Engineering and Informatics.

Prerequisites for participation
Description of the prerequisites for students' participation in the course, i.e. previous modules/courses in other semesters etc. The overall intention is to emphasise the coherence of the programme. This may be a transcript of the text in the study regulations and curriculum.

Prerequisites: The course requires basic information on modeling and models in general.

Module activities (course sessions etc.)

Activity - type and title	Planned instructor*	Learning goals from curriculum
Lecture and exercise: Introduction to modeling	Lars P. Thomsen	• a basic understanding of other model types • building of compartmental models
Lecture and exercise: Basic modeling skills	Lars P. Thomsen	• identifiability and the appropriateness of model complexity • evaluating the goodness of model fitting – model fitting statistics
Lecture and exercise: Optimisation, part 1	Dan S. Karbing	• parameter estimation and numerical optimization
Lecture and exercise: Biochemical modeling, part 1	Lars P. Thomsen	• biochemical models
Lecture and exercise: Optimisation, part 2	Dan S. Karbing	• parameter estimation and numerical optimization
Lecture and exercise: Biochemical modeling, part 2	Lars P. Thomsen	• biochemical models

Lecture and exercise: Optimisation, part 3	Dan S. Karbing	• parameter estimation and numerical optimization
Lecture and exercise: Finite element, part 1	Carsten Dahl	• a basic understanding of other model types including finite element modelling •
Lecture and exercise: Biomechanical modelling, part 1	Mark de Zee	• biomechanical models
Lecture and exercise: Finite element, part 2	Carsten Dahl	• a basic understanding of other model types including finite element modelling
Lecture and exercise: Biomechanical modelling, part 2	Mark de Zee	• biomechanical models
Lecture and exercise: Bioelectrical modelling, part 1	Johannes Struijk	• bioelectric models
Lecture and exercise: Bioelectrical modelling, part 2	Johannes Struijk	• bioelectric models

* *All rights reserved for changes during the semester due to e.g. illness, cancellations etc.*

Examination in Physiologic modeling

The examination is a 20 min. individual oral exam, including assessment. Own notes are allowed. No preparation time.

The aim of the oral exam is to verify if the student is able to demonstrate the basic as well as advanced principles, concepts, and techniques of the intended learning outcomes.

The student receives a topic, from a set of topics that all relates to one or more lectures or exercises of the course. The topics reflect the portfolio of exercises handed in by the student. The student is asked to describe, discuss and reflect on the topic, with point of departure in their portfolio. Follow-up questions will be posed by the assessors to expose the student's knowledge, skills and competences regarding the learning goals. The student and two teachers (course responsible and internal assessor) will be present during the examination.

For further information, please refer to www.smh.aau.dk.