Curriculum for the 
Master of Science (MSc) in Engineering 
(Vision, graphics and 
interactive systems)

1st – 4th Semester

The Faculty of Engineering and Science 
Aalborg University

September 2011
Preface:
Pursuant to Act 695 of June 22, 2011 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's programme is stipulated. The programme also follows the Framework Provisions and the Examination Policies and Procedures for the Faculty of Engineering and Science and The Faculty of Medicine.

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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders
The Master’s programme is organized in accordance with the Ministry of Science, Technology and Innovation’s Ministerial Order no. 814 of June 29, 2010 on Bachelor’s and Master’s Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 857 of July 1, 2010 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 233 of March 24, 2011 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation
The Master’s programme falls under the Faculty of Engineering and Science, Aalborg University.

1.3 Board of Studies affiliation
The Master’s programme falls under the Board of Studies for Electronics and IT.

Chapter 2: Admission, Degree Designation, Programme Duration and Competence Profile

2.1 Admission
Admission to the Master’s programme requires a Bachelor’s degree or Bachelor of Engineering in Electronic Engineering and IT, Computer Engineering or the like.

Students with another Bachelor's degree, upon application to the Board of Studies, will be admitted after a specific academic assessment if the applicant is deemed to have comparable educational prerequisites. The University can stipulate requirements concerning conducting additional exams prior to the start of study.

2.2 Degree designation in Danish and English
The Master’s programme entitles the graduate to the designation civilingeniør, cand.polyt. (candidatus/candidata polytechnices) i vision, grafik og interaktive systemer. The English designation is: Master of Science (MSc) in Engineering (Vision, Graphics and Interactive Systems).

2.3 The programme's specification in ECTS credits
The Master’s programme is a 2-year, research-based, full-time study programme. The programme is set to 120 ECTS credits.

2.4 Competence profile on the diploma
The following competence profile will appear on the diploma:

A graduate of the Master’s programme has competencies acquired through an educational programme that has taken place in a research environment.

The graduate of the Master’s programme can perform highly qualified functions on the labour market on the basis of the educational programme. Moreover, the graduate has prerequisites for research (a Ph.D. programme). Compared to the Bachelor’s degree, the graduate of the Master’s programme has developed her/his academic knowledge and independence, so that the graduate can independently apply scientific theory and method in both an academic and occupational/professional context.
2.5 Competence profile of the programme:

The graduate of the Master’s programme:

Knowledge
- Has knowledge on an advanced level in computer vision, computer graphics and interactive systems based on the highest international research in these areas
- Can understand and, on a scientific basis, reflect over the aforementioned subject area’s key knowledge and can identify scientific problems and propose solutions within these
- Has a comprehensive knowledge of the core subjects for computer vision, such as image recognition, visual scene analysis, object tracking, etc.
- Has knowledge about methods for computer graphics, augmented reality, 3D rendering, etc.
- Has knowledge about interactive systems design, in particular multi modal user interaction and user experience design.
- Has knowledge about machine learning methods and techniques and pattern recognition
- Has knowledge of the theories and methods for realizing complex software systems for vision, graphic and interactive systems

Skills
- Excels in scientific methods, tools and general skills related to design, simulation, real-time implementation, test, evaluation, and documentation of systems within the fields of computer vision, graphics and user interaction
- can evaluate and select among the scientific theories, methods, tools and general skills within the fields of computer vision, graphics and user interaction and, on a scientific basis, advance new analyses and solutions
- can communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists
- Can apply methods and tools for solving complex problems within the aforementioned domains
- Can analyze and apply state-of-the-art methods in Computer Vision
- Can analyze and apply state-of-the-art methods in Computer Graphics
- Can apply user centered design methods to design, implement and test multimodal user interaction strategies

Competencies
- Can manage work and development situations that are complex, unpredictable and require new solutions.
- Can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility.
- Can independently take responsibility for own professional development and specialization
- Can analyze and apply appropriate theories and methods for computer vision problems within e.g. surveillance, robotics,
etc.

- Can select and apply appropriate methods for solving a given problem within computer vision, graphics and interactive systems and evaluate the results regarding their accuracy and validity
- Can identify scientific problems within control and auto computer vision, graphics and interactive systems and select and apply proper scientific theories, methods and tools for their solution
- Can develop and advance new analyses and solutions within computer vision, graphics and interactive systems
- Can take responsibility for own professional development and specialization.
- Work according to a scientific method and present results in the form of a scientific article and at a seminar/scientific conference
- Formulate and explain scientific hypotheses and results achieved through scientific work
- Analyze results and draw conclusions on a scientific basis

Chapter 3: Content and Organization of the Programme

The programme is structured in modules and organised as a problem-based study. A module is a programme element or a group of programme elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods. Examinations are defined in the curriculum.

The programme is based on a combination of academic, problem-oriented and interdisciplinary approaches and organised based on the following work and evaluation methods that combine skills and reflection:

- lectures
- classroom instruction
- project work
- workshops
- exercises (individually and in groups)
- teacher feedback
- reflection
- portfolio work
Overview of the programme:

All modules are assessed through individual grading according to the 7-point scale or Pass/Fail. All modules are assessed by external examination (external grading) or internal examination (internal grading or by assessment by the supervisor only).

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>ECTS</th>
<th>P/C *)</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Computer graphics</td>
<td>15</td>
<td>P</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>PBL and Computer graphics</td>
<td>15</td>
<td>P</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Computer graphics programming</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Machine learning</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>User experience design for multimodal interaction</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td>2nd</td>
<td>Computer vision</td>
<td>15</td>
<td>P</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td>Image processing and computer vision</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Robot vision</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Computer graphics and visualization (elective)</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Scientific computing and sensor modelling (elective)</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td>3rd</td>
<td>Interactive systems</td>
<td>20</td>
<td>P</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Platforms and methods for multimodal system architectures</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Stochastic processes (elective)</td>
<td>5</td>
<td>C</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Creative Innovation and Entrepreneurship (elective)</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Applied experimental psychology and psychophysics (elective)</td>
<td>5</td>
<td>C</td>
<td>Pass/Fail</td>
<td>Internal</td>
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<tr>
<td>4th</td>
<td>Master’s thesis</td>
<td>30, possibly 50</td>
<td>P</td>
<td>7-point scale</td>
<td>External</td>
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<tr>
<td>Total</td>
<td></td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) P = Project -  C = Course
Descriptions of modules

Computer Graphics (Focus on Scientific Communication) (P)
Computer grafik (fokus på videnskabelig kommunikation)

Prerequisites:
Competencies in Project-Oriented and Problem-Based Learning.

Objective:
The objective of this module is two-fold: 1) to provide students with core competencies within the area of real-time 3D computer graphics, enabling them to design and implement software systems that use synthetically generated images as output modality, and 2) to train students in working according to a scientific method and to report results in scientific forms, such as papers and posters.

Students who complete the module:

Knowledge
- Must be able to explain the various stages in a graphics rendering pipeline, including geometric primitives, geometric and projective transformations, local illumination models, and rasterization techniques.
- Must understand the scientific communication processes related to conference presentations and related to publishing in peer-reviewed scientific journals
- Must know how to organize a scientific publication

Skills
- Must be able to apply a graphics API such as OpenGL in the design and implementation of a system which uses real-time 3D computer graphics as an output modality in a user-interface, or a system which aims at developing a novel solution to a computer graphics related problem.
- Can explain the process of and criteria for peer reviewed scientific communications,
- Can write a paper for a scientific conference/journal
- Can prepare and give an oral and poster presentation for a scientific conference

Competencies
- Must be able to evaluate and select relevant computer graphics theories, methods, and tools, and synthesize them to produce new knowledge and solutions.
- Must be able to communicate and discuss research-based knowledge in the area of 3D computer graphics.
- Are able to judge and prioritize the validity of various sources of scientific information.
- Apply internationally recognized principles for acknowledging and citing work of others properly.
- Can formulate and explain scientific hypotheses and results achieved through scientific work
- Are able to analyze results and draw conclusions on a scientific basis
**Type of instruction:**
Students are organized in groups of up to six members working according to the POPBL concept at Aalborg University. Each group will be supervised by at least one staff member doing research within the main topic(s) addressed in the project.

On this semester the project has to be documented in the following forms (all in English):
- A scientific article
- An oral presentation
- A poster
- Edited worksheets, providing all relevant project details

For further information see the introduction to Chapter 3.

**Exam format:**
Individual oral examination based on written documentation including: a scientific article, slides from the oral presentation at the student conference (SEMCON), a poster and edited worksheets.

**Evaluation criteria:**
As stated in the Framework Provisions.
PBL and Computer Graphics (P)
PBL og computer grafik

Prerequisites:
None

Objective:
The objective of this module is two-fold: 1) to provide students with core competencies within the area of real-time 3D computer graphics, enabling them to design and implement software systems that use synthetically generated images as output modality, and 2) to train students in working according to the PBL concept at Aalborg University.

Students who complete the module:

Knowledge
- Must be able to explain the various stages in a graphics rendering pipeline, including geometric primitives, geometric and projective transformations, local illumination models, and rasterization techniques.
- Has knowledge of the phases that a project will go through
- Understand various theories and methods applied in problem based learning and group organized project work

Skills
- Must be able to apply a graphics API such as OpenGL in the design and implementation of a system which uses real-time 3D computer graphics as an output modality in a user-interface, or a system which aims at developing a novel solution to a computer graphics related problem.
- Are able to plan and take part in a small group of students working on a problem based project
- Can reflect on experiences obtained through problem based learning and group project work
- Can communicate the result of the project work in an appropriate form
- Are able to demonstrate skills in project management

Competencies
- Must be able to evaluate and select relevant computer graphics theories, methods, and tools, and synthesize them to produce new knowledge and solutions.
- Must be able to communicate and discuss research-based knowledge in the area of 3D computer graphics.
- Can organize and contribute to a team based project work
- Has competencies in project work and problem based learning in a global/multicultural environment
- Can manage work and development situations that are complex, unpredictable and require new solutions.
- Can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility.
- Can independently take responsibility for own professional development and specialization
- Can find, evaluate and reference literature within the professional field
- Apply internationally recognized principles for acknowledging and citing work of others properly.
Type of instruction:
Project work.

Exam format:
Individual oral examination based on a written report.

Evaluation criteria:
As stated in the Framework Provisions
Computer Graphics Programming (C)
Computergrafik programmering

Prerequisites:
Basic knowledge in linear algebra.

Objective:
The course provides an introduction to real-time computer graphics concepts and techniques. The course focuses on programmable functionalities as offered by graphics APIs, supplemented with a presentation of the relevant underlying theories. The course also introduces the concepts of Virtual Reality and Augmented Reality, and how computer graphics is used in the context of these application areas.

Students who complete the module:

Knowledge
- Must be able to describe the programmable graphics rendering pipeline as exposed for example by OpenGL.
- Must be able to explain relevant mathematical transformations, including rotations, translations and projections in terms of matrix operations in homogeneous coordinates.
- Must be able to explain real-time local illumination models, in particular the Phong reflection model, including the use of linearly interpolated attributes (colors and surface normals.)
- Must be able to explain rasterization techniques, including texture mapping (diffuse reflection maps, gloss maps, environment/reflection maps), framebuffer operations (blending, stencil tests, depth tests), and anti-aliasing techniques (super-sampling, mip-map texture filtering).
- Must be able to describe interpolation with Bezier and Hermite curves.
- Must be able to describe the concepts of Virtual Reality and Augmented Reality, including relevant display technologies.
- Must be able to discuss central issues relating to Virtual and Augmented Reality, including tracking, interaction possibilities, and degrees of realism.

Skills
- Must be able to apply a graphics API such as OpenGL for procedurally generating and interactively controlling three-dimensional content.
- Must be able to program simple vertex and fragment shaders (e.g. implementing per-vertex diffuse lighting and normal mapping)

Competencies
- Must be able to learn further graphics APIs (such as Direct3D, OpenGL ES, SVG, X3D, WebGL in HTML5), game engines and APIs for user interaction

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Machine Learning (C)
Maskin læring

Prerequisites:
Basic knowledge in probability theory, statistics, and linear algebra.

Objective:
The course gives a comprehensive introduction to machine learning, which is a field concerned with learning from examples and has roots in computer science, statistics and pattern recognition. The objective is realized by presenting methods and tools proven valuable and by addressing specific application problems.

Students who complete the module:

Knowledge
- Must have knowledge about supervised learning methods including K-nearest neighbors, decision trees, linear discriminant analysis, support vector machines, and neural networks.
- Must have knowledge about unsupervised learning methods including K-means, Gaussian mixture model, hidden Markov model, EM algorithm, and principal component analysis.
- Must have knowledge about probabilistic graphical models, variational Bayesian methods, belief propagation, and mean-field approximation.
- Must have knowledge about Bayesian decision theory, bias and variance trade-off, and cross-validation.
- Must be able to understand reinforcement learning.

Skills
- Must be able to apply the taught methods to solve concrete engineering problems.
- Must be able to evaluate and compare the methods within a specific application problem.

Competencies
- Must have competencies in analyzing a given problem and identifying appropriate machine learning methods to the problem.
- Must have competencies in understanding the strengths and weaknesses of the methods.

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
User Experience Design for Multi-modal Interaction (C)
Design af brugerlevelsen for multi modal interaktion

Prerequisites:
Basic knowledge in interaction design and usability.

Objective:
This course trains students to research, analyze, prototype, and conceptualize design considering all system aspects including the social and cultural contexts of use. The course gives a comprehensive knowledge about user involvement in the design process going beyond traditional methods such as usability lab testing.

The objectives are realized by presenting methods and tools in a case based framework and through the students' active participation in workshops and assignments.

Students who complete the module:

Knowledge
- Must have knowledge about system design methods including the social and cultural contexts of use.
- Must have knowledge derived from sociological and ethnographic fields for user behaviour research
- Must have knowledge about qualitative research methods involving end users in the field, such as interview techniques and analysis and experience sampling
- Must have knowledge about scenario-based design methods
- Must have knowledge about principles for multi modal interaction design
- Must have knowledge about methods for multi modal evaluation and field studies

Skills
- Must be able to apply the taught methods to solve concrete design problems.
- Must be able to evaluate and compare and apply the methods for a specific design problem
- Must be able to facilitate the design process involving users in real-life contexts

Competencies
- Students will acquire the competencies to decide how to choose the appropriate method to suit different dimensions of a design problem at different stages in the process and the pitfalls of each approach
- Must have competencies in understanding the strengths and weaknesses of the methods
- Must have the competencies to facilitate the design process involving users in context

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Computer Vision (P)

Computer vision

Prerequisites:
VGIS 1st semester or equivalent

Objective:
The objective of this course module is to provide students with core competencies within the field of computer vision and hereby enabling them to design and implement software systems for automatic or semi-automatic analysis of an image or sequence of images.

Students who complete the module:

Knowledge
- Must have knowledge about the terminology within computer vision
- Must be able to understand how a particular computer vision system e.g. the semester project of the student, relates to similar systems and, if relevant, to the surrounding society

Skills
- Must be able to analyze a problem and (if possible) suggest a solution that uses relevant theories and methods from computer vision
- Must be able to analyze a system that is based on computer vision and identify relevant constraints and assessment criteria.
- Must be able to synthesize, i.e., design and implement, a system (or parts hereof) using relevant theories and methods (if possible) from computer vision
- Must be able to evaluate a computer vision system (or parts hereof) with respect to the afore mentioned assessment criteria

Competencies
- Must be able to communicate the above knowledge and skills (using proper terminology) both orally and in a written report
- Must be able to select relevant computer vision theories, methods, and tools, and synthesize them in a new context to produce new knowledge and solutions

Type of instruction:
Project work.

Exam format:
Individual oral examination based on a written report.

Evaluation criteria:
As stated in the Framework Provisions
Image Processing and Computer Vision (C)
Billedbehandling og computervision

Prerequisites:
Basic knowledge in linear algebra and statistics.

Objective:
Cameras capture visual data from the surrounding world. Building systems which can automatically process such data requires computer vision methods. Students who complete the module will understand the nature of digital images and video and have an inside into relevant theories and methods within computer vision and an understanding of their applicability.

Students who complete the module:

Knowledge
- Must have knowledge about the primary parameters of a camera system
- Must have knowledge about the representation and compression of digital images and video signal
- Must be able to understand the general framework of image processing as well as the basic point and neighborhood operations, i.e., binarization, color processing, BLOB analysis and filtering
- Must be able to explain the principles behind invariant feature point descriptors such as SIFT and Harris corners.
- Must have knowledge of different motion analysis methods, such as background subtraction and optical flow
- Must be able to understand the tracking frameworks such as the Kalman filter, mean-shift and the particle filter
- Must be able to understand different shape analysis methods such as active-shape models, procrustes, Hungarian method

Skills
- Must be able to apply stereo vision to generate 3D date from two or more cameras. This implies projective geometry, camera calibration, epipolar geometry, correspondence and triangulation
- Must be able to apply advanced 2D segmentation methods such as Hough transform, compound morphology, and histogram-of-oriented histograms.
- Must be able to demonstrate understanding of error propagation techniques as a tool for performance characterization of computer vision based solutions

Competencies
- Must be able to learn further computer vision methods and theories, and select an appropriate solution for a given problem

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Robot Vision (C)
Robotic Vision

Prerequisites:
Basic knowledge in linear algebra and statistics.

Objective:
Students who complete the module will gain knowledge, skills and competences as follows:

Knowledge
- Must have gained an understanding of fundamental concepts related to robotics.
- Must have an understanding of how vision and other sensors can be integrated with a robot.
- Must have an understanding of relevant technologies enabling the design of intelligent machines (artificial intelligence).
- Must have an understanding of highly flexible and integrated automation technologies.
- Must have an understanding of the business potential of intelligent manufacturing.

Skills
- Must be able to use various technologies to provide manufacturing systems with intelligent capabilities (reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects).
- Must be able to model the direct and inverse kinematics of a robot.
- Must be able to design simple trajectory planners, including Cartesian and joint interpolators.
- Must be able to program an industrial robot to carry out various tasks.
- Must be able to integrate vision with an industrial robot.
- Must be able to integrate and implement intelligent machines into a small and limited manufacturing system.

Competencies
- Must have the foundation to participate in projects aiming at designing intelligent manufacturing systems which more or less autonomously can adapt to variations in its environment and, over time, improve its performance.

Type of instruction:
The form(s) of teaching will be determined and described in connection with the planning of the semester. The description will account for the form(s) of teaching and may be accompanied by an elaboration of the roles of the participants. The course/project theme is performed in either English or Danish dependent of the language skills of the participants.

Exam format:
Individual oral exam on the basis of a small report and a practical demonstration. An internal censor participates in the exam.

Evaluation criteria:
As stated in the Framework Provisions.
Prerequisites:
The course "Computer Graphics Programming" or equivalent qualifications.

Objective: The goal of this course is to provide the foundations necessary to perform advanced work in computer graphics and visualization in the 9th and 10th semesters. Students explore state of the art theories and techniques in a formalized manner by analysing a selection of research texts fundamental to computer graphics and visualization through, e.g., critical annotations, paper presentations, reproduction of experiments, etc.

Students who complete the module will gain knowledge, skills and competences as follows:

Knowledge
- Must be able to understand theories and principles related to computer graphics and visualization

Skills
- Must be able to analyse research topics in computer graphics and visualization
- Must be able to analyse research papers in computer graphics and visualization
- Must be able to apply concepts, tools, theories and technologies of computer graphics and visualization to address a specific research problem.

Competencies
- Must be able to critically evaluate a proposed solution, and explain its relevance in science and society

Type of instruction: As described in the introduction to Chapter 3.

Exam format: Individual oral or written examination.

Scientific Computing and Sensor Modeling (C)
Videnskabelige beregninger og sensor modellering

Prerequisites:
None

Objective:
Students who complete the module:

Knowledge
- Must have knowledge about hardware and software platforms for scientific computing.
- Must have knowledge about the possible speedup by using parallelization (Amdahl's law / Gustafson-Barsis' law) under different conditions.
- Must have knowledge about message and data passing in distributed computing.
- Must have knowledge about programming techniques, profiling, benchmarking, code optimization etc.
- Must have knowledge about numerical accuracy in scientific computing problems.
- Must have knowledge about selected sensors and sensor signal processing devices and their basic working principle (examples of sensors: temperature, pressure, frequency, phase and position; examples of sensor signal processing devices: low noise amplifiers, power amplifiers, mixers and logical gates).
- Must have knowledge about how sensors and sensor signal processing devices can be modeled and how model parameters can be extracted from e.g. measurements or data sheets.
- Must have knowledge about how to simulate single and multiple connected sensors.

Skills
- Must be able to implement software programs to solve scientific computational problems using parallel computing.
- Must be able to debug, validate, optimize, benchmark and profile developed software modules.
- Must be able to assess the performance of different hardware architectures for scientific computing problems.
- Must be able to use sensor models in system simulations.

Competencies
- The student must be able to apply the proper terminology in oral and written communication and documentation within the scientific domains of scientific computing and sensor modeling.
- The student must be able to study and later understand and model sensors, which have not been treated in the course.

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Interactive Systems (P)

Interaktive systemer

Prerequisites:
1st, 2nd semesters MSc in Vision, Graphics and Interactive Systems or equivalent

Objective:
The objective of this project module is to equip students with the abilities to design, build and test advanced multi modal user interfaces, integrating the more traditional information sources with information derived from e.g. computer vision techniques, speech recognition, and contextual knowledge, such as location. Information visualization and presentation must be considered in integrated as well.

The students can freely choose the focus within the above-mentioned fields, however interaction design issues must be considered and elements of user involvement, such as user requirements gathering and end user tests must be treated.

Students who complete the module:

Knowledge
- Must have knowledge of the design and realization of systems utilizing information from a variety of advanced information processing sensors
- Must have knowledge about integration of sensory information from non-standard signal sources.
- Must have knowledge about methods and architectures for fusion of multi modal information
- Must have knowledge about context-aware multimodal interaction.

Skills
- Must be able to analyze a problem and suggest a solution that utilizes information derived from relevant modalities, such as vision, tactile or speech
- Must be able to design and develop a system – partly or in full - that fuses information from several information sources.

Competencies
- Must be able to communicate the above knowledge and skills (using proper terminology) both orally and in a written report
- Must be able to select relevant theories, methods, and tools, and synthesize them in a new context to produce new knowledge and solutions

Type of instruction:
Project work.

Exam format:
Individual oral examination based on a written report.

Evaluation criteria:
As stated in the Framework Provisions
Platforms and Methods for Multi Modal System Architectures (C)
Platforme og metoder til multi modale system arkitekturer

Prerequisites:
Basic knowledge in human-computer interaction and software design.

Objective:
The course will enable the student to understand the principles of multi modal user interaction, including speech based interaction and computer vision, and to extend the methods for HCI GUI design to analyze, design and synthesize multi modal user interaction

Students who complete the module:

Knowledge
- Must have knowledge about integration of sensory information from non-standard signal sources.
- Must have knowledge about methods and architectures for fusion of multi modal information from e.g. speech, gaze, sound and gesture modalities.
- Must have knowledge about context-aware multimodal interaction.

Skills
- Must be able to apply the taught platforms and methods to analyze and design multi modal user interfaces.
- Must be able to evaluate and compare interaction modalities relevant to a specific application.

Competencies
- Must have competencies in analyzing a given problem and identifying appropriate modalities and their fusion to the problem.
- Must have competencies in understanding the pros and cons of the modalities of relevance

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Stochastical Processes (C)
Stokastiske processer

Prerequisites:
Solid knowledge in probability, statistics, linear algebra, Fourier theory, and programming.

Objective:
Students who complete the module:

Knowledge
- Have knowledge about the theoretical framework in which stochastic processes are defined.
- Be able to understand the properties of the stochastic processes introduced in the course, such as white-sense stationary (WSS) processes, Auto Regressive Moving Average (ARMA) processes, Markov models, and Poisson point processes.
- Be able to understand how WSS processes are transformed by linear time-invariant systems.
- Be able to understand the theoretical context around the introduced estimation and detection methods ((non-parametric and parametric) spectral estimation, Linear Minimum Mean Square Error (LMMSE) estimation, Wiener filter, Kalman filter, detection of signals, ARMA estimation, etc.)

Skills
- Be able to apply the stochastic processes taught in the course to model real random mechanisms occurring in engineering problems.
- Be able to simulate stochastic processes using a standard programming language.
- Be able to apply the taught estimation and detection methods to solve engineering problems dealing with random mechanisms.
- Be able to evaluate the performances of the introduced estimation and detection methods.

Competencies
- Have the appropriate "engineering" intuition of the basics concepts and results related to stochastic processes that allow – for a particular engineering problem involving randomness – to design an appropriate model, derive solutions, assess the performance of these solutions, and possibly modify the model, and all subsequent analysis steps, if necessary

Type of instruction:
As described in the introduction to Chapter 3.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Creative Innovation and Entrepreneurship (C)
Kreativ innovation og entrepreneurship

Prerequisites:
None

Objective:
This course will give an in-depth introduction of the various factors that are in play when starting a business in the media and entertainment industry. It will provide the necessary background for startup of business both in context of a team working inside an existing organisation (Intrepreneurship) and startup of new businesses (Entrepreneurship).

Student who complete the module:

Knowledge
- Must have knowledge about methods and concepts for startup of businesses
- Must be able to understand market potentials for new media products or productions
- Must be able to understand different business forms in relation to specific products or productions

Skills
- Must be able to analyze a business case
- Must be able to synthesize a business plan
- Must be able to understand property rights and patents
- Must be able to understand, design and conduct media culture analysis

Competencies
- Must be able to understand how to collaborate within teams developing and implementing new business plans within existing companies or for startup companies
- Be able to analyze, compare and discuss different business strategies
- Be able analyze and evaluate the potential market for new media products or productions

Type of instruction:
Refer to the overview of instruction types listed in the start of chapter 3. The types of instruction for this course are decided in accordance with the current Framework Provisions and directions are decided and given by the Study Board for Media Technology.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Applied Experimental Psychology and Psychophysics
Anvendt eksperimentalpsykologi og psykofysik

Prerequisites:
Basic statistics and probability theory

Objective:
Students who complete the module:

Knowledge
Must have knowledge of the psychophysical methods that can be used to measure human perception, cognition, and performance, including:

- Threshold and comparison methods
- Quantitative methods for measuring psychophysical responses including, nominal, ordinal, interval and ratio scales.
- Transformation of data to relevant scales. Normalization and standardization.
- Comparative and non-comparative scaling: paired comparison and semantic differential techniques.
- Probabilistic choice models for paired comparison (BTL), and the concept of transitivity.
- Descriptive analysis, including selection and use of censor panels for scaling experiments, word elicitation, selection, scaling and analysis.
- Practical design of scales.
- Design of scaling experiments.
- Factor analysis.

Skills
The students must be able to:
- Carry out measurement and scaling of psychophysical responses.
- Use statistical software for analysis of the results.

Competencies
- Can choose the appropriate psychophysical method for a given problem.
- Have experience carrying out experiments using appropriate methods.
- Can analyze the results from experiments using appropriate statistical methods.

Type of instruction:
Lectures followed by exercises and lab-work.

Exam format:
Individual oral or written examination.

Evaluation criteria:
As stated in the Framework Provisions
Master's Thesis (P)

Prerequisites:
Passed semester 1-3 or the like.

Objective:
Students who complete the module:

Knowledge
- have knowledge, at the highest international level of research, of at least one of the core fields of the education
- have comprehension of implications of research (research ethics)

Skills
- are able to reflect on a scientific basis on their knowledge,
- can argue for the relevance of the chosen problem to the education including specifically account for the core of the problem and the technical connections in which it appears
- can account for possible methods to solve the problem statements of the project, describe and assess the applicability of the chosen method including account for the chosen delimitation and the way these will influence on the results of the product
- can analyze and describe the chosen problem applying relevant theories, methods and experimental data
- are able to describe the relevant theories and methods in a way that highlights the characteristics and hereby document knowledge of the applied theories, methods, possibilities and delimitations within the relevant problem area
- have the ability to analyze and assess experimental data, including the effect the assessment method has on the validity of the results.

Competencies
- are able to communicate scientific problems in writing and orally to specialist and non-specialist.
- are able to control situations that are complex, unpredictable and which require new solutions,
- are able to independently initiate and to perform collaboration within the discipline and interdisciplinary as well, and to take professional responsibility,
- are able to independently take responsibility for his or her own professional development and specialization.

If the project is carried out as a long master's thesis the learning objectives include those defined for the 3rd semester of the education.

Type of instruction:
As described in the introduction to Chapter 3.

Problem based project oriented project work individual or in groups of 2-3 persons

Exam format:
Individual oral examination based on a written report.

Evaluation criteria:
As stated in the Framework Provisions
Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculty of Engineering and Science.

Students who wish to complete their studies under the previous curriculum from 2008 must conclude their education by the summer examination period 2012 at the latest, since examinations under the previous curriculum are not offered after this time.

In accordance with the Framework Provisions and the Handbook on Quality Management for the Faculty of Engineering and Science and The Faculty of Medicine at Aalborg University, the curriculum must be revised no later than 5 years after its entry into force.

Chapter 5: Other Provisions

5.1 Rules concerning written work, including the Master's thesis
In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's spelling and formulation ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination can be assessed as ‘Pass’ on the basis of good language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.

The Board of Studies can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

The Master’s thesis must include an English summary. If the project is written in English, the summary must be in Danish. The summary must be at least 1 page and not more than 2 pages. The summary is included in the evaluation of the project as a whole.

5.2 Rules concerning credit transfer (merit), including the possibility for choice of modules that are part of another programme at a university in Denmark or abroad
In the individual case, the Board of Studies can approve successfully completed (passed) programme elements from other Master’s programmes in lieu of programme elements in this programme (credit transfer). The Board of Studies can also approve successfully completed (passed) programme elements from another Danish programme or a programme outside of Denmark at the same level in lieu of programme elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Framework Provisions for the rules on credit transfer.

5.3 Rules for examinations
The rules for examinations are stated in the Examination Policies and Procedures published by the Faculty of Engineering and Science on their website.

5.4 Exemption
In exceptional circumstances, the Board of Studies study can grant exemption from those parts of the curriculum that are not stipulated by law or ministerial order. Exemption regarding an examination applies to the immediate examination.

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1 Or another foreign language (upon approval from the Board of Studies.
2 The Board of Studies can grant exemption from this.
5.5 Completion of the Master’s programme
The Master’s programme must be completed no later than four years after it was begun.

5.6 Rules and requirements for the reading of texts
It is assumed that the student can read academic texts in his or her native language as well as in English and use reference works etc. in other European languages.

5.7 Additional information
The current version of the curriculum is published on the Board of Studies’ website, including more detailed information about the programme, including exams.