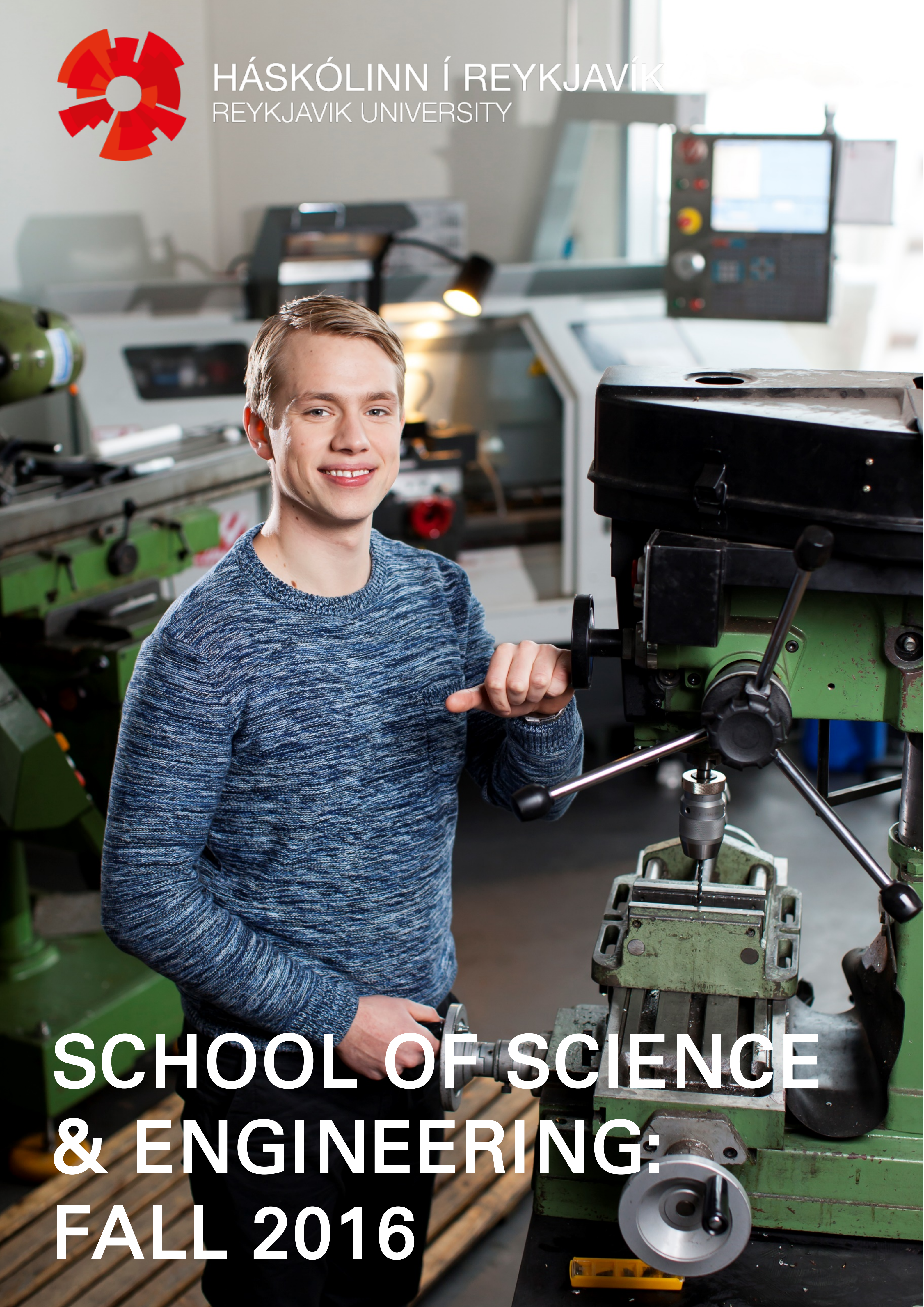
HÁSKÓLINN Í REYKJAVÍK
REYKJAVIK UNIVERSITY



SCHOOL OF SCIENCE & ENGINEERING: FALL 2016

SCHOOL OF SCIENCE & ENGINEERING FALL 2017

Department Contact:

Please contact the department for information regarding; courses and course selection. Please note this is a preliminary catalogue and may be subject to change. Please note, you can only choose one three-week course.

Undergraduate/ BSc/ Ba / First cycle

Graduate /MSc/ Masters/ Second Cycle

Undergraduate/BSc

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Graduate /MSc

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COURSES OVERVIEW

COURSE CODE	LEVEL	COURSE TITLE	ECTS	PAGE
T-316-RAS2	BSc	Analog Circuit Design	6	3
T-503-AFLE	BSc	Derivatives	6	3
T-561-LIFF	BSc	Biomechanics	6	4
T-534-AFLF	BSc	Classical Dynamics	6	4
T-316-STAF	BSc	Digital Electronics * (3 week course)	6	5
T-603-AKVA	BSc	Decision Analysis in Management	6	5
T-536-RENN	BSc	Fluid Mechanics	6	5
T-316-LABB	BSc	Measurement Systems * (3 week course)	6	6
T-411-MECH	BSc	Mechatronics I	6	6
T-801-RESM	MSc	Research Methods I	4	7
T-806-SIMU	MSc	Simulation II * (3 week course)	6	7
T-810-OPTI	MSc	Optimization Methods	8	7
T-807-QUAL	MSc	Quality Management * (3 week course)	6	8
T-860-NEUR	MSc	Neuro-science and Technology	6	8
T-808-NOLI	MSc	Applying Models in Management	8	9
T-809-DATA	MSc	Datamining and Machine Learning	8	9
T-811-PROB	MSc	Applied Probability	8	10
T-814-FINA	MSc	Financial Engineering of the Firm	8	10
T-848-ECOS	MSc	Sustainability and durability of concrete	4	10
T-860-BIOM	MSc	Biomechanics and Biomaterials	6	11
T-860-IMAG	MSc	Medical Imaging and Modelling	6	11
T-863-EIIP	MSc	Energy in Industrial Processes	8	11
T-867-POSY	MSc	Power Systems III	8	12
T-868-LISY	MSc	Linear Dynamical Systems	8	12
T-869-COMP	MSc	Computer Vision Applications * (3 week course)	6	13
T-866-HIVO	MSc	High Voltage Engineering	8	13
T-865-MADE	MSc	Precision Machine Design	8	13

UNDERGRADUATE COURSES

T-316-RAS2 ANALOG CIRCUIT DESIGN — SCIENCE & ENGINEERING

LEVEL: BSc
ECTS: 6

PREREQS: Analog Circuit Analysis, Mathematics III

LECTURER: Mohamed Abdelfattah.

CONTENT:

- Frequency response; transfer function and frequency filters
- Laplace transform and the inverse Laplace transform; definition and properties.
- Laplace transform applications in electric circuit analysis.
- Fourier series; definition and properties.
- Fourier transform and the inverse Fourier transform, and concept of applying Fourier series to circuit analysis.
- Two-port networks; the relationship between input and output currents and voltages, network parameters and different combinations of networks connections.

LEARNING OUTCOMES: Students should learn the fundamentals of the frequency response in AC circuits, including resonance conditions. They should be able to analyse the transfer function, use bode plots and design frequency filters. They should understand the Laplace and Fourier transform methods and how to apply it for electric circuit analysis. They should be familiar with the concept of the two-port network and how to propose and determine the suitable parameters for analysing different networks connections mainly series, parallel and cascaded connections. Students should be able to analyse, design and evaluate simple electric circuits. They should gain adequate experimental experience and skills of using computer programming and simulation to analyse and design simple circuits. Students' individual skills are expected to be improved by using individual assignments and projects. On the other hand, their group work experience is expected to be developed by using group discussions and tasks and presenting their work.

COURSE ASSESSMENT AND LEARNING: Textbook: "Fundamentals of Electric Circuits, C. K. Alexander and M. N. O. Sadiku, Mc Graw Hill, 6th edition, 2016 (Chapters: 14-19). **Teaching and learning activities:** Lectures; for the presentation of the fundamentals and theory. Exercises/problem solving; for the development of the analytical engineering skills. Group discussions; for thinking, brainstorming and understanding. Computer simulations; for the investigation of the behaviour of the circuits. Group work presentations. Individual projects; Workbook; every day record of work done, completed and planned.
Assessment methods: Experiments (group work)/ Projects (group work)/ Assignments (individual task)/ Examination (written, oral and/or on-line)/ Workbook (every day record of work done, completed and planned. N.B. Active participation is mandatory.

T-503-AFLE DERIVATIVES — SCIENCE & ENGINEERING

LEVEL: BSc
ECTS: 6

PREREQS: Securities

LECTURER: Ottó Stefán Michelsen.

CONTENT: The course starts with a brief introduction to derivatives and interest rates. The students will learn to construct the term structure of interest rates and study the models used to explain its shape. Then, forward contracts on interest rates and market assets will be introduced. Swap contracts will be discussed with focus on their cash flows and pricing techniques. Finally, derivative contracts on equity, bonds and interest rates will be discussed in some detail. During the course various cases will be studied where students can apply the acquired knowledge to practical situations.

LEARNING OUTCOMES: At the end of this course the student will be able to price the main derivative products as well as how to use these products for speculation or hedging. This main goal can be broken down into the following sub goals:

- Know the main derivative products and their mechanics
- Understand the difference between spot price and future price and be able to calculate future price. Be able to calculate the value of forward/futures contracts through time and at closing date.
- Be able to calculate a zero coupon yield curve from the prices of traded government bonds. The Nelson-Siegel Model will be introduced.
- Set up interest rate swaps and calculate their value. Understand when using such a contract is appropriate and how they are used for hedging in companies and financial institutions.
- Know the main risk factors (Greeks) of options, be able to calculate them and use for hedging a option portfolio
- Be able to draw up a payoff profile for a portfolio of options
- Use the Black-Scholes model to price options and calculate their risk factors
- Understand the theoretical underpinnings of the Black-Scholes model (Ito-calculus)
- A special emphasis will be placed on the students ability to gather necessary financial data independently from reliable sources on the internet. Be able to assess the appropriate volatility, interest rate level and other important factors.
- Can use Monte Carlo simulation to price exotic derivatives
- Use the binomial model to price options (European, American, Asian)

COURSE ASSESSMENT & LEARNING:
Reading material: John C Hull, Futures, Options and Other Derivatives. **Teaching and learning activities**: Lectures and problem solving classes. **Assessment methods:** Assignments: 30%, Mid-term exam: 10%, Final exam: 60%.

T-561-LIFF BIOMECHANICS — SCIENCE & ENGINEERING

LEVEL: BSc ECTS: 6 | **PREREQS: Statics & Mechanics of Materials Physics I.** | **LECTURER: Magnús Kjartan Gíslason.**

CONTENT: The foundation of biomechanics will be introduced and how movement and muscle forces will affect internal joint forces and stress distribution in various joints within the body. Equilibrium calculations on internal joint moments and joint reaction forces will be introduced as well as muscle forces in statically determinate and indeterminate systems. Motion analysis and how it can be used to capture movement in 3D space. Gait analysis will be discussed and a lab be carried out. Material properties of bone, cartilage, ligaments and tendons will be introduced and structural mechanics used to calculate stress in various joints of the body for a given load case. Biomechanical analysis if various joints of the body, such as knee, hip, back, shoulder and wrist will be discussed. Finally, pathomechanics will be introduced and how diseases such as osteoporosis, arthritis and other degenerative diseased will affect the biomechanics and how mechanical stability can be achieved using total joint arthroplasty or other surgical procedures.

LEARNING OUTCOMES: Understanding on how forces are transmitted and distributed within the body during various motions and how different materials of the human body behaves under loading.

COURSE ASSESSMENT AND LEARNING: Reading material: Margareta Nordin, Victor Frankel, Basic Biomechanics of the Muscoloskeletal System. **Assessment methods:** Coursework 50%, final exam 50%.

T-534-AFLF CLASSICAL DYNAMICS — SCIENCE & ENGINEERING

LEVEL: BSc ECTS: 6 | **PREREQS: Physics I, Calculus II.** | **LECTURER: Andrei Manolescu.**

CONTENT: The goal of the course is to enhance the student´s skill in applying Newton laws of motion. Great emphasis will be put on problem solving. Various forms of Newton´s laws will be used to solve problems related to complex motion in two and three dimensions.

LEARNING OUTCOME: At the end of the course students should be able to solve problems related to:
- The application of Newtons laws for system of particles. Relative motion, impulse, linear momentum and angular momentum
- Kinematics of rigid bodies, angular velocity, torque and moment of inertia
- Rotation in three dimensions, precession and other types of motion related to rotating machine parts
- Free and forced vibrations, both undamped and damped

COURSE ASSESSMENT AND LEARNING: Reading material: J.L Meriam and L.G Kraige, Engineering Mechanics: Dynamics. **Teaching and learning activities:** Lectures and problem solving classes. The lectures will be often based on examples. The students will build workbooks with problems solved by themselves. **Assessment methods:** One hour written test every other week and individual workbooks will account for 30% and the final exam accounts for 70% of the final grade.

T-316-STAF DIGITAL ELECTRONICS — SCIENCE & ENGINEERING

LEVEL: BSc ECTS: 6 3 WEEK COURSE | **PREREQS: Calculus I, Physics I, Linear Algebra, Analog Circuit Analysis.** | **LECTURER: Paolo Gargiulo**

CONTENT: This course it is an introduction to digital electronics with link to Biomedical engineering applications. It covers combinational and sequential logic circuits. Topics include number systems, Boolean algebra, logic families, medium scale integration (MSI) and large scale integration (LSI) circuits, analog to digital (AD) and digital to analog (DA) conversion, and other related topics such as applications in Medical devices.

LEARNING OUTCOMES:
- Explain and manipulate the representation of numbers in binary form and other codes e.g. signed forms of binary, hexadecimal.
- Describe basic digital logic components and use and/or interpret their representation in truth tables.
- Move between and make use of the different representations of digital circuits: truth tables, circuit diagrams and logical word descriptions.
- Explain ways of transmitting and storing data, especially the concepts of computer buses and addressing and multiplexing/de-multiplexing.
- Explain the operation of simple sequential circuits, including counters and shift registers.
- Use laboratory equipment such as power supplies, digital components, cables, oscilloscopes.
- Build and test simple digital circuits.
- Understanding the importance of digital electronics in medical device

COURSE ASSESSMENT & LEARNING: The course assessment is based on the practical exercises that will be performed in the electro technical lab (40-50%) and a final exam based on questions with multiple answers (50-60%).

T-603-AKVA DECISION ANALYSIS FOR MANAGEMENT — SCIENCE & ENGINEERING

LEVEL: BSc
ECTS: 6

PREREQS: Statistics I

LECTURER: Þórður Víkingur Friðgeirsson.

CONTENT: The general learning outcome is to be able to use structured methods to increase the quality, risk awareness and professionalism in decision making when uncertainty is attached to the outcome and best option.
This will be acquired by the following :

- The use of applied statistics in decision analysis.
- The major methods and procedures of decision analysis ea SMART, decision trees, Bayes rule, Monte Carlo simulation, value of information, utility theory, forecasting, NPV etc.
- A study on decision fallacies and cognitive biases.
- A study of basic decision models.
- The methods of group work, negation skills and authentic leadership.

LEARNING OUTCOMES:
Knowledge: Students should be able to apply the basic tools of analytical decision processing i.e. influence diagrams, decision trees, Monte Carlo simulation, pay off tables/matrices, weighted methods, Delphi, group techniques, etc.
Skills: Students should be able to apply the knowledge on to build a decision models/structure to solve decision where multiple objectives are at stake and more than one option to consider for the best possible outcome.
Interpersonal skills: After the course the student should be able to master group work were group techniques are applied to gain consensus and unbiased view on the decision problem.
Competence: Think critically about the decision problem and to be able to design a management process to ensure that the optimal solution based on prevailing information, risk attitude and uncertainty.

COURSE ASSESSMENT AND LEARNING:
Reading material: Goodwin and Wright, Decision Analysis for Management Judgment.
Teaching and learning activities: lectures and exercise classes intended for academic exercises, case studies, teamwork and status exams.
Assessment methods: Individual final exam 65%; Assignments/Status exams (3 * 15%), best results counts in the final grade; Class participation 5%

T-536-RENN FLUID MECHANICS — SCIENCE & ENGINEERING

LEVEL: BSc
ECTS: 6

PREREQS: Calculus II (T-201-STA2), Physics II (T-202-EDL2), Thermodynamics (T-507-VARM).

LECTURER: Ármann Gylfason

CONTENT: Content: The course covers the fundamental concepts in fluid dynamics, properties of fluids, hydrostatics, fundamental laws of fluid dynamics in integral and differential form, Bernoulli´s equation, potential flow, solutions to the Navier-Stokes equation for simple viscous flows, dimensional analysis, pipe flow, boundary layer theory and compressible flows.

LEARNING OUTCOMES: The students will get to know the fundamentals of fluid dynamics and its applications. At the end of the course the students have gained skills in analysing simple fluid flows, make appropriate approximations and apply basic numerical methods to solve them. In particular, the students will:

- Be able to use and understand the fundamental conservation laws of physics in the context of fluid flows.
- Know the differences between flow of viscous and non-viscous fluids, and understand when the non-viscous approximations can be applied in real situations.
- Be able to apply the equations of fluid motions on simple flows, and make appropriate approximations, in flows such as boundary layers and pipe flows.
- Have skills in analysing and solving engineering fluid flow problems in an organized manner, for example by presenting well rounded algebraic derivations in text, carry units systematically through analysis, and cross check consistency of solution by dimensional analysis.
- Be able to perform an experiment/measurement in an organized manner, understand the importance of holding a log book, analyse errors and uncertainties, and presenting the results in scientific form.
- Understand simple measurement systems in fluids, their limitations and errors.

COURSE ASSESSMENT & LEARNING:
Reading material: F.M White, Fluid Mechanics.
Teaching and learning activities: Lectures, sections, and experiments.
Assessment methods: Performance in homework (10%), labs (10%), preliminary examinations (50%), and in the final exam (30%).

T-316-LABB MEASUREMENT SYSTEMS — SCIENCE & ENGINEERING

LEVEL: BSc ECTS: 6
3 WEEK COURSE

PREREQS: Physics I, Statics and mechanics of materials, Classical dynamics.

LECTURER: Yonatan Afework Tesfahunegn

CONTENT: This course introduces the essential general characteristics of measuring devices, data acquisition systems, uncertainty analysis, on how to use uncertainty analysis as a tool to design experiments, and sampling and spectral analysis. Planning and executing experiments, and report writing are also covered.

LEARNING OUTCOMES:
- Principles of operation of commonly-encountered transducers
- Uncertainty analysis
- Sampling and spectral analysis
- Data acquisition systems
- Confidently encounter a sensor or experimental system for the first time
- Planning and executing experiments
- Designing experiments
- Report writing

COURSE ASSESSMENT & LEARNING: Teaching and learning activities: Mini-labs, workshops, and experiments.
Assessment methods: Mini-labs 25%/Experiment 1 report 30%/Experiment 2 design talk 45%

T-411-MECH MECHATRONICS I — SCIENCE & ENGINEERING

LEVEL: BSc ECTS: 6

PREREQS: Practical Programming, Statics and Mechanics of Materials, Calculus III, Electric Circuits.

LECTURER: Joseph Timothy Foley.

CONTENT: Content: This is an introduction to Mechatronics, the technique of interfacing software, electronics, and mechanical components. We will be utilizing the low-cost Arduino microcontroller platform as our method for sensing and control. Students will have pay a fee for their personal lab kit which includes some shared parts for team-based labs.
We will begin with an introduction to microcontroller programming and software engineering. This includes C++ and Subversion (for collaboration). We will then shift to electronics design, implementation, and testing. We will cover both analog and digital electronics with a focus on interfacing to sensors, DC motors, and stepper motors. Students will be designing and building PCB boards using Altium to integrate the electronics being developed. Students will choose a final mechatronics group project to be presented at the end of the semester. This project should involve manufacturing mechanical elements and interfacing them with the microcontrollers to demonstrate their mastery of the subject.

LEARNING OUTCOMES:
- Operate oscilloscopes and benchtop power-supplies
- Be able to design, build, and test advanced circuits with active elements
- Create schematics, layout PCB boards, and solder components to build working devices
- Program a microcontroller to read sensors and control actuators. For example: An Arduino with C++ or a Raspberry Pi with python
- Understand digital and analogue communication interfaces such as wireless networks
- Understand actuator and electronics specification sheets
- Record communication and data into a research notebook properly for international-quality research
- Write lab reports, device documentation, and simple conference papers
- See opportunities, not obstacles, when problems arise.
- Apply the Axiomatic Design methodology to analyse the interaction between different parts of the design.

COURSE ASSESSMENT & LEARNING: Reading material: J. Edward Carryer, R. Matthew Ohline and Thomas W. Kenny, Introduction to Mechatronic Design. **Teaching and learning activities:** Communication and rigor are critical to proper mechatronic design. Students will be shown how to use a research notebook and expected to keep it up to date as part of their grade. Peer-review of designs will be required. Proper citation of included internet and written material must be performed. Each subject will consist of lectures and related labs or projects. Student participation and interaction in lecture discussions is mandatory. Non-verbal participation credit is gained through use of the course's instant messaging client. Some assignments will be individual, some as group work. Collaboration on individual assignments is expected, but each student must do their own write-up (no copying). There will be final project. The final project may be sponsored by an outside company or internal research, otherwise it will be paid for out of the student's own funds. At the end of each project, students will be presenting their design and results along with a short written report. Lab assignments only require a report based upon a standard template. Students are expected to make use of the Machine shop and Electronics lab, taking appropriate International safety precautions where applicable. The instructor will give guidelines on these procedures and assist in execution.
Assessment methods: No final exam, instead a final project presentation and report. Students will each have a research notebook, which must be used on a regular basis on topics relating to the class and will be checked periodically for grading purposes. In-class participation is part of the student´s grade. Each assignment will be evaluated considering these three aspects: process documentation quality/rigor product/result Proper citation is a requirement in this class, without exemptions.

GRADUATE COURSES

T-801-RESM Research Methods I — SCIENCE & ENGINEERING

LEVEL: MSC ECTS: 4 | **PREREQS: NONE**

CONTENT: Industry and society needs people who can think critically, who can analyse complex situations and who can communicate their findings effectively. This can involve many tasks, including searching for and evaluating the worth of scientific literature and other forms of documentation. In this course, we concentrate on scientific writing and reporting, survey techniques and presentations. It will prepare students for dealing with the information gathering, analysis and reporting skills that are required for all other courses. Key topics covered: Literature surveys, search engines and other agencies, scientific writing, academic publishing, thesis writing, reviewing papers, managing a research project.

LEARNING OUTCOMES:
- Understand how to search, survey and select appropriate literature for formulating and resolving a problem.
- know which information to accept and what to reject.
- plan, structure and write a scientific paper or report.
- formulate arguments in writing for a variety of readerships.
- appreciate when the style of writing is appropriate or inappropriate.

T-806-SIMU Simulation II — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 6
3 WEEK COURSE | **PREREQS: TBA**

LEARNING OUTCOMES:
By the end of the course students should:
- know how different types of complex systems and processes can be understood, analysed and modelled (conceptually and numerically)
- be able to apply the systems approach in solving a moderately complex problem
- be familiar with limitations of models
- be familiar with validation of models
- understand different model development phases

COURSE ASSESSMENT & LEARNING: There will be no final exam and the grade will be based on performance in two assignments. Assignment 1 (50%): Modelling project /Assignment 2 (50%): Modelling project. Conceptual model of a system of choice.

T-810-OPTI Optimization Methods — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 8 | **PREREQS: NONE**

CONTENT: Overview and approach: This course introduces the principal algorithms for linear, network, discrete, nonlinear, dynamic optimization and optimal control. Emphasis is on methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton´s method, heuristic methods, and dynamic programming and optimal control methods.

LEARNING OUTCOMES: After the completion of this course students will be capable of using basic methods of Operations Research for analysing and solving complex decision problems. More specifically the student will be able to:
- Understand the properties of linear optimization and how it can be used to analyse and solve complex decision problems
- Use and analyse different forms of linear optimization models
- Applying systematic methods and algorithms for analysing and solving decision problems
- Understand the importance and usefulness of optimization methods and their applications
- Apply software to solve optimization models
- Practice the use of sensitivity analysis and to use formulas for sensitivity of model parameters
- Understand integer programming and how it can used in decision making Use the main solution methods for integer programming
- Know the relevance of stochastic programming
- Use stochastic optimization models and basic solution methods
- Understand the importance of nonlinear optimization.
- Use some of the solution methods for nonlinear optimization.
- Know the concept of dynamic programming.
- Present results in a clear and organized manner

COURSE ASSESSMENT and LEARNING: Final exam 50% -Mid-term exams 25% - Group based project 10%- Attendance and participation (project presentations and special lectures) 5% - Homework 10%

T-807-QUAL Quality Management — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 6
3 WEEK COURSE

PREREQS: NONE

CONTENT: The course covers the quality management as a management science and its important sub disciplines such as lean and 6 sigma. Among the subjects of the course are the quality concept, clients, quality culture, suppliers and quality cost. Management systems, improvement, management standards, quality system design, certification and audits. Statistical quality control, use of SPC and process capability. It is assumed that students have at least minimum background in statistics. It is also important that students have finished a BS (or BA) degree or have considerable experience in management.

LEARNING OUTCOMES:
Student should be able to explain:
- Nature and content of quality management as an academic field.
- The history of quality management.
- Main concepts of quality management.
- Structure and content of the management standard ISO9001.
- Main elements of the EFQM model.
- Main elements of the standards ISO14001 and OHSAS18001 and their relation to ISO9001.
- Argue for the pros and cons of quality management as a tool for managing organisations.
- Relation between quality management and lean management.
- Relation between quality management and 6 sigma.
- Apply the methods, tools and techniques of continuous improvement, for the analysis and solution of real problems. Map processes and present them in a formal way.
- Assess the requirements of ISO9001 and put them into context with different organisations.
- Assess process capability and present simple control charts
- Explain an organisation based on the EFQM model.

After having concluded the course, the student shall have the competence to:
- Apply the methods of continuous improvements to find solutions to real problems.
- Prepare solutions in improvement work and present them in a written and verbal format.
- Do a simple gap analysis of the status of the management system of an organisation as compared to the requirements of ISO9001.
- Develop a simple quality handbook for an organisation.
- Prepare a gap analysis and a simple quality manual and present this in a written and verbal format.

COURSE ASSESSMENT & LEARNING: The flipped classroom method is used for teaching parts of the course. These parts of the course are specifically labelled in the course schedule. The lectures will be made available for students on an information system (BContext) and this system will send an invitation to the students to register. After registration, the students can view lectures that cover the textbook, partly.
It is assumed that the students will prepare for these sessions by listening to the relevant lectures before class. These sessions are organised differently than regular lecture based sessions. There will be discussions and group work based on the lectures. A pre-requisite for participating in these sessions is thus to have read the compendium and listened to the lectures on BContext. Project A (30%). A group project in continuous improvement, to be explained more specifically. Groups suggest problems to solve. The assessment will be based on e.g. written report, data and the success of the group in dealing with the problem. The written report will be 10 pages.

Project B (30%). Based in ISO9001. An assessment of a real company. The groups deliver a report and present it. The assessment will be based on the understanding of ISO9001 and the context with the situation of the organisation. Final exam (40%). Based on all the compendium.

T-860-NEUR Neuro-science and Technology — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 6

PREREQS:

CONTENT: In this course the anatomy of brain and spine, from molecules to basic structures will be discussed. Three main themes of brain function will be presented in detail: development, plasticity and brain repair; learning and memory; and genes circuits and behaviour. In addition, the basic knowledge utilized in electrophysiology, brain modelling and neural and spinal electrical stimulation will be covered, including generation of electrical signals and the physiology of excitable cells. Methods of electrographic recordings presented include: in vitro and in vivo recordings, patch-clamp, intracellular, extracellular, field potential and electroencephalography. Student entering the course are expected to know the basics of molecular biology, cell biology, physiology and electronics.

LEARNING OUTCOMES: TBA

COURSE ASSESSMENT & LEARNING: TBA

T-808-NOLI Applying Models in Management — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 8** **PREREQS: Calculus I, Statistics I, Operation Research, Simulation**

CONTENT: This course is thought as a final course in the field of Operations Research and Operations Management. Vey few new methods will be covered, the objective is rather to train students in designing and applying mathematical OR models in real life management. In each week we study a particular field of management, we analyse the role of this manager and his needs for quantitative methods and we try to search for his possibilities of applying mathematical models more than is done today. These particular fields will be marketing, inventory management, production, distribution, service, financing, quality, executive manager and finally government. This takes 8 sessions with one home assignment after each session. There is also group work where students solve a self selected real life case

Perequisites: The students must have a good knowledge in the field of Operations Research and Operations Management, including courses like Operations Research, Simulation, Operational Analysis and Management II, or a similar knowledge from other courses. It is assumed that the students have already learned OR methods like Linear Programming, Simulation, Network Models, Queueing Theory, Forecasting Models, Integer Programming, Nonlinear Programming, Decision Theory etc. Also that they are have been exposed to some fields of Management like Quality Management, Production Management, Project Management and Financial Management

LEARNING OUTCOMES: Upon completion of the course the student should be able to demonstrate knowledge and skills in the following:

- Understanding the fundamentals of the application of models in management.
- Be able to develop and use models and know about the possibilities and limitations of these.
- Have an overview over the most important types of practical models in Operations Research and training in designing them and applying in the various fields of management.
- Be able to develop OR models for managers with Excel and also other tools like MPL and Simul8. 5.
- Having had the training and developed the necessary insight to use mathematical models in real life situations.

COURSE ASSESSMENT & LEARNING: The Revenue Management is 25% of the final grade, weekly home assignments are 50% and group project is 25%, i.e. report and a presentation

T-809-DATA Datamining and Machine Learning — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 8** **PREREQS: NONE**

CONTENT: Pattern recognition system, classifier design cycle and learning. Statistical pattern recognition, Bayesian decision theory, maximum likelihood and Bayesian parameter estimation. Linear models for classification. Principal component analysis. Multilayer neural networks. Nonparametric methods: k-nearest neighbours and Parzen kernels. Kernel methods and support vector machines. Unsupervised classification, K-means clustering, Gaussian mixture models and expectation maximization. Combination of classifiers, bagging and boosting.

LEARNING OUTCOMES: Knowledge: After the course the students should be able to recall, describe and define, the following terms: Pattern recognition system, classifier design cycle and learning. Statistical pattern recognition, Bayesian decision theory, maximum likelihood and Bayesian parameter estimation. Linear models for classification. Principal component analysis. Multilayer neural networks. Nonparametric methods: k-nearest neighbours and Parzen kernels. Kernel methods and support vector machines. Unsupervised classification, K-means clustering, Gaussian mixture models and expectation maximization. Combination of classifiers, bagging and boosting.

Skills: After the course the students should be able to apply the data mining methods and implement the machine learning algorithms presented in the course using standard programming languages such as Python or Matlab and software packages such as scikit-learn and Weka.

Competence: After the course the students should be able to design a suitable machine learning algorithm for a real world problem, evaluate its performance, compare different designs and implementations and interpret the results. The students should also be able to present findings and new results in the subject.

COURSE ASSESSMENT & LEARNING: 15% Quizzes 8-10 short computerized quizzes based on material from lectures and readings of which 50% is the outcome of the quiz and 50% is participation in the discussion afterwards. 10% Papers Two overview exams 35% Homework 4-5 papers that include computer exercises, problem solving and academic research. 40% Course project One group project of 2-3 people (see detail in hand-out)

T-811-PROB Applied Probability — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 8

PREREQS: Calculus I, Calculus I, Mathematics III T, Statistics I
Some familiarity with matrices will also be useful and will make the entry easier

CONTENT: Overview and approach: This heuristically and practically motivated course will discuss the computation of probabilities of events, discrete/continuous random variables, conditioning of random variables. In addition, the course will also cover transformations of random variables, markov processes, and the applications of stochastic processes to queuing theory, derivatives/finance, decision theory and game theory.

LEARNING OUTCOMES: Understand the basic concepts of probability distribution functions and their role in the modelling of uncertain outcomes – both in the discrete and the continuous case. Use expectation values, variances and covariance's to model various probabilistic phenomena

COURSE ASSESSMENT & LEARNING: Reading material: Sheldon Ross, A First Course in Probability 8th Edition, Pearson 2010. Sheldon Ross, Introduction to Probability Models 11th Edition, Academic Press 2014.
Teaching and learning activities: Interactive lectures, class exercises and class or home projects.
Assessment methods: Performance in class exercises and projects (30%) and a final exam (70%

T-814-FINA Financial Engineering of the Firm — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 8

PREREQS:

CONTENT: This course will analyse the financial performance of firms, both from theoretical and practical perspective. The theory of investment choice will be developed under conditions of certainty and uncertainty. Real options will be introduced as an extension to NPV approach with application to several practical situations. We analyse financial variables that critically contribute to value creation and discuss how focus on wrong financial measures can lead to inaccurate insight into the firm's value creation. Different valuation models will be introduced and applied to realistic scenarios. They include: enterprise discounted cash flow; discounted economic profit; adjusted present value; capital cash flow and equity cash flow. We will discuss how capital structure impacts on the firm's return-risk profile and the probability that the firm defaults on its financial commitments. We will link the CAPM with the theory of options and use that approach to evaluate the credit risk a leveraged firm exposes to its equity and debt providers. In addition to equity and debt financing we will discuss other alternatives such as convertible bonds or instruments with pay-outs that reflect the level of some important market indices.

LEARNING OUTCOMES:
The learning outcome can be broken down into the following sub-outcomes:-
- Appreciate the application of the theory of investment choice under certainty and under uncertainty
- Be able to use productive opportunity curves and utility functions to make investment decisions
- Understand the importance and the limitations of NPV and IRR methods
- Be able to construct decision trees for investment decisions
- Apply real options to real investment scenarios and the valuation of projects/firms
- Appreciate the implications of capital structure and the value of leverage
- Use options to evaluate cost of capital with risky debt
- Appreciate the role of risk capital
- Understand the role of corporate value drivers.
- Appreciate the financing of projects through equity, debt, convertible bonds and various structured notes

COURSE ASSESSMENT & LEARNING: 40% projects and class exams; 60% final exam

T-848-ECOS Sustainability and durability of concrete — SCIENCE & ENGINEERING

LEVEL: MSc ECTS: 4

PREREQS:

CONTENT: The primary scope of the course is to give the student the tools required to evaluate concrete quality from a sustainability point of view. The use of Life Cycle Analysis (LCA) of concrete will be reviewed. As the life span of a concrete unit is a major factor in LCA, focus will be given to durability of concrete. Detrimental mechanisms for concrete durability, such as alkali silica reactions, chloride ingress, high permeability and freeze thaw expansion will be examined. Over estimation of concrete durability within many LCA methods will also be discussed, mainly with regard to the previously mentioned mechanisms. Carbon footprint calculations will be covered in detail as well as means to reduce carbon emissions, with special emphasis on supplementary cementitious materials (silica fume, fly ash, slag etc.). The role of chemical admixtures in the reduction of CO_2 footprints will also be discussed. Specific concepts where rheology plays an important role, such as Ecocrete and EcoSCC, will be examined in detail, both theoretically and practically in the laboratory.

COURSE ASSESSMENT & LEARNING:

T-860-BIOM Biomechanics and Biomaterials — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 6** **PREREQS:**

CONTENT: In the course Biomechanics and biomaterials, the material properties of various tissues in the human body will be discussed and demonstrated how they are going to behave under mechanical loading. Additionally the properties of other inorganic materials such as metals, ceramics and silicon and how they are going to interact with the human tissues will be covered. In the course, the design of total joint implants, prostheses, orthoses and cardiovascular devices such as stents and heart valves will be discussed and how the design of these devices has changed over the last few decades. The loading conditions on these devices will be looked at, what mechanisms are going to cause fracture and degradation of the implants and what currently is being done to manufacture devices that are likely to survive a long time inside the human body.

Student entering the course is expected to know the basics of molecular biology, cell biology and physiology. In addition, it is expected that the student has completed a course in statics and a course in mechanics.

LEARNING OUTCOMES: It is assumed that the students have a solid understanding of structural mechanics. Some knowledge in biomechanics and material science is recommended.

COURSE ASSESSMENT & LEARNING:

T-860-IMAG Medical Imaging and Modelling — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS:6** **PREREQS:**

CONTENT: Medical imaging is important in the diagnosis in medicine and it forms the basis of modelling, like in biomechanics, in electrical stimulation, in EEG and 3D printing. In this course we will focus on computed tomography and it use in CT, MRI and PET, both the underlying theory and technical solutions. Also we will address selected aspects of image processing and image based modelling of different tissue properties. Students entering the course are expected to know the basics of medical imaging, signal processing and the physics underlying various image modalities. In addition, it is expected that the student has completed a course in statics and or materials science.

COURSE ASSESSMENT and LEARNING:
1. Assignments – 30% - Two assignments are done in the semester. The former assignment is about one subject common to all students, Ultrasound imaging. Each student works on one aspect of the subject, and delivers his report on that, but all students work on the same subject and can share work and information. The later assignment is in modelling and will be done during that part of the course. The first assignment on a common subject weights 20% and the later individual assignment weights 10% in the final grade.
2. Practical exercise - 20% - One practical exercise will be done during the semester. See exercise description.
3. Oral exam - 50%

T-863-EIIP Energy in Industrial Processes — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 8** **PREREQS: NONE**

CONTENT: The course covers the use of energy in industrial processes and society. The principles of mass and energy balance are applied to processes taking into account thermodynamics and thermochemistry. The chemistry of metallurgical processes such as iron and steel production is covered but the main focus is on the industrial processes that are prevalent in Iceland, aluminium and silicon. Also other energy intensive processes are addressed such as cement production, mineral wool, fertilizer and synthetic fuel.

The main emphasis is on the student's ability to get an overview over various processes in terms of material and energy flow, raw materials, energy use and efficiency, environmental effects and mitigation. Also the economic background i.e. the cost, profit and market conditions are addressed. Grading is based on problem solving, individual and group projects as well as a final exam. Field trips are an integral part of the course.

LEARNING OUTCOMES:
- Understand how electricity is turned into products
- Explain the main principles in energy intensive processes
- Promote and stimulate innovation in energy utilization
- Have knowledge of production processes, raw materials, energy sources, energy demand, finished products and effect on environment
- Set up process models to verify feasibility of processes

COURSE ASSESSMENT and LEARNING: Five assignments, 10% of final grade. Individual projects, 20% of final grade
Group projects, 40% of final grade – thereof 5% for milestone. Verbal exam, 30% of final grade

T-867-POSY Power Systems III — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 8** **PREREQS: NONE**

CONTENT: This course can be divided into the following main sections:
- Basic principles and use of symmetrical components, grounding principle, balanced and unbalanced operation and fault situation analyses,
- Basic principles and some application of power system protective methods.
- Power systems operation principles and basic functions in energy management system including optimization techniques to solve fundamental operation problems;
- Basic principles of transmission line transient operation including insulation coordination.

The aim of the course is to provide students with a working knowledge of power system problems in both balanced and unbalanced operation situation including faults, protection principles, energy management methods and computer techniques used to solve some of these problems. The transmission line transient operation and insulation coordination is also part of the course.

Topics include: Symmetrical components, Modelling of transformers, lines and cables in the positive, negative and zero sequences based on physical models, The impact of different earthing principles, Methods for power system analysis in steady state operation and during grid faults, Faulty system operation, balanced and unbalanced faults, Symmetrical components and unbalanced fault analysis, Basic protective methods and principles, Load flow calculations in steady-state power system analysis, Model complex power system operation issues for economic and secure operation, Load flow calculations in steady-state power system analysis, Model complex power system operation issues for economic and secure operation, Principles for regular power flow and optimal power flow methods, Power system operation principles and basic functions in energy management system. Optimization techniques to solve fundamental operation problems, N -1 steady state contingency analysis, Transmission lines Transient operation, Insulation coordination, Power system state estimation and the incorporation with phasor measurement units; (Smart Grids). Practical assignments solved in the numerical simulation program Power World.

LEARNING OUTCOMES: The objective of the course is that the student is able to; Calculate complex -voltage, -current and -power in three phase and single-phase system. Use network equations and phasors in power system problem solving. Select model and parameters for Transformers and Generators and be able to select and calculate these parameters based on information from the manufacturer and/or test reports. Use the per unit system when representing the three phase and single-phase power system and in problem solving. Select model for transmission lines for short, medium and long lines and calculate model parameters. Solve power flow problems with use of Gauss-Seidel or Newton-Raphson methods. Identify steady state operation of the power system. Identify power systems transient stability fundamental issues. Identify power systems basic control methods.

COURSE ASSESSMENT & LEARNING: 3 hour written exam 70% - Project 30%

T-868-LISY Linear Dynamical Systems — SCIENCE & ENGINEERING

LEVEL: **ECTS: 8** **PREREQS: NONE**

CONTENT: Linear differential equations as linear systems with practical examples throughout: e.g. Communications Systems, Linear Static Circuit, Total Force on Rigid Body, Cost of Production and Computer Vision. State-space representation, eigenvalues and dynamical interpretation of linear systems. Multiple input multiple output systems. Stability and asymptotic behaviour. Lyapunov functions and the Lyapunov equation. Observability and controllability

LEARNING OUTCOMES: This course gives an introduction to linear systems, applied linear algebra and system dynamics with applications to control systems, circuit analysis, signal processing and communications systems. The course will address theoretical aspects of linear dynamical systems with emphasis on application.

COURSE ASSESSMENT and LEARNING: Lectures, problem solving sections, and computer exercises. Final exam: 50% Problem solving: 15% Computer Exercises: 35%

T-869-COMP Computer Vision Applications — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 6**
3 WEEK COURSE

PREREQS:

LEARNING OUTCOMES:
Knowledge: After the course the students should be able to recall, describe and define, the following terms: Image formation, cameras and projection models, low-level image processing methods such as filtering and edge detection; mid-level vision topics such as segmentation and clustering; shape reconstruction from stereo, as well as high-level vision tasks such as object recognition, scene recognition, face detection and human motion categorization.
Skills: Students should be able to use Open CV and/or other real-time computer vision tools to acquire image data and implement computer vision algorithms to detect and recognize facial expressions and apply these techniques to emotion classification.
Competence: After the course the students should be able to design a suitable computer vision algorithm and recognition techniques for real world problems, evaluate algorithmic performance and compare different designs and implementations and interpret the results. The students should also be able to present findings and new results in the subject.

T-866-HIVO High Voltage Engineering — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 8**

PREREQS: NONE

LEARNING OUTCOMES: The objective of the course is that the student is able to;
- Repeat and use important principles when dimensioning of high voltage apparatus
- Calculate important component parameters and simple electric fields
- Solve electrical field problems numerically (FEM and CSM)
- Explain the relevant factors determining permittivity and dielectric loss value
- Estimate the electrical breakdown strength of different materials i.e. gasses, oils and solid insulating material.
- Explain electrical discharge phenomena and estimate their relevance for electrical insulation systems.
- Explain and discuss principles for component breakdown.
- Explain the gradual degradation mechanisms caused by partial discharges, water trees and electrical trees.
- Repeat and discuss important principles in systems for generation of ac, dc and impulse voltages design
- Choose and apply suitable equipment for measurement of high voltages and currents
- Repeat and use important principles in PD measurements.

T-865-MADE Precision Machine Design — SCIENCE & ENGINEERING

LEVEL: MSc **ECTS: 8**

PREREQS: Basic PLC, Python, C/C++ or Java programming, Basic electronics (resistors, inductors, capacitors) Understanding of structural analysis (stresses, strains, bending) Familiarity with solid modelling tool (Inventor, Solidworks, etc)

CONTENT: A systematic approach to designing machines able to reliably and repeatedly perform a task. Factors that are of minor importance for low-performance machines can quickly become impossible obstacles without the right tools and techniques. I this class these techniques will be applied for designing and building high-performance machine(s) with our sponsors. Simple control systems will be built for such machines using the Arduino/ATMega microcontroller platform using 3D design software such as PTC Creo for modelling machines. LaTeX introduced for proper documentation and citation generation with Subversion as a mechanism for collaboration.

LEARNING OUTCOMES:
- Solve complex and open-ended "hard" mechanical design problems using systematic design processes.
- Analyze error budgets in machine design and propose improvements
- Understand what is "hard" about precision and how to address those challenges
- Model complex machines as part of a team
- Use computer and paper-based tools to come up with estimations and answers quickly
- Create effective design documents including FR/DP, risk assessment, and time assessment Present their ideas effectively for customers and peer reviews
- Design and perform experiments to test design choices
- Build prototypes of their designs
- Analyze their prototypes to develop suggestions for the next design
- Harness creative instincts as part of a deterministic process
- Competently use PTC Creo, LaTeX, Instant Messaging, Arduinos/PLCs, and sensors

COURSE ASSESSMENT and LEARNING: No final exam, instead a final project presentation and report. There will be a midterm oral exam on Design Fundamentals. Students must be able to effectively communicate their ideas through written and oral methods. Students will each have a research notebook which must be used on a regular basis and will be checked periodically for grading purposes. Each assignment will be evaluated considering these three aspects: process – documentation - product/result