Reykjavik University
Department of Engineering

Graduate Programs in Engineerng - MSc

MSc in Biomedical Engineering
MSc in Electrical Power Engineering
MSc in Energy Engineering
MSc in Engineering Management
MSc in Financial Engineering
MSc in Mechanical Engineering
MSc in Mechatronics Engineering
MSc in Engineering

Course Catalogue 2020-2023

Revised June 9th 2022

Efnisyfirlit

Master of Science Programs in Engineering

The Department of Engineering offers the following MSc degree programs in engineering; two-year study programs of 120 ECTS credits:

MSc in Biomedical Engineering
MSc in Electrical Power Engineering *(with the Iceland School of Energy)*
MSc in Energy Engineering *(with the Iceland School of Energy)*
MSc in Engineering Management
MSc in Financial Engineering
MSc in Mechanical Engineering
MSc in Mechatronics Engineering
MSc in Engineering

In addition, The Iceland School of Energy which is run within the Department of Engineering offers four MSc degree programs: MSc in Sustainable Energy, MSc in Sustainable Energy Engineering, MSc in Electrical Power Management, and MSc in Electrical Power Engineering.

As a member of the CDIO network Reykjavik University emphasizes curriculum being taught in the context of professional engineering. The teaching approach balances academic rigour with a practical understanding of work in a fast-changing industry and world. During the course otheir studies graduates will have become accustomed to the process of design, implementation and operation which they will face in their future careers.

This course catalogue contains descriptions of all graduate level courses offered specifically for the department´s engineering programs. Additionally, graduate students have the option of choosing elective master´s level courses from the Iceland School of Energy and from RU´s other departments, i.e. Department of Computer Science, Department of Business, Department of Law, and others. Graduate students may also choose a limited number of advanced undergraduate engineering courses as electives, see the respective course catalogues http://en.ru.is/.

Degree seeking students should generally apply for enrolment starting in the fall semester (August). Exchange students can be admitted in the spring semester (January) or fall semester (August). For information on admission and support for foreign students, as well as the research focus and structure of each MSc program see http://en.ru.is/vfd/.

For further information on Master of Science programs in engineering contact:
Department of Engineering´s graduate program administrator Sóley Davíðsdóttir soleyd@ru.is
Iceland School of Energy's program administrator Alisha Moorhead alisham@ru.is
International Office's administrator: Verity Louise Sharp international@ru.is

All course descriptions may be subject to change.
Teachers will introduce updated information on the course schedule, reading material, teaching and learning activities, and assessment methods in the learning management system Canvas at the beginning of each semester.

Course Descriptions in MSc Engineering

Courses taught in Fall Semester

SE-801-ES1 ENERGY FIELD SCHOOL 6 ECTS

Year of study: First year MSc.
Semester: Fall.
Level of course: 4. Second cycle, introductory.
Type of course: ***Taught in the Iceland School of Energy.*** Core for MSc Energy Engineering, MSc Electrical Power Engineering, and for students enrolled in the Iceland School of Energy. Not open for students of other programs in engineering.
Prerequisites: None.
Schedule: Taught all day, every day for 3 weeks in late July and early August.
Supervisor: Juliet Newson.
Lecturer: David Christian Finger.

Learning outcome: Upon completion of this course students should have the ability to:
Knowledge:
- Distinguish the primary environmental impacts due to the energy industry, and how that impact is assessed and mitigated.
- Recognize how the interplay of technical, environmental and socioeconomic constraints shapes the development and requirements of the energy sector.
- Identify the general characteristics of renewable energy systems and methods of analyzing them.

Skills:
- Apply scientific methods to complex projects
- Has the ability to assess energy projects
- Can identify the key factors in a given situation, and develop an approach to solution.

Competence:
- Independently build an overview of a specific renewable energy system
- Collaborate as a contributing team member on a renewable energy research project

Content: The course offers an introduction to:
- Energy trends
- Geothermal energy
- Sustainability
- Circular Economy
- Hydropower
- Wind power
- Power systems
- Energy economics

Reading material: David J.C. MacKay, *Sustainable Energy - Without the Hot Air*.
- **Teaching and learning activities:** Site visits to power plants and areas of environmental and geoscientific interest. Field trip with overnight stay.

Assessment methods: Will be announced in the learning management system (Canvas).
Language of instruction: English.

SE-805-EC1 **ENERGY ECONOMICS** **6 ECTS**

Year of study: First year MSc.
Semester: Fall.
Level of course: 4. Second cycle, introductory.
Type of course: ***Taught in the Iceland School of Energy.*** Core for MSc Energy Engineering, and for students enrolled in the Iceland School of Energy. Elective for other MSc programs in engineering.
Prerequisites: No prerequisites.
Schedule: Runs for 12 weeks - 5 teaching hours a week.
Supervisor: Juliet Newson.
Lecturer: Jónas Hlynur Hallgrímsson.

Learning outcome: The objective of this course is to introduce fundamental concepts of energy economics. At the end of the course students should be familiar with topics related to energy demand, energy supply, energy prices, environmental consequences of energy consumption and production, and various public policies affecting energy demand, supply, prices, environmental effects, and renewable energy. Basic economic modelling and calculations will be presented in class when appropriate.

Knowledge:

- Basic principles of energy economics.
- Understanding of a broad overview of a variety of theoretical and empirical topics related to energy economics
- Apply methods from mathematics and economics science to analyze complex systems in energy systems or their peripheries.
- Analyze economics of energy project
- Analyze and communicate experimental, numerical and statistical data.
- Apply standard scientific principles to develop analytical solutions to a range of practical problems.

Skills:

- Apply methods from economics science to analyze complex systems in energy systems or their peripheries.
- Analyze economics of energy projects, using current best-practice methods.
- Apply research methodology and critical thinking, including the fundamentals of scientific writing, literature search, evaluate a scientific paper, and be aware of research ethics.
- Give an oral energy economics presentation and write a scholarly research report.

Competence:

- Apply analytical skills and methodologies to recognize, analyze, synthesize and implement operational solutions to energy related problems.
- Apply standard economics principles to develop analytical solutions to a range of energy problems
- Interpret and apply existing economic theories, models, methods and results, both qualitatively and quantitatively, within the field of energy economics.

Content: This is a 12-week course that focuses on the specifics of energy economics. The course will give students a broad overview of a variety of theoretical and empirical topics related to energy economics.

Reading material: There is no official textbook for this course but reading material will be provided on a weekly basis and based on official reports and academic research related to energy economics.
Teaching and learning activities: Lectures, homework sets, debates, and student presentations.
Assessment methods: Student presentation (15%), homework sets (10%), midterm (20%) and final written exam (55%).
Language of instruction: English.

SE-806-EI1 **ENVIRONMENTAL IMPACT ASSESSMENT (EIA)** **6 ECTS**

Year of study: First year MSc.
Semester: Fall.
Level of course: 4. Second cycle, introductory.
Type of course: ***Taught in the Iceland School of Energy.*** Core for MSc Sustainable Engineering, and for students enrolled in the Iceland School of Energy. Elective for other MSc programs in engineering.
Prerequisites: No prerequisites.
Schedule: Taught all day, every day for 3 weeks in late November and early December (potentially also in Spring).
Supervisor: David Christian Finger
Lecturer: David Christian Finger

Learning outcome: Upon completion of this course students should have the ability to:

Knowledge:
- Develop your own EIA for your project development idea
- https://fingerd.jimdofree.com/teaching/courses/environmental-impact-assessment/

Competence:
- Independently develop an EIS providing a holistic overview of environmental impacts of your project idea
- Collaborate as a contributing team member on a renewable energy research project

Content: The course offers an introduction to:
- Environmental challenges
- Environmental Impact Assessment
- Methods to assess environmental impacts
- Environmental disasters

Reading material: Check: Environmental Impact Assessment course: Day 1: The challenge
Teaching and learning activities: The course is composed of three parts: i) theoretical lectures on methods used in the EIA process, ii) first-hand experience through direct contacts with local stakeholders and iii) hands on training by writing an EI statement.
Assessment methods: Will be announced on the first day of the course (Project work, individual exercises and project presentation).
Language of instruction: English.

T-406-TOLU **TÖLULEG GREINING** **6 ECTS**

Ár:	3. ár/4.ár.
Önn:	Haustönn. *Kennt í fyrsta sinn sem 3-vikna námskeið á haustönn 2021 (kennt í síðasta sinn sem 12-vikna námskeið á vorönn 2021).*
Stig námskeiðs:	3. Grunnnám, sérhæft námskeið / 4. Framhaldsnám, inngangsnámskeið.
Tegund námskeiðs:	Skyldunámskeið FV, RV á 3. ári. Skyldunámskeið HEV, VV á 4. ári (þ.e. á fyrsta ári meistaranáms).
Nauðsynlegir undanfarar:	Stærðfræði I (T-101-STA1), Stærðfræði II (T-201-STA2), Línuleg Algebra (T-211-LINA), Forritun fyrir verkfræðinema (T-201-FOR1), Stærðfræði III (T-301-MATH).
Skipulag:	Kennt alla virka daga í 3 vikur skv. sérstakri stundaskrá.
Umsjónarkennari:	Olivier Moschetta.
Kennari:	NN.

Lærdómsviðmið:

Þekking: Stefnt er að því að nemendur þekki:
- nálganir, skekkjumat og stig á skekkju,
- tölulegar aðferðir til að leysa jöfnur og jöfnuhneppi,
- margliðubrúun og aðhvarfsgreiningu,
- tölulegar lausnir á afleiðum og heildum,
- tölulegar lausnir upphafs- og jaðargildisverkefna fyrir venjulegar diffurjöfnur og diffurjöfnuhneppi,
- uppsetningu á mismunaraðferð við lausn á diffur- og hlutafleiðujöfnum,
- undirstöðuatriði bútaaðferðar við lausn á diffurjöfnum.

Leikni: Stefnt er að því að nemendur geti:
- bæta töluvert forritunarkunnáttu sína,
- forritað og útfært reiknirit fyrir tölvur,
- leyst jöfnur og jöfnuhneppi með tölulegrum aðferðum,
- hannað ítranir til að leysa ólínulegar jöfnur,
- metið skekkju í nálgunum sem gerðar eru með tölulegum aðferðum,
- metið reiknihraða reiknirita.
- ritað skilvirkan kóða.

Hæfni: Stefnt er að því að nemendur:
- átti sig á hlutverki tölulegrar greiningar til að leysa stærðfræðileg og verkfræðileg verkefni,
- noti tölulegar aðferðir til að leysa verkefni í stærðfræði og verkfræði,
- skilji reiknirit sem leysa slík verkefni,
- geti valið skilvirkasta aðferð til leysa tiltekið verkefni,

Lýsing: Undirstöðuatriði tölulegrar greiningar og notkun á þeim. Nálganir og skekkjumat. Tölulegar aðferðir til að leysa jöfnur og finna lægsta gildi falls. Tölulegar lausnir á línulegum og ólínulegum jöfnuhneppum. Línuleg og ólínuleg aðhvarfsgreining fyrir gagnasöfn. Töluleg diffrun og heildun. Tölulegar lausnir á upphafs- og jaðargildisverkefni fyrir venjulegar diffurjöfnur og diffurjöfnuhneppi. Mismunaraðferð við lausn á diffurjöfnum. Undirstöðuatriði bútaaðferðar við lausn á diffurjöfnum. Áhersla er lögð á hagnýta forritun til að leysa stærðfræðileg verkefni sem koma upp í verkfræðinni.

Lesefni:	Timothy Sauer, *Numerical Analysis*. Fyrirlestrarnótur frá kennara.
Kennsluaðferðir:	Fyrirlestrar, dæmatímar, forritunartímar. Verkefnamiðuð skilaverkefni.
Námsmat:	Forritunarverkefni leyst í hópum. Ekkert lokapróf.
Tungumál:	Íslenska / Enska.

T-411-MECH **MECHATRONICS I** **6 ECTS**

Year of study: 3^{rd} year BSc / 1^{st} year MSc.
Semester: Fall.
Level of course: 3. First cycle, advanced / 4. Second cycle, introductory.
Type of course: Core for BSc Mechatronics Engineering, elective for other programs.
Mandatory Prerequisites: Programming (T-111-PROG).
Recommended prerequisites: Electric circuits (T-306-RAS1); Statics and Mechanics of Materials (T-106 BURD); Computer architecture (T-107-TOLH, may be taken at the same time).
Schedule: Runs for 12 weeks –6 class hours a week. One lecture and 2 lab sessions
Supervisor: Joseph Timothy Foley.
Lecturer: Joseph Timothy Foley.

Learning outcome:
Knowledge:
At the end of the class, students should have knowledge of:

- Data encoding formats and binary arithmetic
- Different electrical, mechanical, and software components
- Commonly used sensors and actuators in smart devices
- Concepts of modularity, independence, information, and robustness

Skills:
At the end of the class, students should know how to:

- Operate oscilloscopes, multimeters, soldering irons, and benchtop power-supplies
- Create schematics, layout PCB boards, and solder components to build working devices
- Interface a microcontroller with sensors and actuators
- Apply the Axiomatic Design methodology to design modular and robust mechatronic systems.
- Employ rapid-prototyping technologies to design and implement mechanical elements
- Understand digital and analog communication specifications
- Understand actuator and electronics specification sheets
- Measure the accuracy, repeatibility, and resolution of a sensor
- Record observation and analysis into a design notebook regularly

Competences:
At the end of the class, students will be able to:

- Develop an application to accomplish a goal using a real-time microcontroller
- Design, build, and test advanced circuits with active elements
- Build control systems with feedback
- Debug electronic, software, and mechanical issues efficiently
- Present the prototype and its design process effectively

Content:
This is an introduction to Mechatronics, the technique of interfacing software, electronics, and mechanical components. We will be utilizing an Arduino as our platform. Students will have pay a fee for their personal lab kit which includes some shared parts for team-based labs. The chosen textbook is required for the course and critical to completing the Lab assignments.

We will begin with an introduction to embedded programming. This includes C++ and Git (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 and actuators. Students will be designing and building PCB boards using Altium/KiCad to integrate the electronics being developed. Students will choose a final mechatronics team 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. Students will be spending a lot of time in the Electronics Lab in V207 and Machine Shop building projects. This means that each student should have gone through safety training in the labs as a prerequisite. If you are an exchange student, contact the Teaching Assistants about setting up a safety training session so you can use the facilities.

Textbooks: *Exploring Arduino, 2nd Edition* by Jeremy Blum, published by John Wiley and Sons (2019), *ProGit* by Scott Chacon and Ben Straub, published by Apress (2014). Both books are available for free at the RU Electronic Library vi EBookCentral.

Teaching and learning activities: Communication and rigor are critical to proper mechatronic design. Students will be shown how to use a design notebook and expected to use it regularly. Proper citation of included internet and written material must be performed. Each subject will consist of lectures and related labs or projects. Significant student participation and interaction in lecture discussions is expected.

Many assignments are to be done in teams. Collaboration on individual assignments is expected, but each student must do their own writeup (no copying). Document assignments will use LaTeX templates that will be provided.

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: There is no final exam. Assignments will consist of a mixture of group lab assignments and individual competency tests. Students must be able to effectively communicate their ideas through written and oral methods. Students will each have a design notebook which must be used on a regular basis on topics relating to the class, team efforts, and analysis. Students will be presenting their prototype at the end of the course.

Students are required to keep at least a 67% attendance grade in order to complete the course. Students are also expected to assist in cleanup of the mechatronics lab at the end of the course in order to receive their grade.

Proper citation is a requirement in this class, without exemptions. All material from an outside source (ideas, text, pictures) must include a proper citation. IEEE is the preferred format. Failure to include citations will result in a 0 for the assignment and considered plagarism which will be reported to the academic office. Improperly cited material will be assessed a lesser penalty depending upon the assignment. You are explicitly given permission to use the RU logo on your reports and presentations without citation because you are enrolled at our university.

Late work will be penalized according to the degree of lateness: 10% per day to a maximum of 50% points (for 5+ days late). Assigments may only be submitted up to one week late. Software with code that was checked in to version control at the due date/time can be checked off at the next session at full credit. If any changes are made after that time, the late work penalty will be applied. For LaTeX documents and presentations, the CANVAS submission time will be used to assess lateness. Always check the assignment for the appropriate submission procedure.

Whenever possible, the evaluation sheet for a given assignment will be provided before the start of the assignment.

Language of instruction: English.

T-738-EMBE **EMBEDDED SYSTEM PROGRAMMING** **8 ECTS**

Year of study:	3^{rd} or 4^{th} year (final year BSc / first year MSc).
Semester:	Fall.
Level of course:	3. First cycle, advanced / 4. Second cycle, introductory.
Type of course:	Core for MSc Mechatronics Engineering, elective for other programs.
Prerequisites:	Programming (T-201-FOR1 or T-111-PROG). **Additional recommended prerequisites:** Mechatronics I (T-411-MECH).
Schedule:	Runs for 12 weeks – 6 teaching hours a week. A combination of lectures and on-line labs.
Supervisor:	Torfi Þórhallsson.
Lecturer:	Torfi Þórhallsson.

Learning outcomes:

- Write embedded programs in C++ and execute them on microcontrollers
- Explain the important features of the C++ programming language
  - – Basic control structures (if, while, collections, etc.)
  - – Memory management (representations, data structures, and dynamic memory allocation)
  - – Object oriented programming (classes, abstract data types)
  - – Generic programming (templates, inheritance)
  - – Scheduling
- Testing and debugging embedded code
- Explain the importance of real-time operating systems
- How to choose data structures and algorithms

Content:

Learning the basics of programming in resource limited systems such as that found in microcontrollers. The course teaches embedded software development using the C++ programming language. Basic programming skills are assumed. The course covers the following six main topics: memory management, object oriented programming, generic programming, embedded software design, performance validation, and code optimization. Each topic is accompanied by a software project using C++ and open software tool chains.

Reading material: *Real-Time C++: Efficient Object-Oriented and Template Microcontroller Programming* by Christopher Kormanyos. Alternatively, the following three on-line texts used together:

- *Discovering Modern C++: An Intensive Course for Scientists, Engineers, and Programmers* by Peter Gottschling. Addison-Wesley Professional, 2015.
- *Software Engineering for Embedded Systems, 2nd Edition* by Mark Kraeling; Robert Oshana. Newnes, 2019.
- *Hands-On Embedded Programming with C++17* by Maya Posch. Packt Publishing, 2019.

Teaching and learning activities: Six two-week project sprints, supported by lectures.
Assessment methods: Practical online exam. Grades given on lab assignments are part of the final grade. Late assignments are not accepted.
Language of instruction: English.

T-806-SIMU SIMULATION II 6 ECTS

Year of study: First or second year MSc.
Semester: Fall.
Level of course: 5. Second cycle, intermediate.
Type of course: Elective. *Recommended elective for MSc Engineering Management.*
Prerequisites: No prerequisites.
Schedule: Runs for 3 weeks – 4 teaching hours a day.
Supervisor: Páll Jensson.
Lecturer: Anna Hulda Ólafsdóttir.

Learning outcome: By the end of the course students should:

- know how different types of complex systems and processes can be understood, analyzed and modeled (conceptually and numerically)
- understand different model development phases
- be able to apply the systems approach in solving a moderately complex problem
- learn how to critically evaluate models and their limitations (assumptions/simplifications)
- be familiar with validation of models
- understand how to develop a decision support tool for strategic planning.

Content:
The purpose of the course is that students will be able to understand and apply the basic tools of System Analaysis and System Dynamics Modelling from a practical perspective. It has the steps from mission statement, system conceptualization and the process of creating simulation models from the conceptualization using the most modern, user-friendly software available called Stella. The course focuses on the fundamental concepts of system dynamics modelling such as positive and negative feedback structures as well as causal loop diagrams. System dynamics model formulation and simulation is introduced; rate equations and auxiliary equations, delays and graphical converters. Furthermore, policy and sensitivity analysis will be discussed. The course will focus on technical, ecological and economical topics and how they are linked. However, it will also cite examples of a greater variety, such as epidemical studies, interpersonal communications and group dynamics. Practical examples will be analysed both regarding business as well as public policy. The coupling between soft systems, such as decisions and human reactions and physical systems will be trained. By the end of the course the students will hopefully agree that modelling is both fun and useful.

Reading material; Teaching and learning activities; Assessment methods: To be announced in the learning management system (Canvas) at the beginning of the semester.
Language of instruction: English.

T-807-QUAL **QUALITY MANAGEMENT** **6 ECTS**

Year of study:	First or second year MSc.
Semester:	Fall.
Level of course:	5. Second cycle, intermediate.
Type of course:	Elective. *Recommended elective for MSc Engineering Management.*
Prerequisites:	It is assumed that students have at least minimum background in statistics. It is also important that students have finished an undergraduate degree or have considerable experience in management.
Schedule:	Runs for 3 weeks - 4 teaching hours a day.
Supervisor:	Helgi Þór Ingason.
Lecturer:	Helgi Þór Ingason and external lecturers.

Learning outcome: Students who conclude this course can:
• Explain the nature and meaning of quality management as a scientific discipline, explain its history and main concepts and argue for its utility and limits in the management of organisations.
• Explain the connection between quality management and popular ideas/methods/concepts such as lean and 6 sigma.
• Use the practices of continuous improvement, processes, tools and techniques, in the analysis and solviing of real problems, put forward suggestions for problem solving and explain them verbally and in written text.
• Assess the capability of processes and present simple SPC charts.
• Explain the nature and structure of ISO9001.
• Assess the status of an organization in context with ISO9001, designed a very simplified version of a quality manual and deliver professional output verbally and in written text.

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, certificiation and audits. Statistical quality control, use of SPC and process capability.

Reading material: Helgi Þór Ingason, *Gæðastjórnun*, Forlagið 2015 *(available in Icelandic or English).*
Teaching and learning activities: To be announced.
Assessment methods: Project A (30%). A group project in continuous improvement, to be explained more specifically. Groups suggest problems to solve. The assessement 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%) will be based on all the compendium.

Language of instruction: English.

T-808-NOLI **APPLYING MODELS IN MANAGEMENT** **8 ECTS**

Year of study: 5th year (2nd year MSc).
Semester: Fall.
Level of course: 6. Second cycle, advanced.
Type of course: Elective. *Recommended elective for MSc Engineering Management.*
Prerequisites: Calculus I (T-101-STA1), Statistics I (T-302-TOLF), Operation Research (T-403-ADGE), Simulation (T-502-HERM). 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.
Schedule: Runs for 12 weeks - 6 teaching hours a week.
Supervisor: Páll Jensson.
Lecturer: Páll Jensson, Matthías Sveinbjörnsson.

Learning outcome: 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 develope OR models for managers with Excel and also other tools like MPL and Simul8, having had the training and developed the necessary insight to use mathematical models in real life situations.

Content: This course is thought as a final course in the field of Operations Research ans 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

Reading material: *Management Science Modeling*, Winston & Albright Note that we will not follow the textbook chapter by chapter as it is organized in a different way than the course. Further reading: *Optimization in Operations Research*, Ronald L. Rardin.
Teaching and learning activities: Lessons will mostly be used for discussions. The teacher will start the discussions with examples/case studies that show applications of models in real life management. After that there will be discussions analyzing the needs for models in the field of management under consideration. Each session will end with a discussion about next home assignment.
Assessment methods: 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.
Language of instruction: English.

T-809-DATA **DATAMINING AND MACHINE LEARNING** **8 ECTS**

Year of study:	First year MSc.
Semester:	Fall.
Level of course:	5. Second cycle, intermediate.
Type of course:	Core for all MSc programs in engineering.
Prerequisites:	No mandatory prerequisites. Basic knowledge of calculus, linear algebra, statistics and programming and statistics is assumed.
Schedule:	Runs for 12 weeks - 6 teaching hours a week.
Supervisor:	Jón Guðnason.
Lecturer:	Jón Guðnason and Eyjólfur Ingi Ásgeirsson.

Learning outcome:
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.

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.

Reading material: Christopher Bishop. *Pattern Recognition and Machine Learning.* Springer Science and Business Media. 2006. Richard O. Duda, Peter E. Hart, David G. Stork. *Pattern Classification,* 2nd edition, John Wiley and Sons. 2001.
Teaching and learning activities: To be introduced at the beginning of the semester.
Assessment methods: To be introduced at the beginning of the semester.
Language of instruction: English.

T-810-OPTI **OPTIMIZATION METHODS** **8 ECTS**

Year of study:	First or second year MSc.
Semester:	Fall.
Level of course:	5. Second cycle, intermediate.
Type of course:	Core for MSc Engineering Management (in 1st year MSc) and MSc Financial Engineering (in 2nd year MSc).
Prerequisites:	Operation Research (T-403-ADGE).
Schedule:	Runs for 12 weeks - 6 teaching hours a week.
Supervisor:	Hlynur Stefánsson.
Lecturer:	Hlynur Stefánsson.

Learning outcome: 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 analyze and solve complex decision problems;
- Use and analyze different forms of linear optimization models;
- Understand and be capable of analyzing the geometry of linear optimization;
- Apply systematic methods and algoirthms for analysing and solving decision problems;
- Understand the importance and usefullness of linear optimization and its applications;
- Apply software to solve optimization models;
- Implement solution methods for linear optimization models and have in-depth understanding of the mechanics of the Simplex methods;
- Practice the use of sensitivity analysis and to derive 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;
- Understand the special properties of network models and formulate practical problems as network models;
- Understand the nature of non-linear optimization problems and the challenges involved in solving the problems;
- Be familiar with different classes on non-linear optimization models and some of the available solution methods and algorithms;
- Understand the importance of optimization under uncertainty and be able to develop robust programming, change constraints and stochastic programming models;
- Be familiar with dynamic programming;
- Present results in a clear and organized manner.

Content:
Overview and approach: This course introduces the concepts of linear, discrete, stochastic, nonlinear and dynamic optimization. Emphasis is on methodology and the underlying mathematical structures. Topics include basic principles and techniques for implementaiton of optimization models, the theoretical foundations of LP and the Simplex method, sensitivity analysis and applications, robust optimization and chance constraints, stochastic programming (with recourse), introduction to NLP and examples, one-variable and multivariable unconstrained optimization, KKT conditions, quadratic programming and separable programming, convex and nonconvex programming.

Reading material: Hillier and Lieberman, *Introduction to Operations Research,* 10th Edition, Pearson 2014.
Teaching and learning activities: Lectures, exercises, group work, individual homework, mid-term exams, final exam.
Assessment methods: Final exam 50%, mid-term exams 20%, group work 10%, homework 10%, reports 10%.
Language of instruction: English.

T-811-PROB **APPLIED PROBABILITY** **8 ECTS**

Year:	First year MSc.
Semester:	Fall.
Level of the course:	5. Second cycle, intermediate.
Course type:	Core for MSc Engineering Management and MSc Financial Engineering.
Prerequisites:	Probability and Stochastic Processes (T-606-PROB).
Schedule:	Runs for 12 weeks- 6 teaching hours a week.
Supervisor:	Heiðar Ingvi Eyjólfsson.
Teacher:	Birgir Arnarson.

Learning outcomes: This course will cover some important topics in probability theory with particular emphasis on their application to practical problems. At the end of the course the student will have an appreciation of the important role probability plays in various areas of engineering and be able to apply it to a range of concrete real world problems. The learning outcomes can be broken down into the following suboutcomes:

- Understand the basic concepts of probability distributions and their role in the modelling of uncertain outcomes – both in the discrete and the continuous case
- Use expectation, variance and covariance to model various probabilistic phenomena
- Understand the role of probability in Reliability applications
- Understand Poisson processes, birth and death processes and Markov processes and their roles in the modelling of queues
- Understand different types of queues and their classification
- Be able to estimate the performance of different queueing systems in terms of quantities such as, queue length, expected waiting time or the probability of system blockage
- Understand the role of stochastic processes in financial applications
- Understand and be able employ Itô's lemma in financial applications
- Understand how no-arbitrage and replication assumptions can be recast in a probabilistic framework in terms of a so-called risk-neutral probability measures

Content: This course will start by recalling some basic concepts in probability theory. Important discrete and continuous probability distributions will be introduced and applied to concrete problems. The concepts of expectations, variances and covariances will be recalled and applied to selected problems. Poisson and death – birth processes are discussed with several applications, including queueing theory. Applications of reliability theory are introduced. Basic stochastic processes such as Brownian motion and their important role in the modelling and management of uncertainty will be discussed. Applications to pricing financial derivatives under no arbitrage and replication assumptions will be discussed. Elements of Itô calculus are employed to derive and motivate the Black-Scholes model, to price derivatives and discuss the so-called Greeks. Finally, the no-arbitrage and replication assumptions are reformulated in a probabilistic risk-neutral probability framework via a change of measure. Throughout the course examples and applications to various practical problems will be considered.

Reading material: Lecture notes will be handed out. Main books: Sheldon M. Ross, *Introduction to Probability Models*, 11th edition, Academic Press, 2014; and Fred Espen Benth, *Option Theory with Stochastic Analysis: An Introduction to Mathematical Finance*. Springer-Verlag. 2004. Supplementary material on financial applications and stochastic calculus: Louis-Pierre Arguin, *A First Course in Stochastic Calculus*. American Mathematical Society, 2022; Thomas Björk, *Arbitrage Theory in Continuous Time.* Oxford University Press. 2004. Supplementary material on Probability Theory: Hossein Pishro-Nik, *Introduction to Probability Statistics and Random Processes,* available at https://www.probabilitycourse.com/. Kappa Research LLC. 2014.

Teaching and learning activities: Interactive lectures, projects and class exams.
Assessment methods: The final grade will consist of: Student led recitations and assignments 10%; Class exams 30% (best 2 grades out of 3); Final exam 60%.
Language of instruction: English.

T-814-FINA **FINANCIAL ENGINEERING IN THE FIRM** **8 ECTS**

Year of study:	4th year (1st year MSc).
Semester:	Fall.
Level of course:	5. Second cycle, intermediate.
Type of course:	Core in MSc Financial Engineering, elective in other programs.
Prerequisites:	Undergraduate degree in engineering plus selected finance courses such as Securities, Derivatives, Corporate Finance and Risk Management. **Other recommended prerequisites:** Good programming knowledge in Excel, Matlab or Python.
Schedule:	Runs for 12 weeks – a total of 72 teaching hours.
Supervisor:	Sverrir Ólafsson.
Lecturer:	Sverrir Ólafsson.

Learning outcome: This course will analyse the financial performance of firms, both from theoretical and practical perspective. An emphasis will be on the analyses of value creation and the factors that drive it. The theory of investment choice will be developed under conditions of certainty and uncertainty. We will introduce real options as an extension to NPV approach with applications to several practical situations. Considerable effort will be focused on capital structure and its relation to market value of equity and debt as well as credit spread on debt and the probability of corporations defaulting on their debt payments. In addition, various structured financial instruments will be designed and priced and their use in risk management will be compared with the use of more conventional techniques such as forward contracts and vanilla options.

Knowledge*:* On completion of this course, the students will have an extensive knowledge of the complexities of corporate financial matters and the range of models and techniques that have been designed to manage the performance of firms and the variety of financial risks they are exposed to. Students will appreciate the application of the theory of investment choice under certainty or uncertainty. They will understand the importance and the limitations of NPV and IRR methods and the application to real investment scenarios and the valuation of projects/firms. They will appreciate the implications of capital structure and the value of leverage as well as the role of risk capital and the role of corporate value drivers. Appreciate the construction and the application of a range of synthetic financial contracts for risk management purposes

Skills*:* On completion of this course, students will be able to apply their acquired knowledge of financial engineering techniques to a whole range of important situations, either everyday pop-up problems or medium to long term strategic issues relating to investment decision or the designing of risk management strategies.

Competence*:* On completion of this course, students will have a good understanding of how to analyse complex financial situations and be able to apply successfully the appropriate techniques to each given situation.

Content: The course will analyse financial variables that critically contribute to corporate value creation. Different valuation models will be introduced and applied to concrete and 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. The CAPM will be linked with the theory of options and the resulting structure used 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.

Reading material:	Provided by the teacher, will be introduced in the first lectures.
Teaching and learning activities:	Interactive lectures, projects and class exams.
Assessment methods:	Continuous assessment; 35 - 40% projects, 60 – 65% class exams. No final exam.
Language of instruction:	Icelandic/English

T-814-PROD MANAGING RESEARCH AND DEVELOPMENT – METHODS AND MODELS 8 ECTS

Year of study: First or second year MSc.
Semester: Fall.
Level of course: 5. Second cycle, intermediate.
Type of course: Elective.
Prerequisites: No prerequisites.
Schedule: Runs for 12 weeks - 6 teaching hours a week (3 hours lectures and 3 hours project work).
Supervisor: Páll Kr. Pálsson.
Lecturer: Páll Kr. Pálsson.

Learning outcome: At the end of the course the students shall have reliable knowledge of the methods used creating innovation basis and **be capable to develop and construct a system for managing innovation in companies.**

Knowledge:

- Understand the presumption for success and the reasons for mistakes in innovation within companies.
- Understand how companies can develop, maintain and increase their skill for innovation and the value of innovation and initiative thinking for the existence of companies.
- Knowing companies methodology for developing products and innovation and pioneer thinking and the development of new products (goods and service).

Skills:

- Be familiar with companies methodology for developing products and innovation and being able to use it.
- Posses good knowledge of the main items of the innovator science and adaptation and integration of the knowledge of individual employees in order to create strong teams.
- Be able to evaluate the reasons for success and evade mistakes in innovation within companies.

Competence:

- Can by themselves take on a systematical construction and the processes connected to innovation in companies and possess the understanding, skill and knowledge to manage the development and running of such systems within companies.
- Be able to introduce and interpret the conclusions and proposals on the above mentioned fields and be able to express themselves on those issues.

Content: We cover the engineering approach to innovation and entrepreneurship in lectures and a practical program in which students work in an active company.

Due to increasing freedom in trade and internationalization the competition between companies is boosting. At the same time consumers demand new solutions, and the technology developes, resulting in older solutions becoming obsolete. Such conditions require constant innovation in companies management and an understanding of the nature of innovation and entrepreneurship. Innovation is not only necessary in technological companies, but in all companies that intend to live and prosper.

The course will cover innovation and the ability companies have for innovation in light of market, science, engineering, planning and financial presumptions. We deal with the terms innovation and entrepreneurship and their significance for modern management and put in context with success. We will also cover the value of knowledge, intellectual property rights and patent rights. Then we cover the internationalization and its impact on the innovation process.
Special emphasis will be put on systematic development of the processes connected to innovation and worked on a project in a real company in this field.

The aim is that the students aquire an understanding of the cause of success and mistake in innovation within a company and how companies can increase their ability for innovation and the importance of innivation and initative thinking for the existence of companies.

Students will, at the end of the course, have aquired a steadfast knowledge of the method applied within product-developement and innovation in companies and be able to apply them on their own in the furture.

Reading material: *Integrated Product Development*, (IPD). Authors: Andreasen, M. Myrp & Lars Hein. *Handbók athafnamannsins; Stefna, stjórnun og starfsmenn* (marked HASS). Author: Páll Kr. Pálsson. *Handbók athafnamannsins; Gerð rekstrar og viðskiptaáætlana* (marked HARV) Author Páll Kr. Pálsson. Various other reading material, also links to websites and articles connected to the study material.
Teaching and learning activities: Lectures and project work.
Assessment methods: Reports (4), each 18% total 72%. Verbal exam 28%.
Language of instruction: English.

T-815-FIXE **FIXED INCOME AND INTEREST RATE MODELLING** **8 ECTS**

Year of study:	5th year (2nd year MSc).
Semester:	Fall.
Level of course:	6. Second cycle, advanced.
Type of course:	Core for MSc Financial Engineering, elective for other programs.
Prerequisites:	Undergraduate degree in engineering plus selected finance courses such as Securities, Derivatives, Corporate Finance and Risk Management. **Other recommended prerequisites:** Financial engineering of the firm (T-814-FINA) and Derivatives and Risk Management (T-814-DERI).
Schedule:	Runs for 12 weeks – a total of 72 teaching hours.
Supervisor:	Sverrir Ólafsson.
Lecturer:	Sverrir Ólafsson.

Learning outcome: At the end of the course, the student will have an appreciation of the important role fixed income and interest rate models play in financial engineering. They will be familiar with a whole range of different fixed income instruments, ranging from conventional Government bonds to instruments that have cash flows contingent on market indices, the price of various commodities or the inflation level in the economy.

Different risk management techniques in fixed income will be introduced such as those based on duration and convexity. Techniques to immunize bond portfolios against movements in interest rates will be introduced and applied to concrete government and corporate bonds.

Techniques to extract the term structure of interest rates from interest rate sensitive instruments, such as bonds and swaps, will be discussed and applied. For this purpose, we will consider various curve and parameter fitting techniques, such as cubic and constrained splines as well as maximum likelihood estimation.

Finally, stochastic interest rate models will be introduced and their relationship to the term-structure equation (a partial differential equation) discussed. Within this framework, we will discuss how the parameters of some stochastic models can be fixed by using historical data.

Knowledge*:* On completion of this course, the students will appreciate the structure of fixed income instruments and the fixed income markets. They will be familiar with techniques to price different instruments, from simple Government bonds to complex corporate instruments with payoffs contingent on the behavior of some market variables – including interest rates. They will also appreciate the risks in issuing or holding fixed income instruments and how these risks can be hedged.

Skills*:* On completion of this course, the students will be able to apply basic and advanced techniques to price and hedge different positions in fixed income instruments. They will be able to construct bespoke structured financial instruments with terminal payoff profiles designed to manage the risk exposure of the issuer to a whole range of market variables, such as inflation and oil market prices. They will be aware of the alternative use of these instruments to the more conventional contracts in vanilla derivatives.

Competence*:* On completion of this course, the students will have an extensive understanding of the fixed income markets, including its important role for companies seeking debt funding as an alternative to bank loans or equity. They know how to price and risk manage various fixed income instruments and have an understanding of the interconnection between the prices of fixed income instruments and the term structure of interest rates.

Content: The focus of this course is on fixed income securities. Various types of bonds will be introduced, such as fixed and variable rate bonds, zero coupon and coupon paying bonds. Also, bonds that include various options, such as equity conversion, withdrawal rights (callable bonds) and sell back rights (putable bonds) will be discussed. Various models for the term structure of interest rates will be introduced as well as techniques to construct the term structure by using a range of different interest rate instruments.

Risk modelling for fixed income securities is an important activity for bond portfolios. We will demonstrate, by the use of models and examples, how value at risk, duration and convexity are applied in managing and quantifying bond portfolio risks. We will discuss the immunization of bond portfolios and the construction of bond portfolios that cover certain future cash flow liabilities. To manage inflation risk we introduce inflation indexed instruments such as bonds and swap contracts.

Finally, we will cover basic stochastic processes for fixed income analysis and use both binomial trees and continuous processes for the construction of some well-known interest rate models such as, Vasicek, Hull-White, Ho-Lee, and Black-Derman-Toy. These models will be applied to the construction of the term structure of interest rates and to the pricing of bonds and derivatives on interest rate instruments.

Reading material: Provided by teacher, will be introduced in the first lectures. Additional material: Pietro Veronesi, *Fixed Income Securities*, John Wiley, 2010, ISBN 978-0-470-10910-6.

Teaching and learning activities: Interactive lectures, projects and class exams.

Assessment methods: Continuous assessment; 35 - 40% projects, 60 – 65% class exams. No final exam.

Language of instruction: Icelandic/English.

T-828-BIOM **ADVANCED BIOMECHANICS** **8 ECTS**

Year of study: 4th year (1st year MSc).
Semester: Fall.
Level of course: 5. Graduate (Second cycle), intermediate.
Type of course: Elective. *Recommended elective for MSc Biomedical Engineering.*
Prerequisites: Biomechanics (T-561-LIFF). Knowledge of structural mechanics is recommended.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervising teacher: Magnús Kjartan Gíslason.
Lecturer: Magnús Kjartan Gíslason.

Learning outcomes: At the end of the course, the student will have a basic understanding of the material composition of various tissues in the body and their properties. The students will also know about the various different types of materials used in orthopaedic surgery and how those materials are going to interact with the body. Understanding of prostheses for amputees, orthoses and their design

Knowledge**:** At the end of the course, the student will have knowledge on
- Material properties of bones, ligaments, tendons and cartilage
- Basic calculations on tissue properties based on measurements
- Time dependent properties of biological materials
- How metals interact with bone and long term effect on the bone.
- Carry out measurements on biological tissue and assess uncertainties
- Total joint arthroplasty and joint prosthesis design
- Prostheses for amputees and orthoses
- Medical device regulatory aspects

Skills**:** At the end of the course, the student will have skills in:
- Quantifying parameters of biological tissue
- to design measurements involving biological tissue and interpret the results
- to be able to identify the clinical aspect of materials used in surgery
- to be able to identify design features of prosthesis and orthoses design
- to be able to understand the procedures in placing a medical device on the market.

Competence**:** At the end of the course, the student will gain competence on:
- Evaluating measurements on biological tissue, what results are to be expected and limitations.
- Assessing which materials are appropriate for various types of surgical procedures
- Assessing design features in various different types of prostheses, orthoses and how to put them on the market.

Description: The fundamentals of biomaterials are introduced and how the mechanical properties of tissue can be evaluated. Post-processing of bending tests on animal bone, tensile testing on human tendons and measurements on orthopaedic implants will be carried out as well as discussing the limitations of such measurements. Difference between in-vivo and in-vitro will be discussed. The loading conditions on various joints of the body will be discussed and how they will dictate the design criteria for an orthopaedic implant. Visit to surgeons will be made and the students will get a clinical perspective on the application of biomaterials. Visits to Össur prosthetics where the design principles of prostheses and orthoses will be introduced.

Reading material: Selected papers in biomechancis and other in-depth material distributed by teacher. Suggested reading: Ayyana M. Chakravartula and Lisa Pruitt, *Mechanics of Biomaterials: Fundamental Principles for Implant Design*.
Teaching and learning activities: Lectures, lab work, discussions.
Assessment methods: Coursework (50%), Presentation on a selected topic in biomechanics/biomaterials (20%) and final exam (30%).
Language of instruction: English.

T-862-IMAG **MEDICAL IMAGING AND MODELLING** **8 ECTS**

Year of study: 4th year (1st year MSc).
Semester: Fall.
Level of course: 5. Second cycle, intermediate.
Type of course: Core for MSc Biomedical Engineering.
Prerequisites: BSc degree in biomedical engineering. That means adequate coverage of mathematics, physics including modern physics and physiology. Students should also have knowledge in electrical theory, electronics, automatic control theory, computers and signal processing.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Þórður Helgason.
Lecturer: Þórður Helgason.

Learning outcome: At the end of the course the student should...

- .. have a thorough understanding of the tomography image reconstruction methods.
- .. know the functional principle of computer tomography devices.
- .. know the functional principle of magnetic resonance imaging devices.
- .. have a thorough understanding of the functional principle of positron emitting tomography devices (PET), running cost and clinical advantage.
- .. have a thorough understanding of the functional principle of ultrasound imaging, running cost and clinical advantage.
- .. know to a thorrough dept the technique of own choose and corresponding devices in the frame of PET or ultrasound imaging.
- .. have exercised the assembly of a CT device
- .. be able to choose components and assemble a simple computer tomographic device
- .. have exercised the use of image reconstruction algorithms
- .. be able to estimate the quality of slice images and see ways to improve them
- .. have exercise in estimating technical properties of tomographic images.
- .. know the basics of ultrasound current source imaging, be able to estimate what technology is necessary for its realisation and its diagnostic and monitoring possibilities.
- Know the procedures of taking imaging data and convert into 3D model
- Know how material properties of bone can be extracted from a calibrated CT image

Content: The main theme in imaging is tomography as realised in computer tomography (CT), magnetic resonance imaging (MR), positron emitting tomography (PET) and ultrasound imaging. Emphasis is on sensors, methods and algorithms for image reconstruction, and the architecture of the devices.
Students choose two projects they deliver towards the end of the semester. One project is in the field of imaging and the other in modelling. The former will be delivered by a report, lecture slides and a 35 minutes lecture with 10 minutes for questions and discussion. This material is a part of the course for all participating students. Reports and presentations are made accessible for students.
The latter is a modelling project and deliverable is a short report. The goal is that the student acquires a thorough understanding of his own theme and a good understanding of the themes of his fellow students. In the imaging the assignment can be in the frame of positron emitting tomography (PET) or in ultrasound imaging technology. Every student takes one aspect of the imaging chain and in summary the reports should give a good understanding of PET and ultrasound imaging. The later assignment is in the frame of modelling. Its purpose is to train FEA methods and to demonstrate how going from CT/MRI scans to a 3D model to a finite element model can be achieved.
Ultrasound current source density imaging is an emerging technology, technology in development. This is an attempt to investigate the future. The fundamental physics of the method are covered, main properties and the need for technological developments. Then the possibilities in diagnostic and therapy monitoring will be discussed. Loadstar of the coverage is how physiology, physics, mathematics and electronic are applied to define the system and used for its design.

Prerequisite of the course is a BS degree in biomedical engineering. That means adequate coverage of mathematics, physics including modern physics and physiology. Then students should have knowledge in electrical theory, electronics, automatic control theory, computers and signal processing.

Reading material: The book from John Enderle and Joseph Bronzino: „Introduction to Biomedical Engineering“ newest edition serves as a basic literature.
Students and teacher will gather new articles representing the forefront of each technique in order to capture the state of the art in each field. This is especially important in fast evolving areas medical imaging. Students are encouraged to make a thorough literature search in for their chosen projects and list them in their references.
We also refer to the book from John G. Webster: „Medical instrumentation, application and design“ published by John Wiley and Sons 2010 as many students have that book
Teaching and learning activities: Lectures, problem oriented classes, projects and visits.
Assessment methods:

1. Exercise of the week,
   To acquire right to take the final exam at least 80% of the exercises of the week have to be finished with a minimum average grade of 6,0. That is eight out of ten.
2. 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.
3. Practical exercise - 20%
   One practical exercise will be done during the semester. See exercise description.
4. Oral exam - 50 %
   In the end of the semester. The oral exam has to be successful, meaning grade 6,0 or higher, in order to have the above items accounted 50 %

Language of instruction: English.

T-862-NEUR NEURO-SCIENCE AND TECHNOLOGY 8 ECTS

Year of study: 4th year (1st year MSc).
Semester: Fall.
Level of course: 4. / 5. Second cycle, introductory / intermediate.
Type of course: Elective. *Recommended elective for MSc Biomedical Engineering.*
Prerequisites: Students entering the course are expected to know the basics of molecular biology, cell biology, physiology and electronics.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Karl Ægir Karlsson.
Lecturer: Karl Ægir Karlsson.

Learning outcome: At the end of the course the student should be familar with novel developments at the intersection of neuroscience and technology, where leaps in neural understanding are likely to emerge from a beneficial crosstalk with technology.

Content: The course is devided in five topics. First there is a review of basic neuroscience anatomy and principles followed by in-depth look at four seperated topics each representing an emerging field at the intersection of neuroscience and technology. This is revised every year. The topics explored over the course of the last few years have been (for example): Brain-machine-interfacing, the use of brain organiods in basic research, optogenetics and „neural dust“. The review at the beginning is also amended each year to best support the topics to follow. Only during the review a textbook is used, in all other topics original papers are carefully disected; most of the papers are within 12-months from publication.

Reading material: No textbook is required, all materials are provided by the teacher.
Teaching and learning activities: The course is taught seminar style - where students present chapters/papers to the class.
Assessment methods: Assessments are given for the quality of the in-class presentation (understanding of the material, questions raised, etc) and for the in-class exam given after each module of the class. There are two presentations for each student which account for 40% of the grade (20% each) and three short exams, 20% each. There is no final exam.
Language of instruction: English.

T-861-SOSE SOLID STATE ELECTRONIC 8 ECTS

Year of study: 3rd year BSc / 1st or 2nd year MSc.
Semester: Fall.
Level of course: 3. First cycle, advanced / 4.-5. Second cycle, introductory-intermediate.
Type of course: Elective.
Prerequisites: Physics II (T-202-EDL2; mandatory), Mathematics III (T-301-MATH; recommended).
Schedule: Tutorial course. Student reading and self-study, regularly scheduled meetings with teacher.
Supervisor: Andrei Manolescu.
Lecturer: Andrei Manolescu.

Learning outcome: Knowledge about the behavior of electrons in solid materials, and especially in semiconductors. Conduction properties of metals and semiconductors. Understanding basics of modern micro and nanotechnology.

Content: Quantum mechanics of electrons in solid materials. Energy bands. Electrical conductivity. Intrinsic and doped semiconductors. pn junction. Solar cells. Nanowires.

Reading material: Young and Freedman, *University Physics*, Chapters 40-42 (Pearson, any edition). B. G. Streetman, *Solid State Electronic Devices* (Pearson, any edition).
Teaching and learning activities: Lectures, reading, discussions.
Assessment methods: The final exam consists of a selected topic presented by the student in a written and oral form.
Language of instruction: English.

T-863-EIIP **ENERGY IN INDUSTRIAL PROCESSES** **8 ECTS**

Year of study: 3rd year (final year BSc) /4th or 5th year (first or second year MSc).
Semester: Fall.
Level of course: 3. First cycle, advanced / 4. Second cycle, introductory.
Type of course: Elective. *Recommended elective for MSc Electrical Power Engineering, MSc Energy Engineering, and MSc Mechanical Engineering.*
Prerequisites: N/A
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Guðrún Arnbjörg Sævarsdóttir.
Lecturer: Guðrún Arnbjörg Sævarsdóttir.

Learning outcome:
On the completion of the course, the following criteria shall be fulfilled:

Knowledge: Upon completion of the course, students should have good understanding of:
- how electricity can be turned into products
- how Enthalpy and Gibbs energy shape energy intensive production processes
- the use of mass- and energy balance for process analysis
- how production processes, raw materials, energy sources, energy demand and finished products affect the environment and how such effects can be minimized
- the fundamentals of silicon and aluminium smelting and refining

Skills: On completion of the course, the student should be able to:
- apply mass and energy balance to explain the main principles in energy intensive processes
- calculate the energy and gas flow in a combustion process
- calculate the energy needed for aluminium and silicon smelting
- set up feasibility models for simple projects

Competence: On completion of the course, the student should be able to utilize the knowledge and skills to:
- promote and stimulate innovation in energy utilization
- set up process models to verify feasibility and environmental effects of processes

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 focus is on the industrial processes that are prevalent in Iceland, aluminum and silicon. In addition, other energy intensive processes such as cement production, mineral wool, fertilizer and synthetic fuel are discussed.
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. In addition, the economic background i.e. the cost, profit and market conditions are addressed.
Field trips are an integral part of the course.

Reading material: To be announced.
Teaching and learning activities: Lectures, field trips, and discussions. Guest lectures from industry.
Assessment methods: Two mandatory field trips. Assignments (10%), individual projects (20%), group project (40%) and oral exam (30%).
Language of instruction: English.

T-865-MADE	**PRECISION MACHINE DESIGN**	**8 ECTS**

Year of study:	First year MSc.
Semester:	Fall.
Level of course:	5. Second cycle, intermediate.
Type of course:	Core for MSc Mechanical Engineering, elective for other programs.
Prerequisites:	Statics and Mechanics of Materials (T-106-BURD)
Schedule:	Runs for 12 weeks –6 class hours a week.
Supervisor:	Joseph Timothy Foley.
Lecturer:	Joseph Timothy Foley.

Learning outcome: : On completion of the course the student should be able to:

- Interact with stakeholders to collect and organize Customer Needs
- Apply Axiomatic Design to develop Functional Requirements, Design Parameters, and Design matricies/decompositions
- Analyze error budgets in machine design and propose improvements
- Create effective design documents including reports, risk assessment, and time assessment
- Competently use version control and CAD as part of a team
- Present ideas effectively for customers and peers
- Design and perform experiments to test design choices
- Build prototypes of concepts
- Analyze the performance of prototypes through experiments

Content: This course covers a systematic approach to designing machines able to reliably and repeatedly perform a task. Factors that are of minor importance for low-performance simple machines can quickly become impossible obstacles without the right tools and techniques. The tools introduced in this class is Axiomatic Design Theory. In this class these techniques will be applied for designing and building high-perfomance machine(s) with our sponsors. Customers will be interviewed to develop Customer Needs(CN). From these CNs, Functional Requirements and Design Parameters will be developed to evaluate possible solutions. The chosen solution(s) will be prototyped and evaluated. LaTeX/Overleaf is introduced for documentation generation with git as a mechanism for collaboration and version control. There is a high expectation of documentation and mathematical analysis.

Reading material: *Design Engineering Science,* By Nam P. Suh, Miguel Cavique, and Joseph T. Foley. Springer 2022

Teaching and learning activities: Design is a heavily interactive communication process and this will be reflected in the teaching of this class. Students will be given interactive lectures on material then are expected to apply this material to practical problem sets and hands-on labs. Students will be doing peer reviews of each other's written work. Students will be presenting their ideas in design reviews to get proper feedback and develop collaboration skills. Students will be applying these real-world skills on a term project with an outside sponser to develop a high-end precision machine. We will be using some existing equipment to demonstrate such concepts and building others as part of the course. Expect to get your hands dirty disassembling machinery, programming robotic machines, and building new machinery.

Assessment methods: No final exam. An oral exam will be performed to assess knowledge of the material. Basic skills will be assessed through weekly individual assignments. The majority of the assessment is from final project presentation, report, and video or poster. Students must be able to effectively communicate their ideas through written and oral methods. Students will each have a design notebook which must will be assessed regularly.

Due to the high participation required to execute successful teamwork on a final project, there is a 67% attendance requirement. If you have lower than this attendance, you will not pass the course regardless of your other grades.

The final project will be evaluated on these three aspects: process, documentation, product/result. Whenever possible, grading rubrics and checklists will be provided to students in the assignment description.

Proper citation is a requirement in this class, without exemptions. This is most relevant for reports and presentations. All material from an outside source (ideas, text, pictures) must include a proper citation. IEEE is the preferred citation format. Failure to include citations will result in a 0 for the assignment and considered plagiarism. You are explicitly given permission to use the RU logo on your reports and presentations without citation because you are enrolled at our university.

Late work will be penalized according to the degree of lateness. The penalty is 10% per day late, to a maximum penalty of 5 points. Late work will only be accepted up to 1 week late or until the end of finals, whichever is shorter. Individual assignments will not be accepted after solutions are presented.

Language of instruction: English.

T-866-POEL POWER ELECTRONICS 6 ECTS

Year of study: 3rd year BSc / 1st or 2nd year MSc.
Semester: Spring. *In fall semester 2022, the course is taught as a 12-week course with RT PWR 1003 Power Electronics in the Department of Applied Engineering.*
Level of course: 5. Second cycle, intermediate.
Type of course: Elective. *Recommended elective for MSc Electrical Power Engineering.*
Prerequisites: No prerequisites.
Schedule: Runs for 12 weeks - 6 teaching hours a week. *In fall semester 2022, the course is taught 6 hours a week for 12 weeks.*
Supervisor: Ragnar Kristjánsson / Guðmundur Kristjánsson.
Lecturer: NN.

Learning outcome:
Knowledge
- Students should learn basic ideas of how to generate AC voltage from DC and DC voltage from AC voltage
- Students should learn basic ideas of how to control electric power
- Students should learn the fundamental operation and performance of power electronics.

Skills
- They should ba able to calculate the main values of power electronic circuits
- They should be able to use main methods of power electronic converters
- They should gain adequate experience and skills of using computer simulation to design and test simple converters.
- Their experience of group working/discussion for solving the problems and presenting their solutions, should be developed.

Competence
- They should be able to describe, analyze, design and calculate simple power electronic converters behaviour.
- They should be able to investigate, simulate and evaluate simple power electronic converters performance.

Content: Introduction to power electronics and electronic switches. Power computations for AC waveforms. DC-DC converters; the buck converter, the boost converter and non-ideal switches and converter performance. DC Power Supplies; the flyback converter, the forward converter, and full-bridge and half-bridge DC-DC converters. DC-AC inverters; full and half-bridge converters, pulse-width-modulated output, and three-phase inverters. AC-DC rectifiers; half-wave, controlled half-wave, full-wave, single-phase, full-wave, controlled and three-phase. AC voltage controllers; single-phase and three-phase. Resonant converters. Drive circuits, snubber circuits, and heat sinks.

Reading material: Daniel M. Hart, *Power Electronics*, McGraw-Hill 2011.
Teaching and learning activities; Assessment methods: Will be introduced in the learning management system Canvas at the beginning of the semester.
Language of instruction: English.

T-866-HIVO **HIGH VOLTAGE ENGINEERING** **8 ECTS**

Year of study: First year MSc.
Semester: Fall.
Level of course: 5. Second cycle, intermediate.
Type of course: Core for MSc Electrical Power Engineering, elective for other programs.
Prerequisites: No prerequisites.
Schedule: Runs for 12 weeks – 6 teaching hours a week. ***In fall semester 2020, the course is run as an intensive, project oriented course for 3 weeks – 4 teaching hours a day.***
Supervisor: Ragnar Kristjánsson.
Lecturer: NN.

Learning outcome:

Knowledge: By the end of the course the students will be able:

- to understand basic concepts and phenomena relevant to dimensioning and evaluation of high voltage (HV) components with regard to electrical, electro-mechanical, and thermal stress of insulators and conductors,
- to identify key component's parameters and define critical quantities/figures of HV components,
- to examine the influence of the identified component's parameters on the critical quantities/figures,
- to differentiate and subsequently prioritise the critical figures with regard to safe and reliable operation of a particular component/insulator, as well as
- to reliably estimate values and uncertainties of relevant figures.

Skills: By the completion of the course the students should be able:

- to identify electric field characteristics (as well other related quantities, e.g., temperature, pressure, current, etc.,) and material parameters appropriate for a particular HV problem,
- to use analytical methods to estimate: HV components/insulation characteristics, potential relief in the electric stress due to proper component dimensioning/grading, possible value of electric field build up due to insulation defects,
- to develop, modify and, use finite-difference numerical codes for computing and visualization of electric fields and voltage distributions,
- to set up and use electric schematic evaluators for steady-state and transient thermal analyses and ampacity evaluation of HV cables,
- to simulate electric stress using CST EM studio,
- to make a state of the art review on a particular HV problem using available databases (e.g., ieeexplore), as well as to evaluate reliability of the available formulas and approaches for HV problems.

Competence: By the completion of the course, the students should have developed a basic vision of existing methods and tools relevant to design and analysis of HV components/insulators.

Completion of the course assignments requires the student (a) to elaborate the work plan for every assignment, (b) to list modelling approximations/assumptions, (c) to define the figures of interest, (d) to configure evaluation tools, (e) to interpret the evaluation results, (f) to present the completed assignment in the form of a report describing the problem formulation, description of methods, results, conclusion, and bibliography.

Content:
• Electric field characteristics. Analytical estimation of electric fields.
• Numerical computing of voltage distributions and electric fields using Finite-Difference codes. Numerical solving of Laplace Equation.
• Numerical analysis of E-fields using CST EM Studio.

• Generation of DC, AC and impulse high-voltages.
• Measurement of DC, AC and impulse high-voltages.
• Breakdown in gases, liquids, and solid dielectrics. Application of insulating materials in electrical components. Design of insulators.
• Overvoltage phenomenon.

Reading material: Will be introduced in the learning management system Canvas at the beginning of the semester.
Teaching and learning activities: Lectures and practical (project) sessions.
Assessment methods: Projects (incl. project reports): 3 x 25% = 75%; Subject reviews (incl. ppt-presentations): 2 x 12.5% = 25%.
Language of instruction: English.

T-867-POSY POWER SYSTEM OPERATION 8 ECTS

Year of study: First year MSc.
Semester: Fall.
Level of course: 5. Second cycle, intermediate.
Type of course: Core for MSc Electrical Power Engineering, elective for other programs.
Prerequisites: Power systems II (T-866-EPS2 or RT RAK2003) or a similar course.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Ragnar Kristjánsson.
Lecturer: Ragnar Kristjánsson.

Learning outcome:
Knowledge: *By the end of the course, the students will be able to;*
• Explain and use the mathematical formulation and use of symmetrical components.
• Model transformers, lines and cables in the positive, negative and zero sequences based on physical models
• Explain the impact of different earthing principles,
• Explain the main principles for modelling and analysis of power systems subject to symmetrical and unsymmetrical faults,
• Describe faulty system operation, balanced and unbalanced faults;
• Understand and explain basic protective methods;
• Use and explain principles for regular power flow and optimal power flow methods,
• Describe power system operation principles and basic functions in energy management system.
Skills: *By the end of the course, the students will be able to;*
• Apply methods for power system analysis in steady state operation and during grid faults
• Apply symmetrical components for unbalanced fault analysis;
• Apply basic system protection principles;
• Perform load flow calculations and use them for steady-state power system analysis;
• Model complex power system operation issues for economic and secure operation;
• Apply optimization techniques to solve fundamental operation problems;
• Perform N-1 steady state contingency analysis;
• Perform basic transmission lines transient operation calculations
• Apply basic methods of Insulation coordination.
Competence: By the end of the course the students will be able to;
• Describe, formulate, model and simulate in general power system operation main issues, including power flow calculations, unbalanced faults calculations, system protection and basic insulation coordination and simple transient calculation.
• Validate general power system operation issues, calculation and simulations outcome.

Content:
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.

Reading material: *Power System Analysis & Design*, Glove, Sarma and Overbye, 2012.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Written exam 70%, Project 30%.
Language of instruction: English.

T-869-COMP COMPUTER VISION APPLICATIONS 6 ECTS

Year of study: First year MSc.
Semester: Fall.
Level of course: 5. Second cycle, intermediate.
Type of course: Core for MSc Mechatronics Engineering, elective for other MSc programs.
Prerequisites: N/A
Schedule: Runs for 3 weeks - 4 teaching hours a day.
Supervisor: Torfi Þórhallsson.
Lecturer: Torfi Þórhallsson.

Learning outcome:
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:
After the course the 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.

Content: Image formation, cameras and projection models, low-level image processing methods such as filtering, edge detection, interest operators, optical flow; mid-level vision topics such as model fitting and image-to-image matching; shape and motion estimation from multiple cameras, multiple-view constraints, probabilistic models and MAP estimationt, robust estimation using RANSAC; high-level vision tasks such as object and scene recognition, tracking using dynamic models and Kalman filtering.

Reading material: Richard Szeliski, Computer Vision Algorithms and Applications. Other materials will be introduced in the first lecture.
Teaching and learning activities: Tutorials, introductory assignments, and supervised final project.
Assessment methods: Assignments (20%); Seminar (10%); Project definition (15%); Demo 1 (20%); Demo 2 (20%); Final Report (15%).
Language of instruction: English.

Courses taught in Spring Semester

SE-833-FA2 **ENERGY FINANCIAL ASSESSMENT** **6 ECTS**

Year of study: First year MSc.
Semester: Spring.
Level of course: 4.-5. Second cycle, introductory-intermediate.
Type of course: Taught in the Iceland School of Energy. Elective for all MSc programs in engineering. Recommended elective for MSc Engineering Management, MSc Financial Engineering, MSc Energy Engineering and MSc Electrical Power Engineering.
Prerequisites: None.
Schedule: Taught during the 12-week teaching period. Schedule will be introduced in the learning management system Canvas.
Supervisor: Juliet Newson.
Lecturer: Páll Jensson.

Learning outcome:
After the course students will be able to develop computer models to assess the profitability/feasibility of investments. This main Learning Outcome can be broken down into the following sub-outcomes:
Knowledge:
- Understand the theoretical basis for profitability assessment and the time value of money
- Understand the relations and the difference between company financial statement
- Discuss and explain with the concepts and principles of accounting and financial management
- Understand the difference between feasibility studies and business plans and the objectives of each
- Understand Multi Criteria Decision Making
- Understand what working capital is

Skills:
- Use and calculate the main measures of profitability including Net Present Value and Internal Rate of Return
- Know and calculate the main ways to finance a project
- Use the three-point method budgeting and investment cost estimations
- Perform sensitivity analysis including impact analysis and scenario analysis of projects
- Do Monte Carlo simulations for risk assessment of projects
- Use Decision Trees as a method for making investment decisions
- Apply the AHP method
- Calculate the most important financial ratios

Competence:
- Write a good business plan including the economical calculations for profitability assessment of an investment project
- Build up Operating Statement, Cash Flow and Balance Sheet for a planned operation
- Present and interpret the results of profitability calculations

Content:
The basic concepts and principles of project finance with emphasis on profitability assessment of projects and feasibility studies. Among items are project profitability measures, planning cash flow, company operating statements, balance sheets and financial ratios. During the course the students develop themselves an Excel model including measures of profitability assessment. The teaching is mainly computer work and group work exercising project feasibility studies, sensitivity analysis and risk assessment applied to a real world case study.

Reading material; Teaching and learning activities; Assessment methods: Will be introduced in the learning management system Canvas at the beginning of the semester.
Language of instruction: English.

T-423-ENOP **ENGINEERING OPTIMIZATION** **6 ECTS**

Year of study:	3rd year BSc / 1st year MSc.
Semester:	Spring.
Level of course:	3. First cycle, advanced / 4. Second cycle, introductory.
Type of course:	Elective.
Prerequisites:	(1) Working knowledge of Matlab programming. (2) Calculus (elementary linear algebra, in particular, vector/matrix operations and linear systems. Basic knowledge of derivatives, including Taylor expansion.
Schedule:	Runs for 3 weeks – 4 teaching hours a day.
Supervising teacher:	Slawomir Koziel.
Teacher:	Slawomir Koziel.

Learning outcome: Upon completing the course, the students should be able to:
(1) Formulate engineering optimization problem, corresponding objective functions and constraints,
(2) Select appropriate optimization/modeling methodology,
(3) Implement basic optimization and modeling procedures as well as develop necessary Matlab code,
(4) Solve problems using existing packages, in particular Matlab and Matlab's Optimization Toolbox,
(5) Visualize the optimization process and the results.

Content: The course introduces the concept and methods of engineering optimization. Major topics discussed throughout the course are: formulation of unconstrained and constrained optimization problems, objective functions, classification of optimization methods, first- and second-order optimality conditions, gradient-based search methods, derivative-free optimization, stochastic search methods including multi-agent systems and evolutionary algorithms, multi-objective optimization, surrogate-based optimization with focus on space mapping, functional and physical surrogate modeling, design of experiments, model selection and validation, as well as solving real-world engineering optimization problems with interfacing of commercial simulators. The relevant material concerning Matlab programming as well as calculus in the scope necessary for the course will also be given.

Reading material: Lecture slides provided by the teacher
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Grades are based exclusively on the assessment of the solutions to the practical exercises. Requirement regarding the solution format and other details will be given during the first lecture.
Language of instruction: English.

T-424-SLEE **SVEFN / SLEEP** **6 ECTS**

Ár: 3. ár/4. ár (lokaár BSc/fyrsta ár MSc).
Önn: Vorönn.
Stig námskeiðs: 3. Grunnnám, sérhæft námskeið / 4. Framhaldsnám, inngangsnámskeið.
Tegund námskeiðs: Valnámskeið.
Nauðsynlegir undanfarar: Engir undanfarar.
Skipulag: Kennt alla daga í 3 vikur skv. sérstakri stundaskrá.
Umsjónarkennari: Karl Ægir Karlsson.
Kennari: Karl Ægir Karlsson.

Lærdómsviðmið: Stefnt er að því að nemendur:
- Öðlist skilning á hvað svefn er
- Öðlist skilning á þeim vandamálum sem hindra að svefn sé að fullu útskýrður
- Að hverju rannsóknum verður beint í nánustu framtíð
- Kunni skil á helstu mæli og úrvinnsluaðerðum

Lýsing: Efnistök námskeiðsins eru meðal annars: Saga svefnrannsókna, taugafræðilegar undirstöður svefns og vöku, samanburður svefns og vöku milli tegunda, hlutverk svefns í þroska og minni, svefnsjúkdómar, áhrif svefnleysis, og virkni svefn og vökulyfja. Lögð verður áhersla á að skoða hagnýtingu svefnrannsókna til dæmis í tengslum við lyfja og tækjaþróun. Engin kennslubók verður notuð - eingöngu verða lesnar viðeigandi frumheimildir; jafnt sígildar sem glænýjar. Námskeiðið er hugsað fyrir nemendur sem eru í MSc námi eða lengra komnir í BSc námi. Gott væri er nemendur hefðu tekið til dæmis: T-106-LIFV eða E-112-LIAT; en nálgunin verður þverfagleg og er því ekki neinn einn bakgrunnur skilyrði fyrir inngöngu (en er háð samþykki kennara). Verklegar æfingar verða hluti af námsmati. Námskeiðið er á íslensku en verkefnum má skila hvort heldur sem er á íslensku, ensku (eða skandinavísku eitthverri).

Lesefni:
Kennsluaðferðir: Haldnir verða hefðbundnir fyrirlestrar en þeir verða í minnihluta. Námskeiðið byggist upp á umræðum þar sem lesefnið, sem og inntak verklegra æfinga verður greint. Verklegar æfingar verða fyrirferðamiklar.
Námsmat: Þátttaka í tímum 20%, nemendur senda að auki tölvupóst til kennara í hverri viku þar sem inntak greinanna sem verða lesnar í þeirri viku er dregið saman; 30% skýrsla um verklegar æfingar (nánar útlistaðar í upphafi námskeiðs), 50% ritgerðarpróf.
Tungumál: Íslenska/Enska.

T-535-MECH **MECHATRONICS II** **6 ECTS**

Year of study: 3rd year BSc / 1st year MSc.
Semester: Spring.
Level of course: 3. First cycle, advanced / 4. Second cycle, introductory.
Type of course: Core for MSc Mechatronics Engineering, elective for other programs.
Prerequisites: Mechatronics I (T-411-MECH).
Schedule: Runs for 12 weeks - 6 teaching hours a week.
Supervisor: Torfi Þórhallsson.
Lecturer: Baldur Þorgilsson.

Learning outcome:
Knowledge: On the completion of the course the student should know
- What an embedded system is
- In details how a microcontroller works
- Of several options of sensors and actuators

Skills: On completion of the course the student should
- Be able to program an embedded system
- How to interface various sensors and actuators to a microcontroller

Competence: On the completion of the course the student is competent to
- Choose a microcontroller of a specific mechatronic task
- Choose sensors for a given mechatronic problem
- optimize code for a given hardware platform
- can complete a defined personal project in a systematic and predictable way

Content: Mechatronics-2 extends Mechatronics-1 by going into more details. While Mechatronics 1 is broader and more about getting results fast (what is possible), Mechatronics 2 is more about accuracy and how to match a design to a task with economy, accuracy and robustness in mind (what is the limit).
The course includes sensors, signal conditioning, interfacing, analog-digital conversion, digital input/outputs, timers, low level embedded firmware programming, actuators, UARTs and serial communication. It is expected that the student is familiar with digital electronics, analog electronics and the programming language C.
Along with the lectures, each student has his/her own private project based on the fundamental elements of mechatronics: sense-think-act. For this project the student holds a lab notebook. At the end of the course the student delivers a report about the project.

Reading material: *Introduction to Mechatronic Design*, International edition J. Edward Carryer, R Mathew Ohline, Thomas W. Kerry, Pearson 2011, ISBN 978-0-13-609521-7.
Teaching and learning activities: Lectures, lab sessions, student´s private project.
Assessment methods: Homework 20 %, Midterm evaluation 15%, 2 minute video 10%, Lab notebook 10%, Final report 30%, Final project presentation 15 %.
Language of instruction: English/Icelandic.

T-603-AKVA **DECISION ANALYSIS FOR MANAGEMENT** **6 ECTS**

Year of study:	3rd year BSc / 1st year MSc.
Semester:	Spring.
Level of course:	3. First cycle, advanced / 4. Second cycle, introductory.
Type of course:	Core for BSc Engineering Management, elective for other programs.
Prerequisites:	Statistics (T-302-TOLF).
Schedule:	Runs for 12 weeks - 6 teaching hours a week.
Supervisor:	Þórður Víkingur Friðgeirsson.
Lecturer:	Þórður Víkingur Friðgeirsson.

Learning outcome: This course is structured around methods and disciplines used by professionals to make decisions where there are uncertainties regarding the outcome. Uncertainties are dealt with by statistical methods and awareness of cognitive biases related to how the mind processes information. The objective is to train future managers in applying disciplines of Decision and Risk Management in their work.

Knowledge*:* After the course the student 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*:* After the course the student 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*:* After the course the student to 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.

Content: Decisions are a fascinating subject. Most decisions cost next to nothing. It is the consequences that cost or create value.Wecan promise the motivated and interested student a real "eye-opening" course in one of the most exiting fields of today ́s management science.When you think of it, decision making is what managers are really paid for. Decision making is a critical part of every manager's work. The fate of success and failure isprimarilyrelated to the quality of our decisions. Sometimes we get lucky and stumble on the optimal decision accidentally. Sometimes the decision is obvious as no other alternative is apparent.However, big decisionsare usually not straight forward. No professional manager is willing to rely purely on luckor intuition. To solve a problem,the decision maker must analyse the context of the problem, segment it into manageable parts, consider a number of possible options and choose the most promisingonein the light of the prevailing information. In theevaluationprocessa risk isembedded as the optimal problem solution is uncertain at the point of decision. Decisions are therefore attached to uncertainty and risk which must be measured,quantifiedand mitigated.The objective is to train future managers in applying disciplines of Decision and Risk Management in their work.

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 aquired by the following :
1. The use of applied statistics in decision analysis.
2. 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.
3. A study on decision fallacies and cognitive biases.
4. A study of basic decision models.
5. The methods of group work, negation skills and authentic leadership.

Reading Material: *Decision Analysis for Management Judgement* 4th ed, Goodwin & Wright, Wiley.
Teaching and learning activities: The course is structured in lectures and exercise classes intended for pure academic exercises, teamwork and status exams. Exercise classes are either: 1.Selected exercises from the textbook and/or from the teacher; 2.Teamwork assignments on specific course related topics. Among the planned team assignments are (not necessarily in this order): a.Brain storming sessions to achieve consensus on goals and objectives b.Scenario planning c.Decision modelling d.Risk study´s e.Case study´s; 3.Status exams I value a lot a dialog with my students and please observe that the class participation is a part of the final course evaluation. Also observe that the registration list will be removed after the first lecture.
Assessment methods: Individual final exam 65%. Assignments/Status exams (3 * 10%). Class participation 5%.
Language of instruction: English.

T-624-NEEL **NEURO-ELECTROPHYSIOLOGY** **6 ECTS**

Year of study: 3rd year BSc / 1st year MSc.
Semester: Spring.
Level of course: 3. First cycle, advanced / 4.-5. Second cycle, introductory-intermediate.
Type of course: Elective. *Maximum attendance is only 12 students.*
Prerequisites: Necessary prerequisites include: molecular biology, physiology and chemistry.
Skipulag: Runs for 3 weeks – 4 teaching hours a day.
Umsjónarkennari: Karl Ægir Karlsson.
Kennari: Karl Ægir Karlsson.

Learning outcome: Following a successful completion of the course the student should be able to:

- Describe the basic electrical properties of neurons and the ionic basis of membrane potentials
- Describe the basic elements of an electrophysiology recording system
- Describe and critically compare the different electrophysiological recording preparations (e.g. extracellular, intracellular and patch-clamp recordings) and be able to express which questions each method is best suited to address
- Describe and compare different types of tissue preparations
- Describe the most common ways of manipulating neural activity in during electrophysiological recordings
- Understand and be able to carry out standard electrophysiological data analysis (e.g. ionic current calculations, current-voltage curves and spike sorting).

Content: The course is centered on a set of hands-on exercises:
A) preparation of tissue slices (using Danio rerio) for recording;
B) set of recordings and manipulations;
C) data will be analyzed and
D) turned in poster format.

Reading material: Papers, book chapters and other hand-outs will be delivered by the teacher.
Teaching and learning activities: The course is first and foremost hands-on in a laboratory setting. Under instructor guidance the students set-up recording apparatus, prepares tissue samples for recording, records neural activity, and analysis data. Formal lectures will be kept to a minimum, the lectures are few and seminar style.

Assessment methods: Students will be rated on participation in hands on practicums (good attendance is critical), three take home exams and a poster format presentation of data. No final exam.
Language of instruction: English (lectures, materials, exams and posters are all in English only).

T-706-INT1 STARFSNÁM Í VERKFRÆÐI I 6 ECTS

Ár:	3. eða 4. ár (lokaár BSc eða fyrsta ár MSc).
Önn:	Vorönn. *Kennt í fyrsta sinn á vorönn 2021.*
Stig námskeiðs:	3. Grunnnám, sérhæft námskeið / 4. Framhaldsnám, inngangsnámskeið.
Tegund námskeiðs:	Valnámskeið í öllum námsbrautum. Nemandi sem stundar starfsnám getur í mesta lagi verið skráður í 30 ECTS á viðkomandi önn. Námskeiðið er ekki opið skiptinemum.
Nauðsynlegir undanfarar:	Tvö námsár í verkfræði. Þátttakendur eru valdir úr hópi umsækjenda, m.a. er tekið tillit Til námsframvindu og einkunna.
Skipulag:	Kennt í allt að 12 vikur skv. sérstakri stundaskrá.
Umsjónarkennari:	Þórður Víkingur Friðgeirsson. Verkefnastjóri starfsnáms á skrifstofu verkfræðideildar er Sóley Davíðsdóttir.
Kennari:	Leiðbeinendur hjá fyrirtækjum, umsjónarkennari og námsbrautarstjórar við verkfræðideild HR.

Lærdómsviðmið: Lærdómsviðmið eiga að endurspegla það sem nemandinn lærir og þá reynslu sem hann hlýtur meðan á starfsnámi stendur**. Áherslur, sértæk lærdómsviðmið og kröfur um afrakstur** verða skilgreind af umsjónaraðilum HR og viðkomandi fyrirtækis hverju sinni fyrir hvert einstakt verkefni, með eftirfarandi markmið í huga.

- að efla tengsl nemenda tækni- og verkfræðideildar HR við atvinnulífið.
- að auka innsýn og skilning nemenda á viðfangsefnum þess fagsviðs sem þau stunda nám á.
- að auka skilning nemenda á verkferlum og skipulagningu verkefna hjá viðkomandi fyrirtæki/stofnun.
- að nemendur geti skipulagt og útfært faglega vinnu út frá fyrirfram gefnum forsendum og kröfum.
- að styrkja samskiptahæfni nemenda (innri og ytri samskipti í fyrirtæki)
- að nemendur hljóti reynslu af því að vinna að úrlausn raunhæfra viðfangsefna á vettvangi, undir leiðsögn leiðbeinenda úr atvinnulífinu.
- að undirbúa nemendur undir starf eftir námslok.
- að opna nemendum leið inn á vinnumarkað.

Lýsing: Starfsnám I er valnámskeið á lokaári BSc náms eða fyrra ári MSc náms og er skilyrðislaus undanfari fyrir Starfsnám II. Nemandi vinnur að afmörkuðu verkefni undir leiðsögn umsjónarmanns hjá fyrirtæki/stofnun og eftirliti umsjónarkennara hjá HR. Miða skal við að vinnuframlag nemanda sé að lágmarki 120 vinnustundir. Þessu til viðbótar kemur undirbúningur, vinna við gerð lokaskýrslu og kynningu hennar.

Nemendur á lokaári BSc náms geta tekið Starfsnám II í beinu framhaldi af Starfsnámi I á 12-vikna meginkennslutímabili annarinnar, eða tekið einungis Starfsnám I.

Nemendum á fyrra ári MSc náms býðst ekki að taka einungis Starfsnám I. Ef þeir velja starfsnám þá er það samtals 12 ECTS, þ.e. í beinu framhaldi af Starfsnámi I kemur Starfsnám II, sem má taka hvort heldur á 12-vikna eða á 3-vikna kennslutímabilinu. Ef nemandi tekur bæði Starfsnám I og II á 12-vikna kennslutímabilinu, þá dreifast samanlagðar vinnustundir beggja námskeiða á allt að 12 vikur. Starfsnámið ber að skipuleggja þannig að vinnutíminn skarist ekki við kennslustundir í öðrum námskeiðum. Sjá nánar *Leiðbeiningar um starfsnám í verkfræði*.

Verkefnið skal vera skilgreint og afmarkað í samráði við umsjónarmann hjá fyrirtæki/stofnun og umsjónarkennara hjá HR. Að öllu jöfnu er um að ræða hagnýtt verkefni sem byggir á námsefni undangenginna anna og rúmast á 120 vinnustundum. Við upphaf starfsnáms skal liggja fyrir lýsing á verkefninu sem umsjónaraðilar hafa samþykkt.

Áhersla er lögð á skipuleg, sjálfstæð og tæknileg vinnubrögð. Nemandinn skal í upphafi skilgreina verkefnið, þ.e. hvert sé markmið og afrakstur. Meðan á verkefninu stendur skal nemandinn halda dagbók þannig að hægt sé að fylgjast með framvindu verkefnisins. Í lok námstíma skal nemandinn skrifa skýrslu um verkefnið sem er kynnt og varin munnlega.

Heimilt, í samráði við umsjónarkennara, að ákveða að nemandi í BSc námi vinni í Starfsnámi I að mörgum smærri verkefnum hjá fyrirtæki/stofnun í stað þess að vinna að einu afmörkuðu verkefni allan tímann, með það að meginmarkmiði að nemandinn kynnist fjölbreyttri starfsemi viðkomandi vinnustaðar. Þetta er ekki heimilt ef um er að ræða nemanda í MSc námi. Fyrir nemendur í MSc námi er starfsnám einungis í boði sem 12 ECTS, þ.e. nemandinn tekur bæði Starfsnám I og Starfsnám II.

Lesefni: Samkvæmt ábendingum umsjónarmanns.
Kennsluaðferðir: Nemandi vinnur að afmörkuðu verkefni undir leiðsögn umsjónarmanns hjá fyrirtæki/stofnun og eftirliti umsjónarkennara hjá HR. Nemandinn skal í upphafi skilgreina verkefnið, þ.e. hvert sé markmið og lokaafurð. Vinnutími nemanda við verkefnið skal að lágmarki vera 120 klst, því til viðbótar kemur undirbúningur, svo og vinna við gerð lokaskýrslu og kynningu verkefnisins.
Námsmat: Einkunn Staðið/Fall. Lagt verður mat á frammistöðu nemanda á vinnustaðnum ásamt dagbók, lokaskýrsla og kynningu á verkefninu. Við matið skal taka mið af því hvort nemandi hafi sýnt fram á getu til uppfylla lærdómsviðmiðin sem umsjónaraðilar skilgreina í upphafi námskeiðs.
Tungumál: Íslenska/Enska.

T-706-INT2	**STARFSNÁM Í VERKFRÆÐI II**	**6 ECTS**

Ár:	3. eða 4. ár (lokaár BSc eða fyrsta ár MSc).
Önn:	Vorönn. *Kennt í fyrsta sinn á vorönn 2021.*
Stig námskeiðs:	3. Grunnnám, sérhæft námskeið / 4. Framhaldsnám, inngangsnámskeið.
Tegund námskeiðs:	Valnámskeið í öllum námsbrautum. Námskeiðið er ekki opið skiptinemum.
Nauðsynlegir undanfarar:	Starfsnám í verkfræði I (T-706-INT1).
Skipulag:	Kennt í allt að 12 vikur samkvæmt sérstakri stundaskrá, eða kennt alla virka daga í 3 vikur.
Umsjónarkennari:	Þórður Víkingur Friðgeirsson. Verkefnastjóri starfsnáms á skrifstofu verkfræðideildar er Sóley Davíðsdóttir.
Kennari:	Leiðbeinendur hjá fyrirtækjum, umsjónarkennari og námsbrautarstjórar við verkfræðideild HR.

Lærdómsviðmið:
Lærdómsviðmið eiga að endurspegla það sem nemandinn lærir og þá reynslu sem hann hlýtur meðan á starfsnámi stendur. **Áherslur, sértæk lærdómsviðmið og kröfur um afrakstur** verða skilgreind af umsjónaraðilum HR og viðkomandi fyrirtækis hverju sinni fyrir hvert einstakt verkefni, með eftirfarandi markmið í huga. Meginmarkmiðin eru:

- að efla tengsl nemenda tækni- og verkfræðideildar HR við atvinnulífið.
- að auka innsýn og skilning nemenda á viðfangsefnum viðkomandi fagsviðs.
- að nemendur öðlist reynslu af því að vinna að úrlausn raunhæfra viðfangsefna á vettvangi, undir leiðsögn leiðbeinenda úr atvinnulífinu.
- að auka skilning nemenda á verkferlum og skipulagningu verkefna hjá viðkomandi fyrirtæki/stofnun.
- að undirbúa nemendur undir starf á sínu fagsviði.
- að nemendur geti skipulagt og útfært faglega vinnu út frá fyrirfram gefnum forsendum og kröfum.
- að nemendur geti unnið sjálfstætt og borið ábyrgð á eigin þekkingarleit og faglegum áherslum.
- að nemendur tileinki sér sjálfstæð og markviss vinnubrögð við úrlausn raunhæfra hönnunar-, greiningar- og/eða rannsóknarverkefna á fagsviðinu.
- að nemendur beiti aðferðum tæknifræðinnar við lausn hagnýtra verkefna.
- að nemendur fái hagnýta reynslu og yfirsýn yfir fagið með samþættingu námsgreina við úrlausn raunhæfra verkefna.
- að nemendur auki þekkingu sína á félagslegum, hagrænum og siðferðislegum þáttum fagsviðsins.
- að auka þekkingu nemenda á notkun öryggis- og tæknistaðla við faglega vinnu.
- að auka færni nemenda í skýrslugerð og kynningu á niðurstöðum og tæknilegum lausnum.
- að styrkja samskiptahæfni nemenda (innri og ytri samskipti í fyrirtæki)

Lýsing:
Starfsnám II er valnámskeið á lokaári BSc náms eða fyrra ári MSc náms. Undanfari er *AT INT 1003 Starfsnám í verkfræði I.* Nemandi vinnur að afmörkuðu verkefni undir leiðsögn umsjónarmanns/leiðbeinanda hjá fyrirtæki/stofnun og eftirliti umsjónarkennara hjá HR. Að öðru jöfnu er búið að undirbyggja verkefnið meðan nemandinn var í Starfsnámi I og verkefnið í Starfsnámi II þá eðlilegt framhald af því. Miða skal við að vinnuframlag nemanda sé að lágmarki 120 vinnustundir. Þessu til viðbótar kemur undirbúningsvinna og vinna við gerð lokaskýrslu og kynningu verkefnisins. Starfsnám II er unnið í framhaldi af Starfsnámi I, á sömu önn, og dreifist annaðhvort á 12-vikna kennslutímabil annarinnar eða unnið samfellt sem full vinna á 3. vikna tímabili í lok annar. Ef starfsnámið fer fram á 12-vikna kennslutímabilinu ber að skipuleggja vinnutímann þannig að hann skarist ekki við kennslustundir í öðrum námskeiðum. Sjá nánar *Leiðbeiningar um starfsnám í verkfræði*.

Verkefnið skal vera skilgreint og afmarkað í samráði við umsjónarmann hjá fyrirtæki/stofnun og umsjónarkennara hjá HR. Að öllu jöfnu er um að ræða hagnýtt hönnunar-, greiningar- og/eða rannsóknarverkefni sem byggir á námsefni undangenginna anna.

Við upphaf starfsnáms skal liggja fyrir lýsing á verkefninu sem umsjónaraðilar hafa samþykkt. Ætlast er til að lýsingin innihaldi upplýsingar um hvaða viðbótarþekkingu og/eða þjálfun nemandinn þurfi til að vinna verkefnið, með viðeigandi tilvísun í kennslubækur og/eða aðrar heimildir. Áhersla er lögð á skipuleg, sjálfstæð og tæknileg vinnubrögð. Nemandinn skal færa dagbók þannig að hægt sé að fylgjast með framvindu verkefnisins. Í lok námstíma skal nemandinn skrifa skýrslu um verkefnið sem er kynnt og varin munnlega.

Lesefni: Samkvæmt ábendingum leiðbeinanda.
Kennsluaðferðir: Nemandi vinnur að afmörkuðu verkefni undir leiðsögn umsjónarmanns hjá fyrirtæki/stofnun og eftirliti umsjónarkennara hjá HR. Nemandinn skal í upphafi skilgreina verkefnið, þ.e. hvert sé markmið og lokaafurð. Vinnutími nemanda við verkefnið skal að lágmarki vera 120 klst, því til viðbótar kemur undirbúningur, svo og vinna við gerð lokaskýrslu og kynningu verkefnisins.
Námsmat: Einkunn Staðið/Fall. Lagt verður mat á dagbók, lokaskýrslu og kynningu á verkefninu. Við matið skal taka mið af því hvort nemandi hafi sýnt er fram á getu til uppfylla þau lærdómsviðmið sem umsjónaraðilar skilgreina í upphafi námskeiðs.
Tungumál: Íslenska/Enska.

T-738-CONT | **ROBUST CONTROL (íslenska: ÖRUGG OG SVEIGJANLEG STÝRITÆKNI)** | **8 ECTS**

Year of study: 3rd or 4th year (final year BSc or first year MSc)
Semester: Spring. *Taught for the first time in the spring 2021.*
Level of course: 3. Undergraduate (First cycle), advanced / 4. Graduate (Second cycle), introductory.
Type of course: Elective. *Required elective for HÁV.*
Prerequisites: Feedback Control Systems (T-501-REGL).
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervising teacher: Elias August.
Teacher: Elias August.

Learning outcomes:
Having completed this course, for a linear dynamical system, you should be able

- to determine
  - whether it is internally stable.
  - its performance after closing the loop (with respect to reference signal tracking).
  - whether the controller used provides robust stability and performance.
- to design
  - a controller that provides robust performance.

Content:
The topic of this course is the robust performance problem and, thus, has the goal of achieving specified signal levels in the face of plant uncertainty. This course covers theoretical development and practical applications of formal methods in robust and optimal linear control and robust stability analysis. It constitutes of feedback design, containing a detailed formulation of

- the control design problem,
- the fundamental issue of performance/stability robustness trade-off,
- and the graphical design technique of loopshaping, suitable for benign plants (stable, minimum phase).

Finally, for controller design via optimisation, the loopshaping technique will be extended and connected with notions of optimality.

Reading material:
Doyle, Francis, & Tannenbaum, *Feedback Control Theory*, Macmillan Publishing Co. 1990.
Teaching and learning activities: To be decided.
Assessment methods: To be decided.
Language of instruction: English.

T-801-RESM **RESEARCH METHODS I** **4 ECTS**

Year of study:	First year MSc.
Semester:	Spring.
Level of course:	4. Graduate (Second cycle), introductory.
Type of course:	Core for all MSc programs in engineering.
Prerequisites:	No prerequisites.
Schedule:	Runs for 12 weeks - a total of 30 teaching hours.
Supervisor:	Jónas Þór Snæbjörnsson.
Lecturer:	Juliet Newson and Jónas Þór Snæbjörnsson.

Learning outcome: On completion of the course the students should:

- Be aware of the expectations of an MSc thesis.
- Understand the foundations and distinctions of key research methods used in science.
- Understand how research papers and thesis are structured.
- Understand how to source, survey and select appropriate literature for formulating and resolving a problem.
- Know how to plan, prepare and manage a research project such as their MSc thesis.
- Be able to formulate a research question and research aim.
- Be able to write a literature review based on the research aim with a view to select appropriate methodologies for their MSc thesis.
- Be able to convey research information and demonstrate qualitative judgement through written and/or oral presentation.

Content:
Overview and approach:
The aim of the course is to prepare students for the challenges involved in engineering MSc thesis work. The focus will be on scientific writing and reporting, survey techniques and presentations. The goal is to prepare students for dealing with the information gathering, analysis and reporting skills that are required the all project work.

Key topics covered:
Research methods, search engines and other sources, surveying and reviewing literature, planning and managing a research project, scientific writing and presentation.

Reading material: To be announced in the learning management system (Canvas) at the beginning of the semester.
Teaching and learning activities: Lectures, discussions and several written assignments.
Assessment methods: To be announced in the learning management system (Canvas) at the beginning of the semester.
Language of instruction: English.

T-803-VERK PROJECT MANAGEMENT AND STRATEGIC PLANNING 8 ECTS

Year of study: 4th year (1st year MSc).
Semester: Spring.
Level of course: 4. Second cycle, introductory.
Type of course: Elective. *Recommended elective for MSc Engineering Management and MSc Financial Engineering.*
Prerequisites: Students enrolling in this course must have successfully completed a basic managerial course e.g. understand the basics of management.
Schedule: Runs for 12 weeks - 6 teaching hours a week.
Supervisor: Þórður Víking Friðgeirsson.
Lecturer: Þórður Víkingur Friðgeirsson.

Learning outcome:

Knowledge

1. To understand the project system – projects, portfolios, programs and governance.
2. To understand the principles of traditional and Agile project management as discipline.
3. Learn to apply the tools, methods and techniques of project management and related disciplines in context of diagnosing, preparing, planning, executing, controlling, changing and closing a project.
4. Learn to place projects within organizations in context of organizational behaviour and the project lifecycle.
5. To understand the Lean movement in projectized industries.

Skills

1. To be able to work with the holistic project philosophy of projects, portfolios, programs and governance.
2. To be able to lead project preparation and execution in teams.
3. To be able to participate in teams in a productive and positive manner.
4. To be able to communicate results and other relevant information in a project.
5. To be able to prioritize and select options from point of rational thinking.

Attitude

1. To understand and respect the value of professionalism and integrity.
2. To understand the value of authentic leadership.
3. To appreciate logical and normative approach in conjunction with social skills.

Content: The use of projects and project management continues to grow in our society and its organizations. We are required to achieve goals through and objectives in projectized organizations. Research indicate that more than third of the work in a developed society are consumed by projects. Arguably projects and project management is the single form of management impacting most business in any form. Furthermore, project management as a discipline has been enhanced by the embedding of other scientific fields like the Agile and Lean approach, the modern team based approach, etc.

This course of project management is designed to reflect the immense development in the discipline of project management and how it has progressed to be a world-wide profession. The course moves from basic theory to practical application, allowing students to expand their knowledge base by “learning by doing”. The classroom activities include both the traditional lecture approach along with *problem based learning* techniques where students solve cases in teams.

Keywords: *Project management, Projects portfolios, Program management, Agile movement, Lean management, Project governance, research based assignment.*

Reading material: *Project Management-The Managerial Proces,* Larson &Gray, 6th edition, McGraw-Hill, 2014.

Teaching and learning activities: The course is designed so that the concepts covered in the readings are reviewed in class through a combination of lectures, class discussions and case studies. *Your ability to learn during this course will depend upon your understanding of the text and readings, an open and active participation during class, and your thoughtfulness in preparing for class.*
Assessment methods: To be announced.
Language of instruction: English/Icelandic.

T-814-DERI **DERIVATIVES AND RISK MANAGEMENT** **8 ECTS**

Year of study:	4th year (1st year MSc).
Semester:	Spring.
Level of course:	6. Second cycle, advanced.
Type of course:	Core for MSc Financial Engineering, elective for other programs.
Prerequisites:	Undergraduate degree in Engineering. Probability and Stochastic Processes (T-606-PROB) Derivatives (T-503-AFLE) **Other recommended prerequisites:** Financial Engineering of the Firm (T-814-FINA), Risk Management (T-602-RISK)
Schedule:	Runs for 12 weeks – 6 lecture periods each week, grouped into two 3-period sessions.
Supervisor:	Ralph Rudd.
Lecturer:	Ralph Rudd.

Learning Outcomes:
After completing this course, students will have a good knowledge of how to identify, quantify and manage different types of risk. The risks considered include market risk, interest-rate risk, and credit risk.
The learning outcome can be broken down into the following sub-outcomes:

- Be able to define and explain the fundamental concepts used in the measurement and management of financial risk.
- Be able to analyse and model changes in portfolio value and derive loss distributions.
- Apply the loss distribution framework to different kinds of asset and liability portfolios.
- Apply different quantitative approaches to measuring risk, with particular focus on risk measures that are calculated from loss distributions, like value-at-risk and expected shortfall.
- Be able to build realistic models for risk management purposes by considering the empirical properties of fundamental risk factors and developing models that share these properties.
- To model multivariate loss distributions with complex cross-dependencies.
- Be able to aggregate and disaggregate risk across multi-instrument portfolios.
- Manage portfolios with credit risk and price credit derivatives.

Content:
The core focus of this course is study and use of quantitative techniques in risk management.
The approach is centered around the study of portfolio value change, where we consider general portfolios that can consist of a mixture of equity, fixed income, credit, and derivative instruments.

The risk of a portfolio is represented by its loss distribution, which is a function of its risk factors. In this course we examine how to model and manipulate this loss distribution. The modelling proceeds via modelling the risk factors themselves, and we investigate the properties of common risk factors in the real world. The manipulation of the loss distribution is done by modifying the portfolio constituents, usually through hedging.

To assess the risk of a portfolio, we look at summary measures of its loss distribution, primarily value-at-risk and expected shortfall. We examine the properties of these risk measures and investigate their shortcomings.

We place special emphasis on understanding the dependence between risk factors. We cover correlation in detail and introduce the use of copulas to specifically model dependence.

Reading material: *Quantitative Risk Management: Concepts, Techniques and Tools* by McNeil, Frey and Embrechts, Princeton University Press.
Teaching and learning activities: In-person, interactive lectures.
Assessment methods: Assessment consists of short assignments and quizzes, three class exams and one final exam.
Language of instruction: English only.

T-814-INNO **CREATING A COMPLETE BUSINESSPLAN FOR A TECHNICAL IDEA - ENTREPRENEURSHIP AND THE INNOVATION PROCESS** **8 ECTS**

Year of study: First year MSc.
Semester: Spring.
Level of course: 4.-5. Second cycle, introductory-intermediate.
Type of course: Core for MSc Engineering Management; *recommended elective for other MSc programs in engineering.*
Prerequisites: None.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Páll Kr. Pálsson.
Lecturer: Páll Kr. Pálsson.

Learning outcome:

Knowledge:
After the course the student shall be able to explain the following terms: Buisness plan, design and implementation plan, market analysis, expected sales curve, plan for market implimentation, technical feasibility, development of a prototype, calculations of financial need, financing, income, cost, profitabuility and evaluation of business idea.

Skills:
Students shall be able to adapt the most important methods in optimizing business opportunities by analysing current situation and suggesting methods and actions that are likely to lead to optimal results in Innovation. Also students shall be able to describe how to realize their proposals and partly realize them in the form of af working prototype.

Disciplinary skills:
On the completion of the course the student shall be able to formulate technically complex ideas and develop and implement them for a competative market. The student will learn how to develop ideas through the CanvasBusinessModel method, build a buisness plan, execute a feasibility study, carry out a financial plan and test the idea by developing and testing a prototype.

Personal skills:
- Apply engineering methods to complex projects, i.e. have the ability to assess engineering projects, identify the key factors in a given situation, and develop an approach to solution.
- Formulate and work on open-ended problems, including creative thinking.
- Formulate a project plan for development and design of an engineering product.
- Integrate theoretical knowlede and practice though critical analysis of a project.
- Realize the limits of his/her expertise and know when it is necessary and appropriate to seek specialist advice.
- Have insight into how to manage all aspects of a project within a team, including conceptual development/design, prototype creation, market analysis, evt. Fabrication, documentation and testing, businessplan.
- Manage and motivate people by disciplines of human resource management and provide leadership.

Interpersonal skills:
- Communicate effectively and professionally and formulate sound arguments, both in writing and by means of presentations, using appropriate professional language, including statistics, figures, illustrations, equations, tables and video.
- Use time management and work planning related to the organization, implementation and successful completion and reporting of a project.
- Be an effective team member and contribute to the management of team projects.

- Recognize the interdisciplinary nature of technical problems and work with other professions to arrive at a solution for complex engineering problems, respecting the different skillset of individual team members.
- Propose, plan, structure and manage well defined projects involving a team of individuals from different professional disciplines. Prioritize, organize and schedule work activities effectively.

Competence:

- Possess the knowledge to present and interpret the outcome of a business plan and be able to establish and/or operate minor companies.
- Participate in research and product development within the broad field of engineering, recognizing their roles in the innovation process.
- Know how to avoid making mistakes when searching, developing and evaluating business opportunities.

Content:

Technology does not exist in isolation but is dependent upon natural sciences, technical feasibility and market need. This is what makes technological development challenging but if it is successful in integrating these factors it can be very rewarding. The objective of this course is to give the student a comprehensive experience of combining these factors for technological innovation, develpment and marketing.

To accomplish this, students will go through the conceive, design, implement and operate process with the aim to target market need and ensure technical feasability.

The course will cover innovation, entrepreneurship and writing a complete businesplan for a „start up" of a technical idea, in light of market needs, research, technical development, planning and financial presumptions. We deal with the terms innovation and entrepreneurship and their significance for modern management. We also cover the value of knowledge, intellectual property and patent rights.

The course will give an overview of the running and managing business entities, including planning, cost analysis, human resource management and the role of managers and directors. The course will also give an overview of the importance of continuous innovation through technical development processes and market need analysis in relation to product and corporate lifecycles.

Reading material: Lecture notes and other material supplied by teacher on CANVAS, also links to websites and various artcles connected to the study-material. *Handbók Athafnamannsins II. Businessplans, Innovation, Income and cost calculations and analysis, Profitability analysis, Evaluation methods.* Author Páll Kr. Pálsson. Skyggni ehf. Sept. 2018.

Assessment methods: Four reports total 62%, final report 16%, oral exam 22%. An oral exam/project defence takes place at the end of the course, where each group presents their results for 15 minutes, and answer questions from teachers and two examiners for 5 to 10 minutes.

Teaching and learning activities: Lectures in the classroom on the themes we cover. Groups of 5 students deliver a complete business plan including market research, technical feasibility study and planning the prototype, estimates of capital need and financing and a business model for running the operation for 3 to 5 years after entering the market.

Language of instruction: English.

T-828-TISS TISSUE ENGINEERING AND BIOMATERIALS 8 ECTS

Year of study: 4th year (1st year MSc).
Semester: Spring.
Level of course: 6. Second cycle, advanced.
Type of course: Elective. *Recommended elective for MSc Biomedical Engineering.*
Prerequisites: Molecular and Cell Biology (T-106-LIFV); Chemistry (T-204-EFNA); Physiology (T-406-LIFE). **Suggested additional prerequisites:** Materials Science (T-407-EFNI); Advanced Biomechanics (T-828-BIOM).
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Ólafur Eysteinn Sigurjónsson.
Lecturer: Ólafur Eysteinn Sigurjónsson.

Learning outcomes: At the end of the course, the student will have a basic understanding of tissue engineering, regenerative medicine, cell therapy and stem cell biology. The students should also have basic knowledge of bioreactor systems and the processes it takes to take a tissue engineering product from bench to the clinic

***Knowledge*:** At the end of the course, the student will have knowledge on
- Tissue engineering
- Stem cell biology
- 3D printing of organs
- Use of biorector systems in tissue engineering
- Biomaterials
- 3D printing and organoids
-Cell mechanics
-Basic immunology of tissue transplantation
-Cell therapy
-Regulations that are important in tissue engineering and cell therapy for clinical use

***Skills*:** At the end of the course, the student will have skills in:
- Regenerative medicine
-Tissue engineering
-Cell therapy
-Biomaterials
-3D printing of organs
-What forces can affect cell growth and differentiation

***Competence*:** At the end of the course, the student will gain competence on: Basic concepts of tissue engineering, cell therapy and regenerative medicine.

Content: In this course we will look into how tissue engineering and cell therapy will revolutionize how we treat diseases and trauma in the future. We will look into the role of stem cells and stem cell differentiation, how biomaterials can create a 3D environment for tissue building. We will also look into bioreactor systems and the role they play in tissue engineering and how we can use novel approaches such as organs on a chip to understand disease progress and treatment. We will look into 3D printing of organs and whether that could become a key method for organ replacement in the future.

Reading material: To be announced.
Teaching and learning activities: Lectures, discussion groups and practical experiments.
Assessment methods: To be announced.
Language of instruction: English.

T-844-FEMM **FINITE ELEMENT ANALYSIS IN ENGINEERING** **8 ECTS**

Year of study: 3rd or 4th year (final year BSc og first year MSc).
Semester: Spring.
Level of course: 3. First cycle, advanced / 4. Second cycle, introductory.
Type of course: Elective. *Recommended elective for MSc Mechanical Engineering.*
Prerequisites: Statics and Mechanics of Materials (T-106-BURD), Dynamics (T-534-AFLF).
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Jónas Þór Snæbjörnsson.
Lecturer: Jónas Þór Snæbjörnsson.

Learning outcome: On completion of the course the students should be:

- Familiar with the FE method and common FE tools and approaches used for problem solving in mechanics,
- able to build up the stiffness matrices for common element types and to construct the system matrices for the structure,
- able to define the proper boundary conditions and solve the relevant systems of equations,
- able to evaluate errors and deviations in FEM analyses.
- able to build FE models for analysis of problems in mechanics using commercial FE software,
- able to present the result of a FE analysis in a clear and concise manner

Content: The course will present the main features and possibilities of the finite element method (FEM) and its application in analysis of problems in mechanics. Aspects of the finite element method, from the mathematical background through to practical implementation and application are discussed. Emphasis is placed on possible errors and how to minimize them. Students will develop an understanding of the fundamentals of the finite element method and get some training in the use of commercial finite element software. Simple analysis will be done in Matlab, as well as more complex analyses in larger FEM software (such as SAP2000, ANSYS, a.o.).

Reading material: To be announced.
Teaching methods: Lectures and project work.
Assessment methods: Initial introduction task (2%); Individual Assignments (59%); Group Assignments (39%).
Language of instruction: English.

T-845-UMHV **SUSTAINABLE ENGINEERING AND THE ENVIRONMENT** **8 ECTS**

Year of study:	4th year (1st year MSc).
Semester:	Spring.
Level of course:	5. Second cycle, introductory.
Type of course:	Elective.
Prerequisites:	None.
Schedule:	Runs for 12 weeks – 6 teaching hours a week (optional: one or two day field excursion, e.g. Sólheimar ecovillage).
Supervisor:	David Christian Finger.
Lecturer:	David Christian Finger.

Learning outcome: Understand major environmental concerns, environmental impact assessments and mitigation techniques.

Content: The purpose of this course is to get an overview of growing environmental problems and to understand and discuss the integration of sciences and engineering principles to improve the natural environment. In particular the conservation of healthy water, air, and land resources for human habitation and for other organisms will be discussed. In this context an overview of environmental impact assessment and mitigation strategies will be given. Topics include airborne pollution; groundwater; hazardous waste disposal; ecological disruption; climate change; environmental footprint and economic disruption.
Basic scientific principles, such as transport processes, mass balance, reaction rates, toxicity and biodiversity will be discussed in context with examples drawn from the various industry sectors. These can include topics such as reinjection of geothermal brine and sequestration of non-condensable gases; habitat disruption from hydropower plants; nuclear waste disposal; oil spills; and carbon capture and storage.
Upon completion of this course students will be familiar with the most common forms of anthropogenic environmental impact, estimation of their severity and understand possible mitigation techniques.

Reading material: To be announced.
Teaching and learning activities: Student presentations, discussion sessions, group work, projects and guest lectures. Students will work on a semester project dealing with a contemporary topic from the industry (e.g. power plant, incineration plant, sport event). The project should focus on mitigating environmental impacts. Within the project students will incorporate acquired skills while demonstrating how environmental impacts can be minimized. Students will present final projects to an interested audience.

Assessment methods: The written report will be graded and the final presentation will be graded. Grading will focus primarily on the correct application of techniques learned during class.

Language of instruction: English.

T-863-NEUR **NEURAL ENGINEERING** **8 ECTS**

Year of study: 4th year (1st year MSc).
Semester: Spring.
Level of course: 6. Second cycle, advanced.
Type of course: Elective. *Recommended elective for MSc Biomedical Engineering.*
Prerequisites: Good knowledge of electronics, electromagnetic theory, cell and nerve physiology, information theory and signal processing.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Þórður Helgason.
Lecturer: Þórður Helgason.

Learning outcomes:
At the end of the course the student should...

- .. know and be able to apply mathematical models of action potentials, their propagation and equivalent circuits. Also to know experiments to measure the ion currents (Hodgkin and Huxley).
- ..know information processing in the neural system
- ..know electrodes for picking up bio signals from the human body and for electrically stimulating cells and their equivalent circuits
- ..have training in using the above models
- ..know the design of active implants
- ..know neural prosthesis's, external and implanted
- .. know brain-computer interfaces
- ..know uptake, conditioning and analysis of EEG signal
- .. know methods to locate epilepsies focus
- .. know methods of brain stimulation for treatment of tremor and epilepsy
- .. know the cochlear implant and second sight implants
- .. know transcutaneous spinal cord stimulation for treatment of spasticity and facilitation of walk by high level spinal cord injury
- ...know the technology and treatment of flaccid paralysis

Content:
The course begins with mathematical modelling of cell membrane voltage and it equivalent circuit. Then information processing in the nervous system is covered. Properties and design of passive and active electrodes will be presented and their applications in recording and stimulation explained. Next, the focus is on active implant design and external neural prosthesis's, choice of materials and miniaturized electrical design with presentation of selected applications at the end of the course. Brain computer interface will be covered followed by EEG recording and analysis. The student will learn about electrical current distribution in life tissue and its use in manipulating membrane potentials, quantitatively. Location of epilepsy focus based on head surface recordings along with electrical stimulation in the brain. Students will work on one project (see below) chosen according to their interests. They will present their work and deliver a report. This material is a part of the course for all participating students.

Prerequisites for the course are a BS in engineering or equivalent, good knowledge in electronics, electromagnetic theory, cell and nerve physiology, information theory and signal processing.

1. **Reading material:** Jeffrey Arle, Jay Shils, ed.: „Essential Neuromodulation“ Academic Press 2011; Jeffrey Arle, Jay Shils, ed.: „Innovative Neuromodulation“ Academic Press 2017; John Enderle, Joseph Bronzino, ed.: „Introduction to Biomedical Engineering“, Third Edition, Academic Press, 2012; David D. Zhou, Elias Greenbaum, editors: „Implantable Neural Prostheses 2“ Springer 2010; Mark S. Humayun, James D. Weiland, Gerald Chader, Elias Greenbaum, editors: „Artificiaal Sight“. Springer 2007; Kenneth W Horch, Gurpreet S Dhillon, editors: „Neuroprosthetics. Theory and Practice“. World Scientific 2004; Patricia S. Churchland, Terrence J. Sejnowski: „The Computatinal Brain“. MIT Press 1999; A. Pedotti, M. Ferrarin, J. Quinter, R. Riener, editors: „Neuroprosthetics, from Basic Research to Clinical Applications“. Springer 1996; Sid Deutsch, Alice Deutsch: „Understanding the Nervous System“ IEEE Press 1993

Teaching and learning activities: The teaching is in form of lectures. Additionally there are some exercises done as home work and delivered before discussed in class. One assignment will be done according to students interest. Each students delivers a report, a power point presentation and gives a 40 minute lecture on his theme.
Assessment methods: To be announced.
Language of instruction: English.

T-863-WIND	**WIND POWER**	**8 ECTS**

Year of study:	3rd year (final year BSc) /4th or 5th year (first or second year MSc).
Semester:	Spring.
Level of course:	4.-5. Second cycle, Introductory-Intermediate.
Type of course:	Elective. *Recommended elective for MSc Energy Engineering and MSc Mechanical Engineering.*
Prerequisites:	Introductory course in Fluid Mechanics (at the level of T-536-RENN).
Schedule:	Runs for 12 weeks – 6 teaching hours a week.
Supervisor:	Ármann Gylfason.
Lecturer:	Ármann Gylfason.

Learning outcome: At the end of the course, the students will have:
- Knowledge of the fundamentals of the atmospheric boundary layer which relate to wind power.
- Knowledge of the basics of horizontal axis wind turbines, efficiency, and energy extraction.
- Skills in analyzing the aerodynamic performance of a given wind turbine, applying Blade Element Theory.
- Skills to to design an experiment, applying appropriate engineering and measurment techniques to address the research goals.
- Competence in assessing the power generation of a given wind turbine configuration.
- Competence to analyze and present data or findings in reports and presentations, appropriate to describing the project for both scientific and general audience.

Content: This is a project-based course on wind power. Fundamentals of; the relevant boundary layer theory will be covered, fluid mechanics and aerodynamics of horizontal axis wind turbines, structural wind loadings of wind turbine blades. The student will design, implement and perform a wind tunnel experiment specifically designed to evaluate wake properties of a wind farm configuration; this includes developing and implementing a test facility, selecting and deploying appropriate sensors; in addition to analyze and processing data, and interpret results.

In this course we will cover relevant fluid dynamics and design concepts for horizontal axis wind turbines. We will study wind farm configurations and relevant topics of the atmospheric boundary layer, and discuss field measurements and classification of wind regions. A part of the course will be devoted to experiments in a wind tunnel facility, with emphasis of getting better understanding of fluid flow and gaining experience in writing scientific reports.

Reading material: The following texts are on reserve at the RU library: Manwell, McGowan, Rogers, *Wind Energy Explained*; Hansen, *Aerodnamics of Wind Turbines*; Wyngaard, *Turbulence and the Atmosphere*. Journal articles, manuals and catalogues will be posted online at the library reserve.
Teaching and learning activities: The class meets two times a week. Discussions, presentations, lab work.
Assessment methods: Final Grade is based on performance in Homeworks, Projects and Labs, and Final exam.
Language of instruction: English.

T-864-NUFF **NUMERICAL FLUID FLOW AND HEAT TRANSFER** **8 ECTS**

Year of study: 3rd or 4th year (final year BSc or first year MSc).
Semester: Spring.
Level of course: 3. First cycle, advanced / 4. Second cycle, introductory.
Type of course: Elective. *Recommended elective for MSc Mechanical Engineering.*
Prerequisites: Mathematics III (T-301-MATH); Thermodynamics (T-507-VARM); Fluid Dynamics (T-536-RENN), T-606-HEAT Heat Transfer (T-606-HEAT; may be taken parallally).
Schedule: Runs for 12 weeks - 6 teaching hours a week.
Supervisor: Guðrún A. Sævarsdóttir.
Lecturer: Yonatan Afework Tesfahunegn.

Learning outcome: Upon completion of the course students will have a good understanding of the basic theory of CFD, including discretization, accuracy and stability. They will be capable of writing a simple solver and using commercial and open source CFD codes.
Knowledge: After completing this course the students will have knowledge on:
- Mathematical modeling
- Classification of basic equations of fluid dynamics
- Discretization methods
- Stability and accuracy analysis
- Solution methods

Skills: After completion of this course the students will have skills on:
- Practical use and programming of numerical methods in fluid dynamics
- Setting up a given problem using commercial and open source CFD codes
- Generating computation grids
- Choosing appropriate boundary conditions for model problems
- Interpreting the results critically

Competence: After completion of this course, the students will have competence on:
- Numerical solution of model problems in fluid dynamics and heat transfer
- Checking and assessing basic numerical methods for fluid flow and heat transfer problems

Content: The main purpose of this course is to introduce the basic principles of computational fluid dynamics (CFD) for analyzing fluid flows and heat transfer. Hands on exercises are used to study the basic theory of CFD through programming and using existing commercial and open source CFD codes. Finite difference and finite volume techniques are emphasized.

Reading material: *Essential computational fluid dynamics*, Zikanov Oleg, 2010.
Teaching and learning activities: Lectures, tutorials, hands-on exercises, assignments and projects. The course is organized into two parts.
The first part (about 60 % of the total course time) is reserved for lectures of the basic methods of CFD. It includes a programming project using Matlab.
The remainder of the course includes hands-on exercises and projects with CFD commercial grid generator (ICEM-CFD), commercial CFD software (Fluent) and open source CFD code (SU2).
Assessment methods: Programming assignments and homework 10%; Programming project 25%; Grid generation assignments 10%; CFD code assignments 15%; CFD code projects 30%; Quiz 10%; Total 100%.
Language of instruction: English.

T-867-GRID SMART-GRID AND SUSTAINABLE POWER SYSTEMS 8 ECTS

Year of study: First year MSc.
Semester: Spring.
Level of course: 5. Second cycle, intermediate.
Type of course: Core for MSc Electric Power Engineering, elective for other programs.
Prerequisites: None. **Other recommended prerequisites:** Basic knowledge of electric circuits, electric engineering fundamentals and power systems is highly recommended.
Schedule: Runs for 12 weeks- 6 teaching hours a week.
Supervisor: Mohamed Abdelfattah.
Lecturer: Mohamed Abdelfattah.

Description:
The main goal of this course is to present the fundamentals of "Smart-Grids" with a focus on selected related topics. The course will include many lectures, presentations and class discussions, on many topics that are related to smart grids technology, including:

- Introduction to electric power systems.
- Types of energy resources.
- Types of electric power plants.
- Introduction to smart-grids.
- Self-healing and virtual power plant (VPP) concepts
- Information and communications technologies (ICT) applications for Smart-grids
- Fundamentals of the smart-grids protection
- Smart-grids reliability
- Smart-grids automation
- Other selected topics, or case studies, on smart-grids, such as renewable energy and emerging technologies, high voltage direct current (HVDC) transmission, fluctuating renewable energy sources such as wind and solar, energy storage systems, microgrids, electric vehicles, intelligent computational methods, active distribution network, demand response, smart homes, buildings and cities.

Learning outcome:
Knowledge:
After successful completion of this course, the students should be able to:

- Know the basic components of the electric power systems.
- Understand how electrical energy is generated, transmitted, distributed and consumed.
- Explain different energy resources and related types power plants.
- Be familiar with the fundamentals of smart-grids.
- Understand the role of smart-grids technologies in integrating renewables
- Understand the role of information and communications technologies (ICT) solutions on smart-grids including some selected topics such as wide area measurement systems (WAMS) and applications (PMU), Internet protocol (IP) and Internet-based applications, global positioning system (GPS) applications, multi-agent systems (MAS), geographic information system (GIS) applications, automatic meter reading (AMR), wireless and radio communication, power line carrier communication, optical fiber communication, Information and cyber security.
- Define the self-healing and virtual power plant (VPP) concepts.
- Learn the fundamentals of smart-grids protection and its role in self-healing function.
- Understand the importance of reliability and automation in distribution networks.
- Know more details about selected topics, or case studies, on smart-grids, such as renewable energy and emerging technologies, high voltage direct current (HVDC) transmission, fluctuating renewable energy sources such as wind and solar, energy storage systems, microgrids, electric vehicles, intelligent computational methods, active distribution network, demand response, smart homes, buildings and cities.

Skills:
After successful completion of this course, the students should be able to:

- Apply the concept of high voltage transmission in electric power systems for reducing the transmission losses and improving the voltage level at the receiving end.
- Apply the self-healing concept in distribution networks, based on the availability of advanced protection systems which is supported by smart switches with communication capabilities.
- Propose an outage management scenario for simple distribution networks, for fault detection, isolation and supply restoration.
- Calculate the reliability indices in distribution networks.
- Apply basic concepts of smart-grids technologies in different applications for electric power systems, using information and communications technologies (ICT) and renewable energy resources solutions.
- Write a technical background presentation and a research report that covers the current research work on individual selected topics, projects or case studies which related to smart-grids technologies.

Competence:
After successful completion of this course, the students should be able to:

- Estimate the transmission losses and voltage profile in real high voltage electric power systems.
- Integrate smart automatic switches with communication capabilities with advanced protection systems for developing the self-healing function in distribution networks.
- Apply an outage management scenario for simple distribution networks, for fault detection, isolation and supply restoration.
- Evaluate the performance and reliability level of a distribution network based on reliability indices values.
- Propose suitable smart-grids technologies as a solution for different realistic applications in electric power systems, based on the availability of information and communications technologies (ICT) and renewable energy resources solutions.
- Demonstrate a technical background presentation and a research report that covers the current research work on individual selected topics, projects or case studies which related to smart-grids technologies.

Reading material:

- No textbook.
- Lectures slides and notes.
- Selected recent articles, publications and some chapters from recommended references.
- Selected topics presentations.

Teaching and learning activities:

- Lectures; for the presentation of the fundamentals.
- Class discussions; for thinking, brainstorming and understanding.
- Group presentations; for supporting the knowledge exchange and team work skills.
- Individual assignments (projects); for the development of the self-learning and individual research and publication skills.

Assessment methods:

- Exam
- Project, on selected topics, including a review presentation and a report on a research question or task.

In order to pass this course, you need 60% or higher on the exam grade and 60% or higher on the total grade.

Language of instruction: English.

T-867-STAB STABILITY AND CONTROL IN ELECTRIC POWER SYSTEMS 8 ECTS

Year of study: First year MSc.
Semester: Spring.
Level of course: 5. Second cycle, intermediate.
Type of course: Core for MSc Electric Power Engineering, elective for other programs.
Prerequisites: Power System Operation (T-867-POSY).
Schedule: Runs for 12 weeks - 6 teaching hours a week.
Supervisor: Ragnar Kristjánsson.
Lecturer: Hjörtur Jóhannsson.

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

Knowledge:
• Explain the principal causes of power system stability problems (frequency, transient rotor angle, small-signal rotor angle and voltage stability problems);
• Reflect on how the power system stability problems are affected by grid related limitation for the transfer of active power and the machine related limitation for the injection of active and reactive power;

Skills:
• Apply the mathematical model of the synchronous machine to analyze it under stationary and transient conditions;
•Explain the key concepts for primary frequency control in power systems and reflect on how inertina, loads' frequency dependency and regulation constant influence the system's frequency response ;

Competences:
• Analyze rotor angle small-signal stability problems by applying small-signal analysis;
• Analyze transient stability problems and describe means to protect the system against transient stability problems;

Content: To obtain knowledge about conditions in electric power systems that can lead to stability problems, to understand which physical mechanisms are the cause of power system instability, and to give the student insight in the theoretical background for analysis methods used for assessment of system stability. Hands-on experience will be obtained by carrying out numerical simulations and analysis in Matlab/Python, where studencs analyse different stability problems implementing and applying appropriate models and methods for analysis.

Reading material: *Power System Stability and Control*, Prahba Kundur, 1994.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: The students will work on four hand-in assignments throughout the semester. The hand-in reports form the basis for the evaluation of their performance during the semester.
Language of instruction: English.

Courses taught in Fall / Spring / Summer Semester

T-829-GRO1 **GRADUATE RESEARCH OPPORTUNITIES I** **6 ECTS**

Year of study: First or second year MSc.
Semester: Fall/Spring.
Level of course: Second cycle, advanced.
Type of course: Elective for all MSc programs in engineering.
Prerequisites: Approval of course supervisors.
Schedule: As decided by course supervisors.
Supervisor: Eyjólfur Ingi Ásgeirsson and respective program director.
Lecturer: Department of Engineering faculty.

Learning outcome: The main objectives are to introduce research within RU to students, deepen their understanding of a particular research area and give opportunities to students to start their research career.

Content: T-829-GRO1 is available only for outstanding students that are interested in academic research. Students can apply for graduate research positions advertised by faculty, or suggest research projects to the appropriate faculty advisor. Once advisors and students agree on a project, the student must prepare a 1-3 page project proposal, which is submitted to the respective program director for approval. Students are not allowed to receive any monetary payments for their work, and the project must be within RU. The research project can either be a single independent project or a part of a larger research project.

Reading material: As decided by faculty advisor.
Teaching and learning activities: Independent work, under the supervision of an advisor.
Assessment methods: Pass/Fail.
Language of instruction: Icelandic/English.

T-829-GRO2 | **GRADUATE RESEARCH OPPORTUNITIES II** | **6 ECTS**

Year of study: First or Second year MSc.
Semester: Fall/Spring.
Level of course: Second cycle, advanced.
Type of course: Elective for all MSc programs in engineering.
Prerequisites: Graduate Research Opportunities I (T-829-GRO1). Approval of course supervisors.
Schedule: As decided by course supervisors.
Supervisor: Eyjólfur Ingi Ásgeirsson and respective program director.
Lecturer: Department of Engineering faculty.

Learning outcome: The main objectives are to introduce research within RU to students, deepen their understanding of a particular research area and give opportunities to students to start their research career.

Content: T-829-GRO2 is available only for outstanding students that are interested in academic research. T-829-GRO2 is used for larger projects, i.e. only in the exceptional cases where projects cover more than 6 ETCS units in a single semester. Students can apply for graduate research positions advertised by faculty, or suggest research projects to the appropriate faculty advisor. Once advisors and students agree on a project, the student must prepare a 1-3 page project proposal, which is submitted to the respective program director for approval. Students are not allowed to receive any monetary payments for their work, and the project must be within RU. The research project can either be a single independent project or a part of a larger research project.

Reading material: As decided by faculty advisor.
Teaching and learning activities: Independent work, under the supervision of an advisor.
Assessment methods: Pass/Fail.
Language of instruction: Icelandic/English.

T-899-MEIS **MSC THESIS** **30 ECTS**

Year of study: Second year MSc.
Semester: Fall / Spring.
Level of course: 6. Second cycle, advanced.
Type of course: Core.
Prerequisites: One year of study at MSc level.
Schedule: MSc students shall work on a thesis of 30 ECTS credits during their final semester, or a thesis of 60 ECTS credits during their last two semesters. The student can, subject to the course supervisor´s approval, make a study plan to organize the work on the MSc thesis over a longer period of time.

Course supervisor: Eyjólfur Ingi Ásgeirsson, Director of Graduate Studies in the Department of Engineering.
Lecturer: A Department of Engineering faculty member shall in all cases act as supervisor for each Master´s thesis. If applicable, an external specialist in the subject area of the thesis may act as co-supervisor/advisor.

Learning outcome:
Knowledge:
By the end of the course the student should have:
- A deep understanding of the Thesis topic, and the direction of future investigation.
- A broad knowledge of how to apply academic knowledge and understanding to a wide range of questions of importance to society.

Skills:
By the end of the course the student can:
- Frame a research question.
- Design the investigation.
- Perform research.
- Report research results.

Competence:
By the end of the course the student is competent to:
- Independently manage, organize and successfully complete a compressive project in the field of engineering.
- Assess complex engineering problems, identify key factors in a given situation, apply standard engineering and scientific principles to develop, design and implement an appropriate engineering solution.
- Interpret and apply existing theories, models, methods and results, both qualitatively and quantitatively, within the field of engineering.
- Apply research methodology, including the fundamentals of technical writing and presentation, information finding and literature search.

Content: The aim of the course is that the student, under supervision, completes a comprehensive independent project in the relevant field of engineering.

All students conducting MSc studies at the Reykjavík University Department of Engineering shall submit a Master's thesis designed to earn at least 30 ECTS credits. This thesis shall fulfil the following requirements:
- Its subject shall have bearing on the relevant field of science and engineering and related fields and/or address research questions in those fields.
- Its preparation shall involve academic use of relevant sources, primary or secondary, as appropriate to the subject.
- The thesis shall attain the goals set by the student as approved by the supervisor before the thesis work commenced. The goals shall be clearly stated in the introduction to the thesis.

The official completion of the MSc thesis is signified by the student submitting the final electronic version of the thesis, by uploading to Skemman, (see www.skemman.is). See also RU´s rules for submission of theses and final projects (*Reglur um skil á lokaverkefnum við Háskólann í Reykjavík*, www.ru.is/bokasafn/skemman).

The deadline schedule for the purpose of graduation is as follows (where t is the graduation date and the numbers refer to the number of days prior to graduation):

● Final draft of thesis delivered to supervisor [a]	t-50 [b]
● Supervisors comments delivered to student	t-40 [c][d]
● Thesis delivered to supervisor(s), examiner and program director	t-20 [c]
● Examiner confirms that thesis may be put up for defence	t-17 [c]
● Defence	t-14 [c]
● Grade posted to the Registrar by Dept. of Engineering office	t-11 [c]
● Graduation	t [c]

a) Paper and/or electronic form, as requested by the supervisor(s) and/or examiner.
b) Date can be modified by mutual agreement of the supervisor, student and examiner.
c) **Firm deadlines.**
d) Or within 10 days after the supervisor has received the final.

For further information and guidelines see: **RULES FOR MSc PROGRAMMES AT REYKJAVIK UNIVERSITY'S DEPARTMENT OF ENGINEERING, as revised May 29th 2019**
https://www.ru.is/media/tvd/skjol/Rules-for-MSc-programmes-at-RU-Dept.-of-Engineering_2019_as_accepted_29_05_2019.pdf

For further information and guidelines see: **RULES ON THE FORM OF A MASTER'S THESIS, SUBMISSION, DEFENSE AND GRADING, adopted by the Department Council May 29th 2019**
https://www.ru.is/media/tvd/skjol/Vidbotarreglur_um_meistaraverkefni_2019_as_accepted_29_05_2019.pdf

Reading material: As advised by thesis supervisors.
Teaching and learning activities: The student independently carries out a comprehensive project in the relevant engineering field. The description of the work, including results and critical evaluation of the outcome, shall be gathered in a thesis and defended orally. In addition the student shall create a poster containing the abstract of the results.

Assessment methods: The supervisor(s) shall evaluate the thesis together with an examiner appointed by the Director of Graduate Studies. They shall also submit the candidate to an oral examination on the thesis in an open forum. A grade shall be awarded for the thesis. The minimum grade for achieving a pass is 6.0. Equal weight shall be placed on four criteria:

- Significance and originality
- Scientific and technological challenge and results
- Methodological quality
- Presentation

The number of ECTS credits awarded for the Master's project shall be taken into account. Thus, significantly more demands in terms of originality, quantity and scientific quality of the work should be placed on the student for a 60 ECTS thesis than a 30 ECTS thesis.

Language of instruction: English/Icelandic.

T-900-MEIS	**MSC THESIS**	**60 ECTS**

Year of study: Second year MSc.
Semester: Fall / Spring.
Level of course: 6. Second cycle, advanced.
Type of course: Core.
Prerequisites: One year of study at MSc level.
Schedule: MSc students shall work on a thesis of 30 ECTS credits during their final semester, or a thesis of 60 ECTS credits during their last two semesters. The student can, subject to the course supervisor´s approval, make a study plan to organize the work on the MSc thesis over a longer period of time.
Course supervisor: Eyjólfur Ingi Ásgeirsson, Director of Graduate Studies in the Department of Engineering and Juliet Newson, Director of the Iceland School of Energy.
Lecturer: A Department of Engineering faculty member shall in all cases act as supervisor for each Master´s thesis. If applicable, an external specialist in the subject area of the thesis may act as co-supervisor/advisor.

Learning outcome:
Knowledge:
By the end of the course the student should have:
- A deep understanding of the Thesis topic, and the direction of future investigation.
- A broad knowledge of how to apply academic knowledge and understanding to a wide range of questions of importance to society.

Skills:
By the end of the course the student can:
- Frame a research question.
- Design the investigation.
- Perform research.
- Report research results.

Competence:
By the end of the course the student is competent to:
- Independently manage, organize and successfully complete a compressive project in the field of engineering.
- Assess complex engineering problems, identify key factors in a given situation, apply standard engineering and scientific principles to develop, design and implement an appropriate engineering solution.
- Interpret and apply existing theories, models, methods and results, both qualitatively and quantitatively, within the field of engineering.
- Apply research methodology, including the fundamentals of technical writing and presentation, information finding and literature search.

Content: The aim of the course is that the student, under supervision, completes a comprehensive independent project in the relevant field of engineering.

All students conducting MSc studies at the Reykjavík University Department of Engineering shall submit a Master's thesis designed to earn at least 30 ECTS credits. A student may, subject to the approval of the supervising faculty member and the program director, be allowed to submit a Master´s thesis designed to earn 60 ECTS credits instead of a thesis earning 30 ECTS credits. This thesis shall fulfil the following requirements:
- Its subject shall have bearing on the relevant fields of study and/or address research questions in those fields. The thesis shall be the student´s own intellectual exploration, making a notable and independent contribution to the field or fields concerned.
- The thesis shall involve a test of a hypothesis made by the student in response to a research question forming its foundation.
- Original and derived sources shall be used to support or refute the student´s hypothetical reply to his or her research question.

- The scope and standard of the thesis shall be such that it could obviously lead to a publishable, peer-reviewed paper.

The official completion of the MSc thesis is signified by the student submitting the final electronic version of the thesis, by uploading to Skemman, (see www.skemman.is). See also RU´s rules for submission of theses and final projects (*Reglur um skil á lokaverkefnum við Háskólann í Reykjavík*, www.ru.is/bokasafn/skemman).

The deadline schedule for the purpose of graduation is as follows (where t is the graduation date and the numbers refer to the number of days prior to graduation):

● Final draft of thesis delivered to supervisor [a)]	t-50 [b)]
● Supervisors comments delivered to student	t-40 [c)d)]
● Thesis delivered to supervisor(s), examiner and program director	t-20 [c)]
● Examiner confirms that thesis may be put up for defence	t-17 [c)]
● Defence	t-14 [c)]
● Grade posted to the Registrar by Dept. of Engineering office	t-11 [c)]
● Graduation	t [c)]

a) Paper and/or electronic form, as requested by the supervisor(s) and/or examiner.
b) Date can be modified by mutual agreement of the supervisor, student and examiner.
c) **Firm deadlines.**
d) Or within 10 days after the supervisor has received the final.

For further information and guidelines see: **RULES FOR MSc PROGRAMMES AT REYKJAVIK UNIVERSITY'S DEPARTMENT OF ENGINEERING, as revised May 29th 2019**
https://www.ru.is/media/tvd/skjol/Rules-for-MSc-programmes-at-RU-Dept.-of-Engineering_2019_as_accepted_29_05_2019.pdf

For further information and guidelines see: **RULES ON THE FORM OF A MASTER'S THESIS, SUBMISSION, DEFENSE AND GRADING, adopted by the Department Council May 29th 2019**
https://www.ru.is/media/tvd/skjol/Vidbotarreglur_um_meistaraverkefni_2019_as_accepted_29_05_2019.pdf

Reading material: As advised by thesis supervisors.
Teaching and learning activities: The student independently carries out a comprehensive project in the relevant engineering field. The description of the work, including results and critical evaluation of the outcome, shall be gathered in a thesis and defended orally. In addition the student shall create a poster containing the abstract of the results.

Assessment methods: The supervisor(s) shall evaluate the thesis together with an examiner appointed by the Director of Graduate Studies. They shall also submit the student to an oral examination on the thesis in an open forum. A grade shall be awarded for the thesis. The minimum grade for achieving a pass is 6.0. Equal weight shall be placed on four criteria:

- Significance and originality
- Scientific and technological challenge and results
- Methodological quality
- Presentation

The number of ECTS credits awarded for the Master's project shall be taken into account. Thus, significantly more demands in terms of originality, quantity and scientific quality of the work should be placed on the student for a 60 ECTS thesis than a 30 ECTS thesis.

Language of instruction: English/Icelandic.