TÆKNI- OG VERKFRÆÐIDEILD
SCHOOL OF SCIENCE AND ENGINEERING

Applied Mechanical and Energy Engineering BSc

A BSc program of 210 ECTS credits

Course Catalogue
2017-2019

Updated February 15th 2018

Content may be subject to change, for newest updates see www.ru.is

REYKJAVIK UNIVERSITY
School of Science and engineering www.ru.is

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APPLIED ENGINEERING BSc - 210 ECTS

The School of Science and Engineering offers programs in applied engineering of 210 ECTS credits in three disciplines rooted in traditional trades: civil engineering, mechanical and energy engineering, and electrical engineering. Students take a final examination after 3,5 years. The goal is to provide specialized and practical knowledge so that graduates are well prepared for employment in industry upon graduation. A major emphasis is placed on practical, realistic projects that are based on the teachers´ knowledge from industry. The majority of the teachers have considerable experience of design, production or construction. The students enrolled are in many instances qualified tradesmen or have work experience in their field and the program enhances that background. Although preparation for further studies is not the major goal of these programs, there are numerous opportunities and the path towards an MSc degree in engineering is easily accessible.

The admittance criteria is a matriculation examination with emphasis on mathematics and physics, or a comparable examination. Students who do not have practical experience from the workplace at the start of their studies are encouraged to obtain experience by working in the summer breaks. Applicants not having the adequate theoretical basis are offered supplementary courses at RU´s preliminary studies program.

The final examination in BSc Applied Engineering of 210 ECTS credits is completed in 3,5 years and gives very considerable professional competences seen in relation to the duration. Those graduating from this study program receive accreditation from the Icelandic Ministry of Industry to practice as fully qualified engineers, with the professional title of engineer (Icelandic: Tæknifræðingur) which is protected by law. At the same time it is easy to base studies for a MSc degree on the final examination, either in Iceland or at universities abroad. In the study programs, an emphasis is placed on the students´ work on practical projects in cooperation with engineering firms and research institutes, and students have the option of taking up to 18 ECTS credits as internship with an industrial firm. The student's final project of 24 ECTS is a design and/or research project with emphasis on independent work and goal oriented methods in practical project work in the industry.

As a member of the CDIO network www.cdio.org 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 of their 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 courses offered fall semester 2016 to spring semester 2018. Course descriptions may be subject to change without notice. **For further information see** www.ru.is **or contact RU School of Science and Engineering´s programme administrator for applied engineering Hjördís Lára Hreinsdóttir** tvd@ru.is

APPLIED MECHANICAL AND ENERGY ENGINEERING BSc - 210 ECTS

Mechanical and Energy Engineers work in various fields such as management, inspection, consulting, design and development. They are employed with consulting engineering firms, in production enterprises and with energy producers. Future opportunities are to be found in renewable energy sources and sustainable development, including the harnessing of hydropower and geothermal energy, the utilization of hydrogen and biomass, and development for fuel cells. The studies are based on theoretical courses and on the students work on real-life projects in the mechanical or energy industry, under the guidance of highly qualified teachers and experts from the industry. Key subjects are structural mechanics, computer aided design, mechanical design, thermodynamics and control systems. Automation, simulation and the optimisation of work and energy processes are also an important part in the studies and professional activities of mechanical engineers.

The students are encouraged to develop an investigative approach to problem solving and to develop independent study skills, good writing skills and oral communications skills. Develop management, teamwork, problem-solving, and design skills through a combination of directed practical projects, and independent projects. The goal is to produce graduates with the theoretical and practical knowledge and skills that enables them to make an immediate contribution in the mechanical and energy industries.

In the first 6 semesters, students generally take five courses per semester (6 ECTS each). Four of the courses are taught during the first 12 weeks of the semester, ending with written or oral examinations. After the examination period comes a three-week intensive, project-oriented courses. In the 7th semester, students work on a specialized final project (24 ECTS) and one elective course (6 ECTS). During the 5th, 6th and 7th semesters students take elective subjects that offer a degree of specialization. Instead of elective courses, they have the option of taking up to 18 ECTS credits as internship with an engineering firm. Two fields of specialization are offered; Energy Technology and Mechanical Design.
For further information see www.ru.is

STUDY PLAN IN APPLIED MECHANICAL AND ENERGY ENGINEERING

Plan for students who commence their studies in FALL 2017 or FALL 2018

	Fall **VT1** **1st semester**	Spring **VT2** **2nd semester**	Fall **VT3** **3rd semester**	Spring **VT4** **4th semester**
	1st – 4th semester: Core courses – mandatory			
Brain Storming (1 ECTS)	T-100-HUGM			
Practical Programming	AT FOR 1003			
Physics	AT EÐL 1003			
Mathematics	AT STÆ 1003	AT STÆ 2003	AT STÆ 3003	
Structural Mechanics I	BT BUÞ 1013			
Intro to Engineering Design	AT TÆK 1002			
Statistics and Methodology		AT AÐF 1013		
Machine Elements		VT VHF 1003		
Metallurgi & Metal Processes		VT EFV 1003		
Practical Project I		VT HVV 1003		
CAD/ Mechanics with FEM			VT FEM 1003	
Dynamics			VT AFL 1003	
Electric Circuits and Power				VT RAR 1003
Thermodynamics			VT VAR 1013	VT VAR 2013
Machine Element Design			VT VHF 2013	
Fluid Mech. and Heat Transfer				VT STV 1003
Theory of Vibrations				VT SVF 1003
Practical Project II				VT HVV 2003

	VT5 **5th semester**	**VT6** **6th semester**	**VT7** **7th semester**
	5th – 7th sem: Core and specialized courses		
Core courses:			
Control Engineering	VT STÝ 1003		
Feedback Control Systems	VT REG 1003		
Metals and Manufacturing Processes	VT EFV 2003		
Turbomachinery	VT STR 1003		
Project Management	AT VST 1003		
Design		VT HUN 1013 /	
Computer-aided Design II** OR		VI TEI 2013**	
Operation Research**		T-403-ADGE**	
Management and Innovation			AT RSN 1003
Final Project			VT LOK 1012
Specialization: Energy or Mechanical Design			
Internship I		AT INT 1003*	
Industrial Controllers / Robots		RT IÐN 1003*	
Electrical Machines		RT RVE 1003*	
Refrigeration and Heat Pumping		VT KÆL 1013*	
Design X		T-420-HONX*	
Geothermal Energy		VT JAH 1003*	
Energy in Industrial Processes			T-863-EIIP*
Geothemal Power Plant Design		SE 815 PPE*	
Practical Project or Internship II		VT HVV 3003	
		AT INT 2003*	

*Recommended electives, other elective courses are also available.

**Restricted electives; a student must take either T-403-ADGE or VI TEI 2013, and may take the other course as an elective.

Taught as an intensive 3-week course at the end of the semester.

COURSE DESCRIPTIONS

First year courses – Fall semester

BT BUÞ1013 STRUCTURAL MECHANICS I 6 ECTS

Year of study: First year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: No prerequisites.
Schedule: Runs for 12 weeks – 4 lectures and 2 problem solving classes each week. Weekly support classes are also offered as part of this course.
Supervising teacher: Jónas Þór Snæbjörnsson.
Lecturer: Jóhann Albert Harðarson.

Learning outcome: This course covers the fundamental concepts of structural mechanics with applications to civil and mechanical structures. The subject deals with statics of structures and the introduction of mechanics of materials.

Knowledge:

- Know and understand the laws of physics applied to a system of forces and their actions.
- Understand the difference between static determinacy and/or indeterminacy of commonly occurring structures, such as trusses and beams.
- Be familiar with the evaluation of reaction forces at structural boundaries, support points, of statically determined structures.
- Know and understand the evaluation of internal forces of statically determined truss structures.
- Know and understand the evaluation of internal forces of statically determined beam and shaft structures.
- Be familiar with relevant physical properties and fundamental laws governing the behaviour of materials and structures.
- Be familiar with the concepts of stress and strain, and their basic relation through Hook's law.
- Be able to evaluate normal stresses and shear stresses for simple line like structures such as trusses and beams.
- Know how to evaluated cross-sectional properties for basic cross-sectional geometries.

Skills:

- Be able to calculate the total force and moment for a system of forces.
- Be able to calculate support reactions and internal forces in common types of two dimensional and simple three-dimensional trusses.
- Be able to evaluated axial deformation in truss like elements.
- Be able to calculate support reactions and internal forces, i. e. bending moment, shear force and normal force, in statically determinate beams and frames.
- Be able to calculate cross sectional properties for common cross sectional geometries, such as area, centroid and moment of inertia.
- Be able to calculate normal and shear stresses in beams and frames for various actions.

Competence:

- Be able to evaluate determinacy or indeterminacy of a structural system.
- Understand the different bearing capacity of common structural elements such as, trusses, beams and frames.

- Understands the different deformation behaviour of common structural elements and structural systems.
- Understand the transfer of forces within simple structural systems, from external loads, through internal forces, to support reactions.
- Be aware of which properties determine the stiffness of common structural elements.
- Understand the key parts and properties of simple structural mechanics models.
- Understand how the different actions transform to stresses and strains within structural elements.
- Be able to test and proof basic calculation results in structural mechanics.

Content: The course deals with static analysis of structures. Topics addressed include: Force systems in two and three dimensions. Equilibrium. Statically determinate structures. Beams, trusses and frames. Stability of structures. Distributed forces, internal effects. Normal force, shear force and moment diagrams. Definitions of strain and stress. Sectional properties such as centroids, area, shear area and moments of inertia.

Reading material: Gere & Goodno, *Mechanics of Materials*. Merian & Kraige, *Mechanics, Statics* (supplementary material). Megson, *Structural and Stress Analysis* (supplementary material).
Teaching and learning activities: Lectures and problem-solving sessions.
Assessment methods: A 3 hour written final examination counts 70%, a 2 hour mid-term exam 10%, two due projects 10%, five smaller due exercises 10%. To pass the course, a minimum grade of 5.0 in the final exam is required.
Language of instruction: Icelandic.

AT EÐL1003 PHYSICS 6 ECTS

Year of study: First year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: No prerequisites.
Schedule: Taught for 12 weeks – 4 lectures and 2 problem-solving classes a week, with additional weekly tutorial sessions and 3 lab sessions.
Supervising teacher: Sigurður Ingi Erlingsson.
Lecturer: Vilhelm Sigfús Sigmundsson. Andrei Manolescu (labs).

Learning outcome: At the end of the course the student should know the concepts and solve problems related to:
- Motion in one dimension and using vectors to desribe motion in 2 and 3 dimensions
- Newtons laws of motion, force diagrams and decomposing forces into components
- Work and how it connects kinetic and potential energy
- Conservation of momentum and impulse and decribing simple collisions
- Kinematic of rotation, angular momentum and moment of inertia
- Statics and properties of static fluids and fluid motion
- Free, damped and driven oscillations
- Heat, temperature and simple heat flow
- Performing measurements, quantitative error analysis and report writing

Content: Physics is a cornerstone to the traditional engineering desciplines. In the course students will be trained in describing simple motion using Newtonian mechanics and the basics of thermodynamics. Special emphasis will be placed on understanding the various concepts in preparation for further studies in applied engineering.

Reading material: H.D Young and R.A Freedman, *University Physics with Modern Physics*.
Teaching and learning activities:. Lectures and practical sessions. Laboratory work (3 experiments with reports) and weekly due exercises.

Assessment methods: 3 hour written exam counts for 80% of the final grade. Laboratory work and due exercises count for 20%.
Language of instruction: Icelandic.

AT FOR1003 PROGRAMMING IN MATLAB 6 ECTS

Year of study: First year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: No prerequisites.
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Magnús Kjartan Gíslason.
Lecturer: Magnús Kjartan Gíslason.

Learning outcome: The aim is that students will:

- Know the basics of programming and understand the associated concepts.
- Be able to use the Matlab programming environment to solve mathematical problems and various other technical assignments.

Content: In this course students learn the basic principles of programming. Emphasis is on the students understanding of basic programming concepts, such as variables, calculations, assignment of variables, statements, loops, command scripts, subroutines or functions and algorithms. Students learn to program in the Matlab program environment and are trained in the use of Matlab as a tool for solving technical problems. Methods in handling data and reporting results through graphics using Matlab are also introduced.

Reading material: Stormy Attaway, *Matlab: A practical introduction to programming and problem solving.*
Teaching and learning activities: Lectures and exercise classes.
Assessment methods: 10%: 6 due exercises. 20%: 3 semester exams, the lowest grade is not counted. 30%: 1 larger programming assignment. 40%: Final exam. Students are required to pass the final exam.
Language of instruction: Icelandic.

T-100-HUGM BRAIN STORMING 1 ECTS

Year of study: First year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: No prerequisites.
Schedule: An intensive project course taught for 3 days in September; Wednesday afternoon, and all day Thursday and Friday.
Supervising teacher: Haraldur Auðunsson.
Lecturer: Haraldur Auðunsson, and others.

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

- have experienced teamwork and understand the importance of cooperation and diversity in a group.
- have experienced situations where decisions and planning are based on uncertain information.
- have been introduced to diverse ways of presenting solutions.

Content: The course is based on brainstorming and group work. Students in the first semester of BSc Engineering, BSc Applied Engineering and BSc Sports Science work for three days on formulating a solution to a practical probelm proposed to them. Students must have completed the course before entering the third year of study.

Reading material: Handout from teachers.
Teaching and learning activities: Teachers give short presentations on teamwork, brainstorming and various methods of presenting ideas. Students work in groups of 5-6 under the guidance of teachers.
Assessment methods: The final grade is either “Pass” or “Failed” and is based on active participation in the course.
Language of instruction: Icelandic.

AT TÆK1002 INTRODUCTION TO ENGINEERING DESIGN 5 ECTS

Year of study: First year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: None.
Schedule: An intensive course taught every weekday for 3 weeks.
Supervising teacher: Haraldur Auðunsson.
Lecturer: Haraldur Auðunsson, and others.

Learning outcome: After completing the course the student should:

- have experienced an organized approach to brainstorming.
- be able to use design software, like Inventor, Revit and AutoCAD, to draw and design simple structural objects.
- have been introduced to good standard practice regarding technical drawings.
- be able to describe the engineering methods of work an and project management.
- be able to keep a workbook according to standard practice.
- be able to identify and to solve a problem in his field of study.
- have some experience with teamwork and understand the importance of cooperation and the benefits of diversity of group members.
- be able to make a well argumented decision on solutions to assignments and propose solutions.
- be familiar with various methods of presenting results, such as oral presentation, poster, a short film and a structural model.
- have been introduced to some ethitical issues in engineering.

Content: The course is based on brainstorming and teamwork were first year students in the BSc programs in engineering and applied engineering work on solving a practical project for three weeks. In the course, an emphasis is placed on computer-aided design, project management and presentations. At the end of the course, each group will submit drawings, a logbook and a short film about the project. To construct a model is optional.

Reading material: Material will be provided by teachers.
Teaching and learning activities: Lectures, assignments to be solved either by each student or by a group, and teamwork.
Assessment methods: The following will be evaluated: Projects using computer-aided design and drawing, participation and contribution in group work, workbooks, and presentation of the project results including presentations, posters and a short video.
Language of instruction: Icelandic.

AT STÆ1003 MATHEMATICS I 6 ECTS

Year of study: First year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: No prerequisites.
Schedule: Taught for 12 weeks – 4 lectures and 2 problem-solving classes a week, with additional weekly tutorial sessions.
Supervising teacher: Hlynur Arnórsson.
Lecturer: Hlynur Arnórsson.
Learning outcome: On completion of the course students should:

Knowledge:

- Know complex numbers and basic operations with complex numbers.
- Know polar representation and roots of complex numbers
- Know basic functions and their characteristics.
- Know limits and be familiar with continuity and differentiability.
- Know the Intermediate-value theorem.
- Know the Mean Value theorem.
- Know integrals and their graphical interpretation.
- Know inverse functions
- Know integration by parts, the method of substitution, partial fractions and finding the area between the curves of two functions.
- Know the fundamental theorem of Calculus.
- Know how to find extreme-values of functions.
- Know linear approximation.
- Know Taylor Polynomials.
- Know initial value problems.
- Know second order differential equations with constant coefficients and their solution.
- Be acquainted with mathematical reasoning.

Skills:

- Be able to calculate with complex numbers.
- Be able to write complex numbers in polar coordinates and draw them in the complex plane (Argand diagram).
- Be able to find the roots of a complex number on the form $z^n = w$.
- Be able to determine basic properties of functions.
- Be able to find the limit of a function.
- Be able to use the Intermediate-value theorem.
- Be able to evaluate integrals of basic functions.
- Be able to use integration by parts, the method of substitution, partial fractions to evaluate integrals.
- Be able to find the area between two curves of functions.
- Be able to use the fundamental theorem of Calculus.
- Be able to find functions extreme values.
- Be able to find the linear approximation of a function and evaluate the error term.
- Be able to find a functions Taylor polynomial and evaluate the Lagrange remainder.
- Be able to solve a initial value problem.
- Be able to find the solution of a second order differential equation with constant coefficients.
- Be able to use mathematical symbols and reasoning to show a solution in a clear and precise manner.

Competence:

- Be able to use mathematics to solve technical problems.

Content: In Calculus I we learn about functions of one variable. Complex numbers, roots and polar coordinates. Calculus of real-valued functions of one variable. Real numbers, functions and their graphs. Discussion of the most important functions and their properties. Limits, continuous functions, differentiation, anti-derivatives and integration, Taylor-polynomials and second order differential equations with constant coefficients.

Reading material: Adams, *Calculus, A complete course*. Teacher´s lecture notes.
Teaching and learning activities: Lectures and practical sessions, and problem-solving sessions with tutorial assistance.
Assessment methods: Written examination counts 80%, home projects 20%.
Language of instruction: Icelandic.

First year courses – Spring semester

VT EFV1003 METALLURGI AND METAL PROCESSES 6 ECTS

Year of study: First year.
Semester: Spring.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: Structural Mechanics I (BT BUÞ1013).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Einar Jón Ásbjörnsson.
Lecturer: Einar Jón Ásbjörnsson.

Learning outcome: On completion of the course students should:

- Have developed an understanding of the fundamental principles of materials science and manufacturing processes and be able to apply these to the solution of technical problems.
- Have obtained sufficient basic knowledge to be able to assimilate subjects of engineering such as structural design.

Content: Production of steel. Atomic structure. Imperfections in the atomic arrangement. Phase diagrams. Principles of solidification strengthening and processing. Deformation of metals. Mechanical testing and properties. Standards. Recrystallization. Deformation of metals. Technical properties of metals.

Reading material: Callister and Rethwisch, *Materials Science and Engineering, SI version*, 9th edition
Teaching and learning activities: Lectures and practical lab sessions.
Assessment methods: Four mandatory projects 40%; Final examination 60%. Attendance in practical exercises is mandatory.
Language of instruction: Icelandic.

VT HVV1003 PRACTICAL PROJECT IN CAD 6 ECTS

Year of study: First year.
Semester: Spring.
Level of course: First cycle, introductory.
Type of course: Core.

Prerequisites: Machine Elements I (VT VHF1003), Introduction to Engineering Design (AT TÆK1003).
Schedule: An intensive course, taught every weekday for 3 weeks.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Ásgeir Matthíasson, Eiður Örn Þórsson, Gísli Freyr Þorsteinsson.

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

- Have knowledge and skills in use of three-dimensional design software (Solid Works) for analysis and design of machine parts.
- Have a basic knowledge of the use of lathes, milling machines, drills and welding machines.
- Set up construction drawings of machine parts according to standards.
- Can make 3D drawings of assembled engine components from measurements and simulate functionality.
- Can design and build machinery components to solve actual problems.

Content: Drawing of machine parts and assemblies and construction drawings made with Solid Works. ISO fits, tolerances, surface finish, drawing standards. Basics in the construction and production of machines. Dynamic simulation, accelerator design, sheet metal, frame generator. Presentation of design data in video format. Design and construction of machinery.

Reading material:
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: projects 100%
Language of instruction: Icelandic.

AT STÆ2003 MATHEMATICS II 6 ECTS

Year of study: First year.
Semester: Spring.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: Mathematics I (AT STÆ1003).
Schedule: Taught for 12 weeks – 4 lectures and 2 problem-solving classes a week, with additional weekly tutorial sessions.
Supervising teacher: Hlynur Arnórsson.
Lecturer: Hlynur Arnórsson.

Learning outcome: On completion of the course students should:

Knowledge:

- Know basic matrix operations.
- Know how to solve a linear system of equations.
- Be familiar with vector operations and their utilization in geometry.
- Know methods for computing determinants, eigenvalues and eigenvectors.
- Know linear dependent and linear independent vectors.
- Know linear combination and be familiar with rank, basis and dimensions in R^n.
- Know matrixes and systems of linear equations.
- Know the reduced row echelon form.
- Know the parametric representation of basic curves, e.g. a line and a circle.
- Know how to describe a particle in 3 space by a parametric curve and find its speed, velocity and acceleration.
- Know how to find curve length and line integral.

- Know partial derivatives and directional derivatives and know how to interpret them graphically.
- Know the Jacobian matrix and the chain rule for functions of several variables.
- Know extreme values of functions of several variables.
- Know how to evaluate double integrals in Cartesian and polar coordinates.
- Know Cartesian, spherical and cylindrical coordinates.
- Know conservative vector fields and their potential.
- Be familiar with iteration.

Skills:

- Be able to solve a linear system of equations.
- Be able to find dot product, cross product and write the equations for lines and planes.
- Be able to find the determinant of a matrix.
- Be able to find eigenvalues and eigenvectors for a matrix.
- Be able to determine if vectors are linear dependent or independent.
- Be able to write a linear combination of vectors.
- Be able to write a matrix in a reduced row echelon form.
- Be able to find the parametric representation of basic curves.
- Be able to describe a particle in 3 space by a parametric curve and find its speed, velocity and acceleration.
- Be able to set up and evaluate a integral to find arc length and line integral.
- Be able to calculate partial derivatives and directional derivatives and know how to interpret them graphically.
- Be able to find the derivative of functions from m-space to n-space and use the chain rule.
- Be able to find extreme values of functions of several variables.
- Be able to set up and evaluate double integrals in Cartesian and polar coordinates.
- Be able to set up give the Cartesian, spherical and cylindrical coordinates for a point in 3-space.
- Be able to determine if vector fields are conservative and if so find a potential.

Competence:

- Be able to use linear algebra and multivariate calculus to solve technical problems.

Content: Vectors and matrices. Dot product, cross product, eigenvalues and eigenvectors. Systems of linear equations. Parametrization of curves. Position vector of a particle in space, velocity, speed and acceleration. Arc length and line integrals. Functions of several variables; limits, continuity, differentiability, partial derivative, directional derivative, Jacobi matrix, the chain rule, linear approximation and extreme values. Double integrals in cartesian and polar coordinates. Conservative vector fields, potential function.

Reading material: R.A.Adams, *Calculus, A complete course*, 7th or 8th edition. P.V. O'Neil, *Advanced Engineering Mathematics*, 6th or 7th edition**.** Lecture notes from teacher.
Teaching and learning activities: Lectures and practical sessions, and problem-solving sessions with tutorial assistance.
Assessment methods: Written examination counts 70%, home projects 10% and short exams 10%.
Language of instruction: Icelandic.

AT AÐF1013 STATISTICS AND METHODS 6 ECTS

Year of study: First year.
Semester: Spring.
Level of course: First cycle, introductory.

Type of course: Core.
Prerequisites: Mathematics I (AT STÆ1003).
Schedule: Taught for 12 weeks – 6 hours a week: 4 hours statistics and 2 hours research methodology.
Supervising teacher: Hera Grímsdóttir.
Lecturer: Hera Grímsdóttir.

Learning outcome: The course is divided into two parts; statistics and research methodology.

After completion of the statistical part of the course the student should be able to:

- describe the extent to which a sample can describe the sampled population
- calculate descriptive statistics, i.e. average and standard deviation, median, quartiles and interpret the results
- evaluate measurement uncertainties and explain what it means for both single and repeated measurements
- calculate the uncertainty of a function of several random variables
- briefly describe the normal, lognormal, binomial and Poisson probability distributions
- calculate confidence intervals for the averages of large and small samples, and interpret the results
- set up a statistical test for the difference of two averages and interpretation of the results
- set up a statistical test for the difference between paired measurements, and interpret the results
- calculate the "best fit" for linearly correlated measurements, and explain what "best fit" means
- interpret the uncertainties of the coefficients of the “best fit” line, and evaluate the correlation coefficient
- use software, such as Excel, to compute descriptive statistics and the “best line”.

After completion of the research methodology part of the course the student should be able to:

- describe and follow the classical structure of research papers (IMRaD)
- prepare a list of references according to standards, focusing on the IEEE standard
- write a short essay, evaluate the quality of references and use databases
- give a short lecture.
- design a simple research project, carry it out, and present the results according IMRaD and with a poster.

Content: The aim of the course is to prepare students such that they can:

- apply statistical methods to organize a research project, perform statistical analysis of data, interpret and present the results, as well as evaluate statistical results from others.
- organize and manage a design or research project, and present the results in a report, in a lecture and by a poster.

Reading material: William Navidi, *Statistics for Engineers and Scientists*. Material from teacher.
Teaching and learning activities: Lectures, projects, exercises and presentations.
Assessment methods: There will be no final exam. The final grade is based on six exams during the semester in statistics (every other week), homework in statistics (to be turned in every other week), and several projects in research methodology. The statistics part counts for 2/3 of the final grade and the methodology part counts for 1/3.
Language of instruction: Icelandic.

VT VHF1003 MACHINE ELEMENTS 6 ECTS

Year of study: First year.

Semester: Spring.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: Structural Mechanics I (BT BUÞ1013), Introduction to Engineering Design (AT TÆK1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson.

Learning outcome: On completion of the course students:

- Have a good understanding of the subjects of Machine Elements and receive practical experience in the design and construction of machine elements.
- Are familiar with and know to use the basic tools of modern machine shop, such as lathes, milling- and drilling machines and know all safety rules related to work with such devices.
- Can use load calculations to estimate the strength of simple machine elements under both steady and variable load (Fatigue strength).
- Gain training in the design and construction of simple machine elements using stress analysis and material selection.
- Know and can use three dimensional design software for design and stress analysis and present design data on a comprehensible and thorough way.
- Know the basic methods of assembling machine elements and be able to design welded and bolted connections and know advantages and limitations of this methods with both constant and variable load.
- Will be able to design springs and suspension from the conditions of deformations and strength.

Content: Design of machine elements. Calculation of strength. Failure theories. Steady and variable loading. Fatigue strength and stress concentration. Axles and shafts. Bolts and screws. Bolted connections. Welded and glued connections. Mechanical springs.

Reading material: Budynas, Nisbitt, *Shigley's Mechanical Engineering Design*, 10. Edition.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Home projects 10%, lab projects 30%, and final exam 60%.
Language of instruction: Icelandic.

Second year courses – Fall semester

VT AFL1003 DYNAMICS 6 ECTS

Year of study: Second year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Mathematics I (AT STÆ1003), Physics (AT EÐL1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Andrei Manolescu.

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

- Be able to apply mathematical techniques to describe the motion of particles in a single, double and three dimensional spaces.
- Be able to apply the principles of Newton to particle system and rigid part.
- know how to use the concepts: relative motion, impulse, linear- and angular momentum
- Be able to use energy methods to determine the position and movement of objects
- Be able to describe movements of rigid parts, speed, torque and inertia.
- Know the rotation in three dimensions, precession and other types of motion related to rotating machines.
- Know the basic principles of free and driven vibration.

Content: Kinematics: Planar and spatial motion of particles. Planar and spatial motion of rigid bodies, including relative motion. Mass moments of inertia. Work-energy relations. Impulse-momentum relations. Introduction to vibrations: Free vibrations, free-damped vibrations. Forced vibrations, damped and undamped.

Reading material: J.L. Meriam / L.G. Kraige, *Dynamics*, 7 editions.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Final exam 60%. Exam middle of the semester 40%. Home project.
Language of instruction: Icelandic.

AT STÆ3003 MATHEMATICS III 6 ECTS

Year of study: Second year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Mathematics I (AT STÆ1003), Mathematics II (AT STÆ2003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Hlynur Arnórsson.
Lecturer: Hlynur Arnórsson.

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

- Know the term general solution to a differential equation and particular solution to an Initial Value Problem (I.V.P.)
- Know differential equations with separable variables.
- Know 1. order linear differential equations.
- Know a fundamental set of solutions of a second order differential equation with constant coefficients and know how to calculate a Wronski determinant.
- Know the method of undermined coefficients and the method of variation of parameters.
- Know the Laplace transform and how to use it to solve a I.V.P.
- Know the Heaviside function and the Dirac delta function.
- Know Fourer series, Fourier Sine Series and Fourier Cosine Series.
- Know 1. order system of linear differential equations.
- Be acquainted with how to change a n-th order differential equation to a first order system of linear equations.
- Be acquainted with partial differential equations, e.g. the wave equation and the heat equation.

Skills:

- Be able to find a solution to a differential equation with separable variables.
- Be able to find a solution to a first order linear differential equation.
- Be able to determine which method above is suited to solve a first order differential equation.

- Be able to find a fundamental set of solutions of a second order differential equation with constant coefficients.
- Be able to use a Wronski determinant to determine if two solutions are linearly independent.
- Be able to use the method of undermined coefficients and the method of variation of parameters.
- Be able to solve I.V.P. using the Laplace transform, including I.V.P. with the Heaviside function and the Delta dirac function.
- Be able to find a solution to an I.V.P. using the Laplace-transform. Including problems with Heaviside functions and the Dirac Delta function.
- Be able to find a functions Fourer Series, Fourier Cosine Series and Fourier Sine Series.
- Be able to find solutions to systems of linear first-order differential equations.
- Be able to change a n-th order differential equation to a first-order system of differential equations.
- Be able to solve partial differential equations, e.g. the heat equation and the wave equation.

Competence:

- Be able to solve differential equations for simple dynamical systems.

Content: First order linear differential equations and differential equations with separable variables. Second order differential equations with constant coefficients. Method of variation of parameters and method of and the Method of undetermined coefficients. The Laplace transform, the Heaviside function and Diracs delta function. Fourier- Cosine- and Sine-series. Systems of first order linear differential equations. Partial differential equations.

Reading material: P.V. O'Neil, *Advanced Engineering Mathematics*, 6th or 7th edition**.** Lecture notes from teacher.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Written examination counts 60%, home projects 30%, short exams 10%.
Language of instruction: Icelandic.

VT FEM1003 CAD STRUCTURAL MECHANICS FEM 6 ECTS

Year of study: Second year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Mathematics II (AT STÆ2003), Structural Mechanics I (BT BUÞ1013), Practical Programming (AT FOR1003).
Schedule: Taught for 12 weeks - 6 hours.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson.

Learning outcome: On completion of the course students should:

- Know the fundamental aspects of the finite element method (FEM) and be able to use it in solving structural and thermodynamic problems.
- Be able to analyse statically indeterminate beam type structures and know the method of displacement and compare the results to FEM results
- Be able to find buckling forces in beams and trusses with standard methods and compare to results from FEM buckling analysis
- Know the basics of the ANSYS Mechanical ADPL analysis software and the ANSYS Workbench three dimensional analysis tool and can use them for structural and thermodynamic analysis on two and three dimensional mechanical parts.

- Have obtained training in the design and analyse of real machine parts with FEM methods and can realize the limitations of these methods.
- Have done measurements and tests on real machine part which is designed and built on basis of FEM analysis and can realize the difference between test results and FEM analysis.

Content: FEM (the finite element method) and its use in stress analysis, of two- and three-dimensional structures and machinery parts. Base theory of undetermined beams structures. Deformations of beams under load. The deformation method. Buckling of steel columns and frames. Virtual Work. Energy Methods. Training in the use of the ANSYS program. Forces and stresses in beams. Stress concentrations. Strain analysis of the composite machinery parts. Heat deformations and stresses in machinery parts. Design, construction and testing of structures with the help of FEM

Reading material: Saeed Moaveni, *Finite Element Analysis: Theory and Application with ANSYS*, 4. útgáfa.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Project grade 100%.
Language of instruction: Icelandic.

VT VAR1013 THERMODYNAMICS I 6 ECTS

Year of study: Second year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Physics (AT EÐL1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Jens Arnljótsson.
Lecturer: Jens Arnljótsson.

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

- Will know the first law of thermodynamics, potential energy, kinetic energy, internal energy, heat and work.
- Be able to find thermodynamical properties for pure substances and two-phase liquid-vapour mixture and use them in thermodynamic systems.
- Be able to sketch thermodynamic processes in p-v, t-v and t-s diagram.
- Wii know adiabatic processes.
- Be able to calculate thermal efficiency in power cycles.
- Will know ideal gas equations.
- Will know Clausisus and Kelvin Planck statements and the second law of thermodynamic cycle.
- Have sufficient knowledge and understanding of the basic principles of thermodynamics to be able to apply them to the solution of commonplace technical problems in the field of Mechanical Technology.
- Have sufficient general and integrated knowledge in the field of Mechanical Technology and Mechanical Engineering to be able to analyse common problems in that field, assess the need for assistance and seek specialist advice from mechanical engineers and/or other specialists.

Content: Basic concepts in Thermodynamics. Energy and the first law of thermodynamics. Work, heat and thermal efficiency. Thermodynamic systems and changes. of properties. Key concepts including phase and pure substance, state principle for simple compressible systems, p-v-T surface, saturation temperature and saturation pressure, two-face liquid-vapour mixture, quality, enthalpy, and specific heats. Control volume. Conservation of mass and energy for a control volume. Analysing control volume at steady state. Throttling devices. The second law of thermodynamics. Kelvin-plank and

Clausius statements of the second law. Irreversible and reversible processes. Carnot power and refrigeration and heat pump cycles. Clausius inequality. Entropy. Entropy balance for closed systems. Isentropic processes. Isentropic efficiency. Exergy rate balance for control volumes at steady state.

Reading material: Moran and Sharpiro, *Principles of Engineering Thermodynamics,* 8th edition.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Final exam (75%): A four hour written exam. Midterm exam (15%). Homework (10%).
Language of instruction: Icelandic.

VT VHF2013 MACHINE ELEMENT DESIGN 6 ECTS

Year of study: Second year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Machine Elements (VT VHF1003).
Schedule: An intensive course, taught every weekday for 3 weeks.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson, Gísli Freyr Þorsteinsson (labs).

Learning outcome: On completion of the course students should:

- have a good understanding of the topics of Machine Elements and receive practical experience in the design and construction of machines.
- know and can use the basic tools of modern machine workshop such as lathes and milling and know all safety regulations while working with such devices.
- gain training in the construction and design of machine elements from stress analysis, functionality, choice of materials and choice of standard components.
- know and know how to use three-dimensional design programs for design, load and performance analysis.
- know the main types of rolling bearings and can choose bearings with respect to the load and duration.
- know the function and nature of journal bearings and to determine the size of such bearings based on load and speed.
- know the main types of brakes and clutches and can determine the size of brakes and clutches from force and power of analysis. Can also select suitable friction materials for brakes and clutches.
- be able to design belt and chain drive from the load and power conditions as may select sizes of belts and chains according to manufacturers´ catalogues.
- know the main types of gears and tooth systems. Can determine the size of gear systems, based on power, loads and speed ratios. Know the nature of planetary gears and how they work.
- be able to calculate the load on axles and bearings in gear systems from power transfer.

Content: Rolling and journal bearings, theoretical background and design basis for steady loading. Brakes and friction clutches, their mechanics and design. Rigid couplings. Belt- and chain drives, their mechanics and design. Geometry of involute gearing. Design of spur-, helical-, bevel- and worm gearing in accordance with design standards. Design and construction project related to the course material

Reading material: Budynas, Nisbitt, *Shigley's Mechanical Engineering Design*, 10th edition. H. E. Krex, *Maskin Ståbi*
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Home projects 10%, lab projects 40% and final exam 50%.

Language of instruction: Icelandic.

Second year courses – Spring semester

VT HVV2003 PRACTICAL PROJECT:THERMO AND HYDRAULICS 6 ECTS

Year of study: Second year.
Semester: Spring.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: Thermodynamics I (VT VAR1003), Thermodynamics II (VT VAR2003), Fluid mechanics and heat transfer (VT STV1003).
Schedule: An intensive course, taught every weekday for 3 weeks.
Supervising teacher: Jens Arnljótsson.
Lecturer: Jens Arnljótsson, Indriði Sævar Ríkharðsson.

Learning outcome: At the end of the course students should:
- be able to design, build and test equipment built on thermal and fluid dynamics using theoretical approaches, technical software and other tools that apply.
- can perform measurements of effectiveness of equipment, for example, power, efficiency, fluid and heat flow and compare with theoretical values and models.
- can make good design- and measurement data and can present the results of design and measurements in a clear manner.

Content: Students work in groups on design projects and/or experiments in the field of thermal and fluid dynamics. Selected projects in consultation with teachers that include various aspects of thermal and fluid analysis, along with construction of equipment and measurement of functionality. Emphasis is placed on theoretical design and analysis and professional building skills. The students must submit an informative report with high quality drawings of equipment.

Reading material: As decided by teacher.
Teaching and learning activities: Project work.
Assessment methods: Assessment of project work and student activity 100%.
Language of instruction: Icelandic.

VT RAR1003 ELECTRIC CIRCUITS AND ELECTRIC POWER 6 ECTS

Year of study: Second year.
Semester: Spring.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Physics (AT EÐL1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Kristinn Sigurjónsson
Lecturer: Kristinn Sigurjónsson

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

- Know the basic concepts of electricity, voltage, current, power and energy and the difference between AC and DC electricity.
- Know how electricity is converted into kinetic energy (motor) and kinetic energy converted into electricity (generator).
- Know real-, - reactive-, and apparent impedance and how they influence the power transmission system.
- Calculate losses in transmission lines and transformers

Content:

The first section: Handles the general electricity where the emphasis is on ac electricity. Specially the relationship between voltages, currents, resistor and reactance. How phase difference between voltage and current affects real-, reactive- and apparent power. Thevenin and Norton circuit and their usefulness in identifying and simplifying circuits.
The second section covers: How electricity is produced and how electricity is converted into mechanical energy, main type's dc- and ac motors. 3 phase electricity, the advantages of power transmission with 3-phase system and different connections to the load. 1-phase equivalent diagram of a 3-phase systems. Voltage and power losses in transmission lines are covered and how it can be minimized. The function of transformers and losses in them and how impedances beyond them is calculated.

Reading material: Theodore Wildi, *Electrical Machines, Drives, and Power Systems*, 6th edtion. Kristinn Sigurjónsson*, Rafmagnsfræði fyrir vél- og orkutæknifræðinga*. 1. útgáfa 2016.
Teaching and learning activities: Lectures and practical lessons.
Assessment methods: A 3 hour written exam counts 70% of the final grade, 3 quizzes count 20%, lab work and reports count 10%.
Language of instruction: Icelandic.

VT STV1003 FLUID MECHANICS AND HEAT TRANSFER 6 ECTS

Year of study: Second year.
Semester: Spring.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Thermodynamics I (VT VAR1013).
Schedule: Taught for 12 weeks - 6 hours a week, with additional lab exercises. Fluid Mechanics is taught for the first 8 weeks and then Heat Transfer for 4 weeks.
Supervising teacher: Einar Jón Ásbjörnsson.
Lecturer: Einar Jón Ásbjörnsson.

Learning outcome: Upon completion of this course, students should be able to:

- Solve problems related to hydrostatics, including manometry, buoyancy, and pressure on submerged surfaces.
- Apply conservation of mass, momentum, and energy to control volume systems
- Apply Beroulli´s equation and mechanical energy balance to systems
- Determine and use appropriate dimensionless parameters to solve a problem
- Understand characteristics of and properly analyze internal-flow problems
- Understand characteristics of and properly analyze external-flow problems
- Apply governing equations for conduction, convection, and radiation problems
- Evaluate 1-D, steady, and transient conduction models
- Evaluate internal and external forced convection
- Analyze performance of heat exchangers

Content: Properties of fluids. Hydrostatics. Conservation laws in integral form. Pipe flow. External flow. Boundary layer. Thermal conduction in one dimension. Thermal convection. Thermal radiation. Heat exchangers. Problem sessions, homework, and laboratory experiments.

Reading material: White. *Fluid Mechanics,* 7.útgáfa**.** Incropera, DeWitt, et al. *Foundations of Heat Transfer,* 6th edition.
Teaching and learning activities: Taught for 12 weeks - 6 hours a week, with additional lab exercises. Fluid Mechanics is taught for the first 8 weeks and then Heat Transfer or 4 weeks. Lectures, problems sessions, and laboratory experiments.
Assessment methods: Homework (10%**)**: Students hand in solutions to homework problems each week. Solutions handed in after the deadline are not accepted. Laboratory experiments (20%)**:** Students work in groups and perform several laboratory experiments. Each group hands in a joint report for each experiment. 100% lab attendance is required. Final exam (70%**)**: A four hour written exam. Closed book and closed notes. Students can only bring a calculator of the type Casio FX350. Formula sheets are provided.
Language of instruction: Icelandic.

VT SVF1003 THEORY OF VIBRATIONS 6 ECTS

Year of study: Second year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Core.
Prerequisites: Dynamics (VT AFL1003), Finite Element Analysis (VT FEM1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Andrei Manolescu.

Learning outcome:

- Understand the basic principles of vibration theory and know methods to reduce disturbances and vibration.
- Know how to calculate the main parameters in systems with free and forced vibrations in one degrees of freedom and can set up system of equations with force methods or energy methods. These parameters are for example undamped resonance, damped resonance, damping ratio, maximum amplitude, maximum speed, acceleration, and the forms of oscillation as a function of time.
- Know how to calculate the maximum amplitude and transfer forces in systems with driven oscillations with one degree of freedom. Be familiar with the response of systems with fluctuating load and moving base.
- Can apply matrix methods to analyse Eigen frequencies and vibrations in systems with two or more degrees of freedom. Be familiar with the formalism of Modal analysis.
- Know the main methods to reduce the effects of vibration on machines.
- Be able to find Eigen frequencies of simple continuous bodies.
- Know how to use computational software such as MATLAB or MathCad for modal analysis.
- Have training in the use of instruments and software for measuring and analysing vibration.
- Know and can apply three-dimensional FEM software to analyse vibration machinery components.

Content: Free, damped and excited vibrations in linear systems. Nonlinear vibrations. Two-degree-of-freedom systems. Design for vibration suppression. Measurement and analysis of vibrations. The use of the ANSYS program for vibration analysis.

Reading material: Daniel J. Inman, *Engineering Vibration*, 4th edition.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: A 3 hour written exam counts 70%. Evaluation of projects 30%.

Language of instruction: Icelandic.

VT VAR2013 THERMODYNAMICS II 6 ECTS

Year of study: Second year.
Semester: Spring.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Thermodynamics I (VT VAR1013).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Jens Arnljótsson.
Lecturer: Jens Arnljótsson.

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

- are able to analyse vapor power cycles.
- know how internal combustion engines work.
- are able to model gas turbine power plants, regenerative gas turbines with reheat and intercooling and how it influences the efficiency.
- are familiar with refrigeration and heat pump systems, know how to calculate their coefficient of performance, and are able to analyze vapor-compression refrigeration systems with various coolants.
- know the definition of moist air with different conditions and can apply this knowledge to design heat and air conditioning systems.

Content: Exergi, anergi.Vapour power systems. Gas power systems. Air standard Otto, Diesel and Brayton cycle. Reheat and intercooling. Refrigeration and heat pump systems. Mixing of ideal gases. Psychrometric systems and applications.

Reading material: Moran og Sharpiro, *Principles of Engineering Thermodynamics,* 8th edition.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: A four hour written final exam (70%). Homework (10%). Midterm exams (15%). Student activity 5%.
Language of instruction: Icelandic.

Third year courses – Fall semester

VT EFV2003 METALS AND MANUFACTURING PROCESSES 6 ECTS

Year of study: Third year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Metallurgi and Metal Processes (VT EFV1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Einar Jón Ásbjörnsson.
Lecturer: Einar Jón Ásbjörnsson.

Learning outcome: On completion of the course students should:
• have an understanding of the fundamental principles of materials science and manufacturing

processes and be able to apply these to the solution of technical problems.
• have sufficient basic knowledge to be able to assimilate subjects of engineering.

Content: Iron. (Fe). Heat treatment of steels. Alloying elements. Types of steel. Stainless steel. Surface treatment. Cast Iron. Aluminium and its alloys. Copper and its alloys. Welding and weldability of steel. Polymer structures.

Reading material: William D. Callister, David G. Rethwisch, *Materials Science and Engineering, SI version*, 9th edition.
Teaching and learning activities: Lectures and practical lab sessions.
Assessment methods: Three mandatory projects 30%, home assignments 10% and final examination 60%. Attendance in practical exercises is mandatory.
Language of instruction: Icelandic.

VT REG1003 FEEDBACK CONTROL SYSTEMS 6 ECTS

Year of study: Third year.
Semester: Fall.
Level of course: First cycle, advanced.
Type of course: Core.
Prerequisites: Mathamatics III (AT STÆ3003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson.

Learning outcome: On completion of the course students should:

- Be familiar with different control and regulation systems, and know the most common calculation- and design methods.
- Have a good understanding of how an automated system with feedback is structured and function to achieve desired goal.
- Have gained a basic understanding of how mathematical models of common systems are presented in the form of linear ordinary differential equations and transfer functions.
- Be able to determine the main characteristics of linear control systems from transfer functions in Laplace form.
- Understand how such models are calibrated with experiments, measurements and data processing.
- Knowledge of stability and how to influence it by applying feedback control.
- Know how to construct root locus and Bode diagrams and understand their meaning.
- Be familiar with function and characteristics of P, PD, PD and PID compensators and their impact on errors and stability.
- Be able to use Matlab and Simulink for simulation and design of control systems.
- Have practical knowledge of controllers and their application in industry.

Content: Emphasis is placed on fundamental feedback control technology, its use and design of control systems. Traditional control methods and properties of controllers, especially PID control. Design methods and tools that can be used in the development of compensators in control systems. Development of transfer functions. Laplace transform. Basic principles of feedback control systems. Block diagrams and block diagram algebra. Time and frequency response. Stability. Simulation of control systems with Matlab and Simulink. Different kind of control and regulator systems. P , PD, PI and PID compensators. Design methods for compensators. Root locus. The Bode diagram.

Reading material: Richard C. Dorf, Robert H. Bishop, *Modern Control Systems*, 12th edition.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: A 3 hour written examination counts 60% and exercises 40% of final grade.
Language of instruction: Icelandic.

VT STR1003 TURBOMACHINERY 6 ECTS

Year of study: Third year.
Semester: Fall.
Level of course: First cycle, advanced.
Type of course: Core.
Prerequisites: Fluid Mechanics and Heat Transfer (VT STV1003).
Schedule: Taught for 12 weeks – 6 teaching hours a week.
Supervising teacher: Jens Arnljótsson.
Lecturer: Jens Arnljótsson.

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

- Will have developed an understanding of the types, usage and function of turbomachinery,
- Are able to pre-design and select turbomachinery,
- Will have a good foundation for further studies of turbomachinery.

Content: Basic relations of turbomachinery. Euler's equation for turbomachinery. Velocity diagrams. Power, flow, and pressure coefficients. Characteristic curves. Specific speed. Specific diameter. Efficiency. Cordier graph. The centrifugal pump. Slip. Cavitation. Design of pumps. Piping systems with pumps. Selecting pumps. Aerodynamics of blades. Axial flow pumps. Water turbines; Pelton, Francis, and Kaplan. Wind turbines. Class problems, homework problems, lab experiments, and a design project.

Reading material: Frank M. White, *Fluid Mechanics*, 7th edition.
Teaching and learning activities: Lectures, homework, and lab experiments.
Assessment methods: Four short exams 16%; Four due homeworks 10%; Two lab exercises 20%; Student's activity 4%; Written final exam 50%.
Language of instruction: Icelandic.

VT STÝ1003 CONTROL ENGINEERING 6 ECTS

Year of study: Third year.
Semester: Fall.
Level of course: First cycle, advanced.
Type of course: Core.
Prerequisites: Dynamics (VT AFL1003), Fluid Mechanics and Heat Transfer (VT STV1003), Practical Programming (AT FOR 1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson.

Learning outcome:

At the end of the course students should:

- Have a good understanding of the principles of control technic and acquired skills to apply it in practical design projects.
- Be able to simulate and design systems where linkages (mechanisms), hydraulic, pneumatic and electrical systems work together by use of design software.
- Be able to set up a mathematical dynamic model for two dimensional mechanisms with one degree of freedom in matrix form and resolve with respect to position, speed and acceleration.

- Be able to use computational software such as Matlab/Mathcad to solve non-linear dynamic equations in matrix form and present the results in graphical form.
- Be able to use a common design software such as ANSYS / Inventor / SolidWorks to perform dynamic motion analysis of linkage systems.
- Know the function of the key components in hydraulic control systems and know the advantages and disadvantages of such systems compared with other possible control methods.
- Be able to determine the size of the main parts of a hydraulic system (pumps, reservoirs, cylinders, motors and pipes) from power and dynamic analysis of the system to control.
- Be able to find power and pressure losses in fluid systems and to realize the effects of different control methods on the overall efficiency of hydraulic systems.
- Know the function of the major components of pneumatic control systems and know the advantages and disadvantages of such systems compared with other possible control methods.
- Be able to determine the size of a simple pneumatic control systems based on performance, force, and power requirements.
- Be able to design simple sequential pneumatic control system and verify its effectiveness by testing and simulation.
- Know how hydraulic, pneumatic and electric systems may work together in one unit to control and move mechanical equipment.

Content: Linkages. Simulations of linkage motion with help of a computer program. The use of FEM and CAD software in motion simulation. Hydraulic systems. Pneumatic systems. Hydraulic and pneumatic control. Actuators, transmissions, transport systems and fish processing machines. Electronic control. The FluidSim program used for design and simulation of hydraulic and pneumatic control systems. Design of equipment where linkages, hydraulic, pneumatic and electronic systems are used together in one unit and control of such equipment. Group design projects. Exercises in pneumatic control.

Reading material: Delivered by teacher. Manufactures catalogues.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Evaluation of project accounts for 100%.
Language of instruction: Icelandic.

AT VST1003 PROJECT MANAGMENT 6 ECTS

Year of study: Third year.
Semester: Fall.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: No prerequisites.
Schedule: An intensive course, taught every weekday for 3 weeks.
Supervising teacher: Hera Grímsdóttir.
Lecturer: Hektor Már Jóhannsson, Kristinn Alexandersson, Ólafur Hermannsson.

Learning outcome: On completion of the course students should:

- Have a good understanding of the methodology of project management, the basic theories and methods that have been developed in the field of project management.
- Have a good understanding of the importance and different aspects of project work and project management in business operations.
- Be familiar with available software and technology that can be used in project management.
- Know how project management is practiced in local companies.

- Have obtained skills sufficient to apply project management methods within his field of discipline.
- Know how tender documents are structured and learn about the different forms of the bidding process.
- Be able to prepare tender documents, offers, work schedules and cost estimates for common and traditional projects and evaluate plans made by others.
- Be familiar with the basic principles and procedures in supervision of construction projects and the use of quality systems in construction.
- Attain a good understanding of the implementation of construction management methods in an actual construction project.
- Be able to apply the knowledge gain to administrate and oversee a construction project and on-site inspection.

Content: The course is on project- and construction management.

Project management:

Overview of project management methodology. Coordination of projects to attain direction and organizational management. Selecting and defining projects. Life cycle and characteristics of projects. Goals, work analysis, breakdown of work into components and creation of a flowchart. Planning, resource management, schedule, execution, progress and performance, report and sharing information. MS Project program - basis.

Optimization of the project time schedule, risk management. MS Project - inputs. Procurement, project management, project team, stakeholders. Prince2 and other methods, Gantt, CPM, PERT etc. How to choose between viable projects. MS Project - continuation.

Construction Management:

Contracting documents, design at various levels, project descriptions, specifying and registering material quantity. The bidding process and different bidding practices. Cost planning and estimating, assumptions, uncertainties, presentation. Making bids and contracts, advertising, bidding time, opening of tenders. Bidding, cost factors, data collection, structuring unit prices, estimating volume, risk, uncertainty, profits.

Contracting, evaluation of tenders, accepting a bid, rejecting a bid, negotiations. Project surveillance and control, project organization, project meetings, communication protocols, information sharing etc. Basic quality control, Project quality manual, examples of the use and benefits of the quality system. Legal concerns regarding implementation of projects, settlement and disagreement.

Reading material:
Teaching and learning activities: Lectures and practical sessions. A main construction project entails scrutinizing tender documents, making offers and organizing the project. Students deliver their offer and schedule and defend their work orally, working in groups of 3-4, teachers select students into groups.
Assessment methods: Small projects and quizzes counts 30%, grade for project work and oral examination counts 70% of final grade.
Language of instruction: Icelandic.

Third year courses – Spring semester

T-403-ADGE OPERATION RESEARCH 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, intermediate.
Type of course: Core. It is mandatory for students to take either Computer-Aided Design II (VI TEI 2013) or Operation Research (T-403-ADGE).
Prerequisites: Mathematics I (T-101-STA1 or AT STÆ1003), Statistics (T-302-TOLF or AT AÐF1013).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Hlynur Stefánsson.
Lecturer: Drífa Þórarinsdóttir.

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 specificly the student will be capable of:

- Using standardized processes to work on complex decision problems
- Applying systematic methods and algoirthms for analysing and solving decision problems
- Understand how to use data and quantitative methods for decision making
- Understand the importance and usefullness of linear optimization and its applications
- Applying commercial software to solve optimization models with particular emphasis on MS Excel and MPL
- Solving optimization models with Simplex method
- Understand the use of sensitivity analysis
- Understand integer programming and how it can used in decision making
- Identify traditional transportation and distribution problems and be able to solve problems with the relevant methods
- Understand the special properties of network models
- Formulate and solve network models from practical problems
- Apply methods from decision science to solve simple practical problems
- Present results in a clear and organized manner

Content: Introduction to standard Operations Research methods. Linear programming and sensitivity analysis, integer programming, dynamic programming, queuing theory, scheduling, networks. Using software for modelling and optimisation.

Reading material: Hillier & Lieberman, *Introduction to Operation Research*.
Teaching and learning activities: Taught for 12 weeks - 6 hours a week. Lectures and problem solving classes.
Assessment methods: A final exam counts 60%, two midterm exams 20% each. Permission to take the final exam is granted based on participation in problem based classes. See course website for further information.
Language of instruction: Icelandic.

VT HVV3003 PRACTICAL PROJECT III 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Core.
Prerequisites: Design (VT HUN1003).
Schedule: An intensive course, taught every weekday for 3 weeks.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson.

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

- Design, construct and test mechanical equipment and apply theoretical approaches, technical software and other tools that matters.
- can make measurements of effectiveness of equipment, for example, power, efficiency and strength
- Know the various methods of utilization of renewable energy sources.
- Be able to make a good design and analysis of data and are able to present the results of design and analysis in a clear manner.

Content: Students work in small groups on design projects in the field of mechanical and / or energy technology. The project is selected in consultation with teachers that includes the key elements of machine element design, as well as construction and testing. The project may be associated with projects from other courses of the department, but the focus is on projects related to energy production and renewable energy. Emphasis is placed on engineering design and analysis, and professional construction. Students present the progress of the project through regular presentations. The applicant must submit a good report, along with quality construction drawings.
Reading material: As decided by teacher.
Teaching and learning activities: Project work.
Assessment methods: Project grade 100%.
Language of instruction: Icelandic.

VT HUN1003 DESIGN 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, intermediate.
Type of course: Core.
Prerequisites: Maching Element Design (VT VHF2013), Fluid Mechanics and Heat Transfer (VT STV1003), Metals and Manufacturing Processes (VT EFV2003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Joseph Timothy Foley.
Lecturer: Joseph Timothy Foley.

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

Knowledge:
- Know fundamental design principles
- Understand how uncertainty and entropy direct design selection
- Know the elements of design processes such as Axiomatic Design

Skills:
- Use computer and paper-based tools to come up with estimations and answers quickly
- Create functional requirements, design parameters, and design matrixes
- Create effective design documents using LaTeX
- Present their ideas effectively for customers and peer reviews
- Design and perform experiments to test design choices
- Build prototypes of their designs
- Analyse their prototypes to develop suggestions for the next design
- Use the creative instincts as part of a deterministic process
- Work collaboratively using IT tools such as SVN

Competences:
- Solve complex and open-ended mechanical design problems using systematic design processes.
- Understand the challenges and requirements of inter-discipline collaboration to successfully complete projects in a wide range of environments.

Content: Prerequisites: Basic structural mechanics, basic fluid mechanics, solid modelling, linear algebra.
Focus: "Defensive" mechanical design.
Design of machine elements with respect to function, shape, material and viability.
Emphasis on cross-discipline collaboration, systematic methods and use of design software.
Classes will be taught with traditional lectures with interactive modules.
Time will be given in-class to work on design projects in partnership with other institutions and industry.

Course will begin with lectures on the basics of design including systematic processes to harness creative thinking. Course will cover basics of collaboration software usage. Emphasis and evaluation will be placed equally on effective process, documentation/presentation, and results. The semester´s assignments will consist of a mixture of individual and team assignments.

Reading material: Ulrich and Eppinger, *Product Design and Development,* 5th or 6th edition (main textbook). Nam Pyo Suh, *The Principles of Design,* 1st edition.
Teaching and learning activities: Material is presented in lectures and practical sessions. Students will be designing and build a solution for a problem. The choice of problems to solve varies from year to year.
Assessment methods: Student capability will be assessed primarily based upon quality and presentation of projects. No final exam or midterm. Students must be able to effectively communicate their ideas through written and oral methods. Assignments must be passed in using the method described in the assignment. If one is not described, then the assignment should be turned in using MySchool. Late work will be graded at a penalty of -1 point (to a maximum of -5). Late work will only be accepted up to 14 days late. Late work must be submitted via SVN or homework box. Assignments that are sent as email attachments will be deleted without a response except in exceptional circumstances.
Language of instruction: English.

SE 815 PPE GEOTHERMAL POWER PLANT DESIGN 6 ECTS

Year of study: Third year BSc or first year MSc.
Semester: Spring.
Level of course: Second cycle, advanced.
Type of course: Core in the MSc Sustainable Energy Engineering program. Closed for exchange students without permission from ISE office.
Prerequisites: Thermodynamics and fluid dynamics are required. Previous courses covering topics like turbomachinery, Engineering Equation Solver (EES), engineering drafting software, or powerplant technology would be helpful.
Schedule: 4 teaching hours a day for a period of 3 weeks.
Supervisor: María Guðjónsdóttir
Lecturer: William Scott Harvey.

Learning outcome: Upon completion of this course students should have the ability to:
• Understand some of the major design-point selection processes of a thermal power plant
• Design piping and pumping stations, with technical and economic considerations
• Perform technical and economic optimizations of major equipment
• Describe and understand the major conceptual drawings that describe a process plant
• Understand basic construction and maintenance safety considerations

Content: The purpose of this course is to expand student mastery of thermodynamics, fluid dynamics and turbomachinery as it applies to the detailed design of an industrial process facility, such as a geothermal powerplant or chemical process plant. The overall design-project management structure will be discussed and developed. Students will perform conceptual-level and detailed design, such as development of process flow diagrams, piping design, equipment selection and optimization. Case studies will be used as the foundation of the course. Students will form design subgroups to cooperate in executing conceptual design for facilities. Students should load EES before the start of classes, and some practice using it is advised. This can be a useful tool for Master´s thesis or lokaverkefni work. Taught in English.

Reading material: *Geothermal Power Plants*, DiPippo, 2nd or 3rd, Elsevier.
Teaching and learning activities: Lectures, independent reading, periodic assignments, frequent beatings, and independent project work.
Assessment methods: Attendance and in-class participation 30%, Project work 70%.
Language of instruction: English.

T-420-HONX DESIGN X 12 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Elective.
Prerequisites: Teacher approval. Admission into the course is limited and efforts are made to ensure that students with various talents and backgrounds are admitted, in order to create an integral group.
Schedule: 3 -4 lectures per week + project work for 12 weeks. Project work for 3 weeks following the 12-week period.
Supervising teacher: Indriði S. Ríkharðsson.
Lecturer: Indriði S. Ríkharðsson, Baldur Þorgilsson.

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

- Analyze an open-ended problem and establish requirement specifications
- Assess the merits of, and choose between, competing design alternatives
- Productively operate in an inter-disciplinary project team environment
- Work disciplined on a sub-task of a larger project.
- Demonstrate project management skills, including meeting important deadlines and operating within budgetary limits.
- Execute a design, build, test, and refine process of machines that are combined of hardware, electronics and software.

Content:
Objective: Students in Design X works in (possible big) group on a project that is defined each year. The students goal is to design, build, test, and refine subsystems enabling the participation of a RU student team in the 2017 Formula Student competition or similar open ended inter-disciplinary projects. (see http://events.imeche.org/formula-student and http://www.auvsifoundation.org/2014-robosub-teams)
Example projects:

- Rocket.
- "Mars" rowers.
- Autonomous submarine.
- Robot for temperature inspection in aluminum smelter.
- Walking robot for Össur.
- Sound probe for recording whale sounds in sea.
- Formula Student race car.

Challenges:
Working in an inter-disciplinary team environment. Project management. Applying principles of engineering design.
Prerequisites: Teacher approval. Admission into the course is limited and efforts are made to ensure that students with various talents and backgrounds are admitted, in order to create an integral group. This course is aimed to students on 3rd year in engineering, applied engineering and computer science but 2nd year students can also apply. Those students who are interested in the course should register

and send a short resume to honnunx@ru.is. This resume should include which courses the student has completed in addition to any special competencies.

Reading material:
Teaching and learning activities: Project supervision, including regular discussions with project team leaders.
Assessment methods: Group work assessment 60% (design report, meeting goal criteria), Individual assessment 40 % (notebooks, peer review).
Language of instruction: Icelandic/English.

RT IDN1003 INDUSTRIAL CONTROLLERS AND ROBOTS 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Elective.
Prerequisites: Practical Programming (AT FOR1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: Indriði Sævar Ríkharðsson.

Learning outcome: On completion of the course students should:

- be able to design computer-controlled production processes and be able to apply the programming control and monitoring in the industry.
- know the function and internal construction of industrial control computers (PLC) and how they are connected to sensor and actuators.
- know the function key sensors and actuators that are used in industrial control.
- be able to program simple control of Zelio PLC with Ladder, FDB or SFC programming language.
- be able to program more complex control of Modicom M340 PLC. Using analogue output and the input signals and the setup of the PID controller. Using Ladder, FDB, SFC and ST programming languages.
- be able to set up a simple display system for industrial control.
- know the basics of using and programming of industrial robots and be familiar with different coordinate systems and industrial robots.
- be familiar with the functionality of CRS industrial robot, can manually control it through Active Robot terminal and know the basic safety rules of the use of industrial robots.
- can program CRS industrial robots in Visual Basic with the ActiveX components and know all major control and motion commands and can set up user interface.
- be able to program a simple computer vision in Visual Basic with the aid of LabVIEW Vision Assistant and use it to control the movements of the robot.
- be able to connect industrial robots, PLC and other devices through the input / output unit to form an integrated system.
-

Content: Programmable logic controllers (PLC) in industry and their programming, industrial robots, computer manufacturing, monitoring system, etc. Main programming language for Industrial Controllers, Ladder, FBD, SFC (Grafset) and structured text (ST). Students work on projects that involve control of actual equipment with PLC. Programming of industrial robots and basic safety rules of their use. Basics in computer vision. Using Visual Basic with ActiveX components to program the robot and vision. Students do projects that combine control with PLC, robots and vision.

Reading material: Delivered by teacher.
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Practical exercises 50% and a 3 hour written exam 50%.
Language of instruction: Icelandic.

VT JAH1003 GEOTHERMAL ENERGY 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Elective.
Prerequisites: Thermadynamics I (VT VAR1003 or T-507-VARM).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: María Sigríður Guðjónsdóttir.
Lecturer: María Sigríður Guðjónsdóttir, Árni Ragnarsson, Benedikt Steingrímsson, Sverrir Þórhallsson.

Learning outcome: On completion of the course students should:
• understand the structure of geothermal systems and know their main components and equipment.
• be able to assess geothermal reservoirs and production.
• know the main potentials for the utilization of geothermal energy.
• have an overview of the main equipment of geothermal power plants and be able to design simple systems.

Content: Geothermal systems. The mining of geothermal heat. Boreholes. Research, drilling, wells, measurement and testing of boreholes, grouping of geothermal systems, resource models, supply models. The role of geothermal heat in the energy system. The multifarious use of geothermal use in Iceland and abroad. Direct use of geothermal heat in district heating, swimming pools, greenhouses, snow melting and in industry. Design of geothermal power systems, strength, control and safety equipment. Design of direct and indirect heat exchangers. Selection of steam turbines, cooling towers, condensers and pumps. EGS systems. The use of EES software. The environmental impact of geothermal energy.

Reading material:
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: Evaluation of project work counts 100%.
Language of instruction: Icelandic.

VT KÆL1013 REFRIGERATION AND HEAT PUMP SYSTEMS 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Elective.
Prerequisites: Thermodynamics I (VT VAR 1003), Thermodynamics II (VT VAR 2003), Fluid mechanics and heat transfer (VT STV 1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Jens Arnljótsson.
Lecturer: Ásgeir Matthíasson.

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

- Be familiar with the functionality of the main cooling and heat pump systems.
- Be able to calculate cooling need for refrigeration and freezer chambers.
- Know the main components of cooling and heat pump systems and to determine the size of such systems.
- Know the main methods for treatment and storage of food.

- Be able to select cooling medium for different conditions and use.

Content: Cooling systems and heat pumps and their main types. Calculations of heat needed for housing along with the utilization of low temperature heat. Calculation of cooling needed for cooling and refrigerating chambers, with a special focus on the food industry. Different types of insulation and the main components of heat loss. Treatment and storage of food. The structure of the cooling hardware with condensers, evaporators and compressors and other parts related. Choice of cooling and calculation of heat pump and cooling systems. One-stage and two-stage system, intercoolers, pump systems.

Reading material: To be decided.
Teaching and learning activities: Lectures and practical sessions
Assessment methods: To be decided.
Language of instruction: Icelandic.

BT LOF1003 HEATING, VENTILATION AND AIR-CONDITIONING 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, intermediate.
Type of course: Elective.
Prerequisites: Hydraulics (BT REN 1003).
Schedule: Runs for 12 weeks – 6 hours in class each week.
Supervising teacher: Aldís Ingimarsdóttir.
Lecturer: NN.

Learning outcome: Upon completion of the course, students should be able to:

Knowledge:
- Be able to determine the need for ventilation depending on requirements set forward in building regulations on indoor air comfort both in terms of air quality and cooling needs for the inside temperature.
- Know different type of mechanical ventilation system that suits the subject and its components.
- Know the the characteristics and use the use of I-x graph. (Mollier)

Skills:
- Draft a control system for an air-conditioning system.
- Choose and dimension a ventilation system for mechanical air conditioning that meets the building regulation and standards for energy use.
- Describe the use of I-x graph (Mollier)
- Calculate the need for fresh air and cooling air for air quality and cooling requirements of buildings.
- Draft methods to verify and describe the functionality of the air-conditioning systems and their design criteria's.
- Draft operational guidelines for air conditioning.

Competence:
- Students should be able to design mechanical and natural air ventilation system in buildings with regard to the requirements of comfort, indoor air quality and energy consumption

Content: The course is on air-conditioning technology with an emphasis on mechanical and natural air conditioning for cooling of buildings and to improve air quality. The aim of the course is to enable students to design mechanical and natural air conditioning for buildings by considering the requirements for comfort, indoor air quality and energy consumption. It is necessary that students have taken courses in heat engines or installation technology.

The course will discuss requirement for indoor air quality and cooling, energy saving for air-conditioning systems and design of ventilation systems. Emphases are on the use of I-x graphs for air, cooling of air using cooling equipment and cold water, heat recycling and different efficiency and economy evaluations. Intake devices (distributors and control systems) are studied as well as the construction of air duct systems. Ventilation machinery and different control of air-conditioning systems are discussed including blowers and electricity use. Sound design for ventilation systems is presented. Software is introduced, to assist with selection and dimensioning of equipment as well as the calculation of the cooling needs of buildings. Building regulations and relevant standards will be examined. A tour will be organized to inspect a complete air conditioning system in operation.

Reading material:
Teaching and learning activities:
Assessment methods:
Language of instruction: Icelandic.

RT RVE1003 ELECTRICAL MACHINES 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle, advanced.
Type of course: Elective.
Prerequisites: Electric Power Systems (RT RAK1003) or Electric Circuits and Electric Power (VT RAR1003).
Schedule: Taught for 12 weeks - 6 hours a week.
Supervising teacher: Kristinn Sigurjónsson
Lecturer: Kristinn Sigurjónsson
Learning outcome: On completion of the course students should:

- Be able to understand synchronous and asynchronous generators and motors
- Know how ac electricity and power flows in impedances
- Know single phase, linear induction and stepper motors

Content: Asynchronous motors and generators, synchronous motors and generators, linear induction motor. Single phase motors and stepper motor. Electrical power production and transmission.

Reading material:
Teaching and learning activities: Lectures and practical sessions.
Assessment methods: 3 hours written examination accounts for 80%, projects and reports account for 20%.
Language of instruction: Icelandic.

AT INT1003 INTERNSHIP IN APPLIED ENGINEERING I 6 ECTS

Year of study: Third year.
Semester: Fall/Spring.
Level of course: First cycle, advanced.
Type of course: Mandatory for students in the applied civil engineering program. Elective for students in the applied electrical engineering and applied mechanical and energy engineering programs.
Prerequisites: Two years of study in applied civil, electrical or mechanical and energy engineering.
Schedule: Runs for up to 12 weeks, according to a fixed schedule.
Supervising teacher: Ingunn Sæmundsdóttir.

Lecturer: Hera Grímsdóttir (civil), Indriði Sævar Ríkharðsson (mechanical and energy), Ragnar Kristjánsson (electrical), Ása Guðný Ásgeirsdóttir (administrative).

Learning outcomes: Learning outcomes should reflect what the student learns and the experience he/she gains during the internship period. Specific learning outcomes, points of emphasis, deliverables and other requirements will be defined by the supervisors for each individual project, with the following objectives in mind.

- Strengthen students´ ties to the relevant industry.
- Enhance students´ knowledge and understanding of their chosen field of study and their future profession.
- Enhance students´ understanding of processes and the importance of planning their tasks.
- Enhance students´ competence in working with given criteria and fulfilling set requirements.
- Strengthen students´ communication skills, both external and internal within a company.
- Give students the opportunity of solving real life problems under the supervision of experienced professionals.
- Prepare students for their future careers.
- Pave students´ way into the job market.

Content: The course *Internship in Engineering I (AT INT 1003)* is mandatory in the third year of the BSc in Applied Civil Engineering program. It is also offered as an elective in the third year of the BSc programs in Applied Electrical Engineering and Applied Mechanical and Energy Engineering. Students work on a designated project under the guidance of a supervisor in a company/institution and a supervisor in HR. The student´s contribution in the company/institution shall be a minimum of 120 working hours over a period of 10-12 weeks during the semester, as well as preparatory work, work on the final report and an oral presentation. The internship must be organized in such a way that working hours do not overlap with classes in other courses. For information see: *Guidelines on Internships in Applied Engineering*.

The project must be defined and delineated in consultation with the supervisors. Typically, the intern will work on a practical project in which he/she utilizes knowledge and skills from the curriculum of previous semesters. Before the start of the internship period, the student delivers a project description which must be approved by the supervisors.

Emphasis is placed on an organized, independent and technical approach. The student must initially define the project, i.e. goals and deliverables. During the internship the student will keep a journal so that progress can be monitored. At the end of the internship period, the student writes a project report which he/she presents orally.

If a student takes the course *AT INT 1003 Internship in Engineering I* as an elective (i.e. a student of Applied Electrical Engineering or Applied Mechanical and Energy Engineering) he/she may, subject to the supervisors permission, work on a number of smaller tasks during the internship period rather than one specific project for the whole period. The primary objective of such an internship is that the student become acquainted with the diverse activities of the workplace.

Reading material: As advised by supervisors.
Teaching and learning activities: Runs for up to 12 weeks according to a previously defined schedule. Students work on a designated project under the guidance of a supervisor in a company/institution, and a supervisor in RU. The student must initially define the project, i.e. goals and deliverables. The student´s contribution in the company/institution shall be a minimum of 120 working hours. In addition, there is work on preparation, the final report and the presentation.
Assessment methods: The grade is Pass / Fail. The student´s performance in the workplace will be evaluated, as well as his/her project logbook, and the final report and presentation. The evaluation will take into account whether the student has fulfilled the learning outcomes which the supervisors defined at the beginning of the internship period.
Language of instruction: Icelandic.

AT INT2003 INTERNSHIP IN APPLIED ENGINEERING II 6 ECTS

Year of study: Third year.
Semester: Fall/Spring.
Level of course: First cycle, advanced.
Type of course: Elective for students in the applied civil engineering, applied electrical engineering and applied mechanical and energy engineering programs.
Prerequisites: Internship in Applied Engineering I (AT INT 1003).
Schedule: Runs for up to 12 weeks according to a fixed schedule, or as an all-day intensive course for 3 weeks.
Supervising teacher: Ingunn Sæmundsdóttir.
Lecturer: Hera Grímsdóttir (civil), Indriði Sævar Ríkharðsson (mechanical and energy), Ragnar Kristjánsson (electrical), Ása Guðný Ásgeirsdóttir (administrative).

Learning outcomes: Learning outcomes should reflect what the student learns and the experience he/she gains during the internship period. Specific learning outcomes, points of emphasis, deliverables and other requirements will be defined by the supervisors for each individual project, with the following objectives in mind.

- Strengthen students´ ties to the relevant industry.
- Enhance students´ knowledge and understanding of their chosen field of study and their future profession.
- Give students the opportunity to solve real-life problems under the supervision of experienced professionals.
- Enhance students´ understanding of processes and the importance of planning their tasks.
- Prepare students for their future careers.
- Enhance students´ competence in working with given criteria and fulfilling set requirements.
- Train students in working independently and in taking responsibility for their search for knowledge and professional priorities.
- Teach students independent and effective methods in practical design, analysis and/or research within the profession.
- Help students gain practical experience and an overview of the engineering profession by applying their knowledge and skills to solve practical, real-life projects.
- Help students develop their knowledge of the social, economic and moral aspects of the profession.
- Increase students´ knowledge and experience in the use of safety standards, and other technical standards and codes that are important in the profession.
- Improve the students´ competence in the reporting and presentation of technical solutions, and generally of the results of their work.
- Strengthen students´ communication skills, both external and internal within a company.

Content: The course *Internship in Engineering II (AT INT 2003)* is an elective in the third year of the BSc programs in Applied Civil Engineering, Applied Electrical Engineering, and Applied Mechanical and Energy Engineering. Students work on a designated project under the guidance of a supervisor in a company/institution and a supervisor in HR. The student´s contribution in the company/institution shall be a minimum of 120 working hours which can be scheduled over a period of 10-12 weeks, or as full work-days for an intensive period of 3 weeks. In addition the student does preparatory work, works on the final report and an oral presentation. The internship must be organized in such a way that working hours do not overlap with classes in other courses. For information see: *Guidelines on Internships in Applied Engineering*.

The project must be defined and delineated in consultation with the supervisors. Typically, the intern will work on a practical design-, analysis- or research-project in which he/she utilizes knowledge and skills from the curriculum of previous semesters. Before the start of the internship period, the students delivers a project description which must be approved by the supervisors.

The student must initially define the project, i.e. goals and deliverables. The project description shall provide information on what new knowledge and/or training the student will need to complete the project, with appropriate references to textbooks, specifications and/or other sources. Emphasis is placed on an organized, independent and technical approach. During the internship the student keeps a journal so that progress can be monitored. At the end of the internship period, the student writes a project report which he/she presents orally.

Reading material: As advised by supervisors.
Teaching and learning activities: Runs for up to 12 weeks according to a previously defined schedule, or as an all-day intensive course for 3 weeks. Students work on a designated project under the guidance of a supervisor in a company/institution, and a supervisor in RU. The student must initially define the project, i.e. goals and deliverables. The student´s contribution in the company/institution shall be a minimum of 120 working hours. In addition, there is work on preparation, the final report and the presentation.
Assessment methods: The grade is Pass / Fail. The student´s performance in the workplace will be evaluated, as well as his/her project logbook, and the final report and presentation. The evaluation will take into account whether the student has fulfilled the learning outcomes which the supervisors defined at the beginning of the internship period.
Language of instruction: Icelandic.

AT INT3003 INTERNSHIP IN APPLIED ENGINEERING III 6 ECTS

Year of study: Third year.
Semester: Fall/Spring.
Level of course: First cycle, advanced.
Type of course: Elective for students in the applied civil engineering, applied electrical engineering and applied mechanical and energy engineering programs.
Prerequisites: Internship in Applied Engineering I (AT INT 1003), Internship in Applied Engineering II (AT INT 2003).
Schedule: Runs for up to 12 weeks according to a fixed schedule, or as an all-day intensive course for 3 weeks.
Supervising teacher: Ingunn Sæmundsdóttir.
Lecturer: Hera Grímsdóttir (civil), Indriði Sævar Ríkharðsson (mechanical and energy), Ragnar Kristjánsson (electrical), Ása Guðný Ásgeirsdóttir (administrative).

Learning outcomes: Learning outcomes should reflect what the student learns and the experience he/she gains during the internship period. Specific learning outcomes, points of emphasis, deliverables and other requirements will be defined by the supervisors for each individual project, with the following objectives in mind.

- Strengthen students´ ties to the relevant industry.
- Enhance students´ knowledge and understanding of their chosen field of study and their future profession.
- Give students the opportunity to solve real-life problems under the supervision of experienced professionals.
- Enhance students´ understanding of processes and the importance of planning their tasks.
- Prepare students for their future careers.
- Enhance students´ competence in working with given criteria and fulfilling set requirements.
- Train students in working independently and in taking responsibility for their search for knowledge and professional priorities.
- Teach students independent and effective methods in practical design, analysis and/or research within the profession.
- Help students gain practical experience and an overview of the engineering profession by applying their knowledge and skills to solve practical, real-life projects.

- Help students develop their knowledge of the social, economic and moral aspects of the profession.
- Increase students´ knowledge and experience in the use of safety standards, and other technical standards and codes that are important in the profession.
- Improve the students´ competence in the reporting and presentation of technical solutions, and generally of the results of their work.
- Strengthen students´ communication skills, both external and internal within a company.

Content: The course *Internship in Engineering III (AT INT 3003)* is an elective in the third year of the BSc programs in Applied Civil Engineering, Applied Electrical Engineering, and Applied Mechanical and Energy Engineering. Students work on a designated project under the guidance of a supervisor in a company/institution and a supervisor in HR. The student´s contribution in the company/institution shall be a minimum of 120 working hours which can be scheduled over a period of 10-12 weeks, or as full work-days for an intensive period of 3 weeks. In addition the student does preparatory work, works on the final report and an oral presentation. The internship must be organized in such a way that working hours do not overlap with classes in other courses. For information see: *Guidelines on Internships in Applied Engineering*.

The project must be defined and delineated in consultation with the supervisors. Typically, the intern will work on a practical design-, analysis- or research-project in which he/she utilizes knowledge and skills from the curriculum of former semesters. Before the start of the internship period, the students delivers a project description which must be approved by the supervisors.

The student must initially define the project, i.e. goals and deliverables. The project description shall provide information on what new knowledge and/or training the student will need to complete the project, with appropriate references to textbooks, specifications and/or other sources. Emphasis is placed on an organized, independent and technical approach. During the internship the student keeps a journal so that progress can be monitored. At the end of the internship period, the student writes a project report which he/she presents orally.

Reading material: As advised by supervisors.
Teaching and learning activities: Runs for up to 12 weeks according to a previously defined schedule, or as an all-day intensive course for 3 weeks. Students work on a designated project under the guidance of a supervisor in a company/institution, and a supervisor in RU. The student must initially define the project, i.e. goals and deliverables. The student´s contribution in the company/institution shall be a minimum of 120 working hours. In addition, there is work on preparation, the final report and the presentation.
Assessment methods: The grade is Pass / Fail. The student´s performance in the workplace will be evaluated, as well as his/her project logbook, and the final report and presentation. The evaluation will take into account whether the student has fulfilled the learning outcomes which the supervisors defined at the beginning of the internship period.
Language of instruction: Icelandic.

VI TEI 2013 COMPUTER – AIDED DESIGN II 6 ECTS

Year of study: Third year.
Semester: Spring.
Level of course: First cycle - Intermediate.
Type of course: Core. It is mandatory for students to take either Computer-Aided Design II (VI TEI 2013) or Operation Research (T-403-ADGE).
Prerequisites: Computer-Aided Drawing (AI TEI 1001), Computer-Aided Design (VI HON 1001).
Schedule: Distance learning for 15 weeks, two weekend sessions on campus.
Supervising teacher: Indriði Sævar Ríkharðsson.
Teacher: Indriði Sævar Ríkharðsson.

Learning outcome: On completion of the course students should:

- Have sufficient knowledge of computer aided design to be able to solve common and traditional tasks in designing machine elements with 3D CAD software.
- Be able to make a high quality mechanical drawings according to standards.
- Have learned more advanced features of Autodesk Inventor and are able to solve a variety of specialized tasks.
- Be familiar with sheet metal design and know how to work with sheet metal drawings.
- Know how to use formulas in dimensions and make models that are smart model (Parametric models).
- Know how to create new material types.
- Be familiar with drawing of frame and beam structures (frame generator)
- To be able to make weldment drawings and perform load calculation of welding's.
- Can perform load calculations on medium complex parts. Beam models and solid FEM models.
- Know how to use ready made parts from parts catalogs on the Internet.

Content: Drawing machine elements, use of drawing software. Drawing standards. Part and sheet metal drawings, assembly drawings. Parametric design. Design of frame structures. Three dimensional design and strength calculation using Autodesk Inventor. Making a video presentation which show mechanical functionality. Design projects.

Reading material: Material from teacher.
Teaching and learning activities: Distance learning for 15 weeks, two weekend sessions on campus. Lectures, sample problems, assignments and projects during on-campus sessions, and through the electronic teaching system. Material on the web is followed up by regular assignments during the term. Instructions from the teacher on the web, audiovisual aids.
Assessment methods: Grade awarded for 6 projects counts 100%. To pass the course, the Individual grade for each project shall be 5,0 or higher.
Language of instruction: Icelandic.

Courses in the 4th year – Fall or Spring semester

VT LOK1012 FINAL PROJECT 24 ECTS

Year of study: Fourth year.
Semester: Fall / Spring.
Level of course: First cycle, advanced.
Type of course: Core.
Prerequisites: Six semesters in VT. The student must have completed at least 174 ECTS credits in the Applied Mechanical and Energy Engineering program to enrol for the final project.
Schedule: Runs for 15 weeks.
Supervising teacher: Indriði Sævar Ríkharðsson.
Lecturer: External supervisors from the industry.

Learning outcome: On completion of the course students should:

- Have used engineering methods to solve extensive projects in the field of mechanical design and/or energy systems.
- Have learned to use independent and goal oriented methods in practical project work and/or research work in the field of mechanical and energy engineering.
- Have obtained a broad overview through the interaction of courses where he applies knowledge from many subjects previously studied in the Mechanical and Energy Engineering program.

- Be able to present design and/or research results in a clear way, both in writing and orally.

Content: A practical design and/or research project selected by the student and approved by the department. The student is required to show his capability to work independently. Projects are drawn from the field of mechanical design or energy utilization, in cooperation with firms and companies in the industry. The main emphasis is on an organized technical approach to the problem and it´s definition, gathering of information, synthesis, analysis and optimization, evaluation and presentation. The student is allotted 15 weeks to complete the project. The project is presented orally and assessed by faculty members and an external assessor.

Reading material: As recommended by supervisors.
Teaching and learning activities: The student works independently for 15 weeks, with the guidance of a supervising teacher and an external expert from the relevant industry. Regular meetings with supervisor and other instructors, see RU´s *Rules for Final Projects in Applied Engineering*.
Assessment methods: Evaluation of project thesis, presentation and oral examination counts 100%.
Language of instruction: Icelandic / English.

T-863-EIIP ENERGY IN INDUSTRIAL PROCESSES 8 ECTS

Year of study: First or second year MSc engineering. Also offered for final year BSc students (VT/RT).
Semester: Fall.
Level of course: Second cycle, introductory.
Type of course: Elective.
Prerequisites: BSc in mechanical, electrical or energy engineering.
Schedule: Taught for 12 vikur - 6 teaching hours a week.
Supervising teacher: Einar Jón Ásbjörnsson.
Lecturer: Einar Jón Ásbjörnsson.

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

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

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

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

Reading material: To be decided.
Teaching methods: Runs for 12 weeks – 6 teaching hours a week. Lectures, field trips and discussions. Guest lecturers from industry.
Assessment methods: Two mandatory field trips. Final grade: Five assignments 10%; Individual projects 20%; Group projects 40%, thereof 5% for milestone; Oral exam 30%.

Language of instruction: English.

AT RSN1003 MANAGEMENT AND INNOVATION 6 ECTS

Year of study: Third year / Fourth year.
Semester: Fall.
Level of course: First cycle, introductory.
Type of course: Core.
Prerequisites: None.
Schedule: Taught for 12 weeks – 6 hours a week.
Supervising teacher: Páll Kr Pálsson.
Lecturer: Páll Kr Pálsson.

Learning outcome:
Knowledge: On the completion af the course students should be able invent business ideas that are then fostered scrutinised and matured through brainstorming, canvas methods and the creation of a business plan. On the completion of this course the students also should:
- Possess a clear understanding of the methodology and theoretical understanding of the managerial aspect used in defining and writing complete business plans.
- Understand innovation through the search for promising, inspiring and rich ideas, idea evaluation and selection.
- Understand the basics of innovation through technical developmental processes and life-cycle of both products and businesses.
- Understand marketing through market analysis and create a marketing and sales plans that define customers and market demands.
- Understand the technical challenges in innovation and define developmental processes for solutions and plan actions accordingly.
- Understand the financial and funding aspect of innovation: Plan for capital and financing, revenue and cost estimates, cash flow plan and balance sheets. Also cost estimations, revenue, value assessment and sensitivity analysis.
- Understand innovation through the human aspect of management such as the need for direction, strategy, organisation chart, and human resource management.
- Define business opportunities and write a business plan and interpret business plans.

Also students should at the completion of the course know how to define business opportunities and make a text- and calculation models in order to evaluate the business opportunity according to demand, solution, profit and financing interest. To know how to avoid making mistakes when searching and evaluating business opportunities.
Skills: Students should be able to adapt the most important methods in optimizing business opportunities by analysing current situation and suggest methods that are likely to lead to optimal results in business planning and business plans. Also students shall be able to describe how to realize their proposals.
Competence: To possess the knowledge to present and interpret the outcome of a business plan and be able to establish and/or operate minor companies.

Content: 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 importance of continuous innovation is emphasised and related to the corporate lifecycles. As a practical project the students will develop a full business plan for a start-up or mature company.

Reading material: As recommended by teacher.
Teaching and learning activities: Lectures, company visits and project work.
Assessment methods: Four interim reports count 62%, the final report 18%, and an oral examination 20%.
Language: Icelandic.