Computational Engineering
SCI-A1010: Research and Academia

Luc St-Pierre
06/10/2022
Today

• Learn about the main MSc programmes offered at the School of Engineering.

• Remember that by completing your BSc in Computational Engineering you can automatically continue your studies in one of these MSc programmes.

• More information here: https://into.aalto.fi/display/enbsctech
Three options after your BSc

1. **Continue to a MSc programme at the School of Engineering.**
   - No pre-requisites (in terms of minor/electives).
   - Four programmes that will be introduced today.

2. **Continue to a MSc programme at a different School.**
   - Usually requires a specific minor.
   - All conditions are detailed on Into, [click here](#).

3. **Continue at a different university.**
   - Separate admission process.

 Older students: “I wish I had paid attention to this earlier!”
Program

14.25  MSc in Building Technology
      •  Prof Gerhard Fink

14.45  MSc in Mechanical Engineering
      •  Prof Jukka Tuhkuri

15.05  Break

15.15  MSc in Geoengineering
      •  Prof Mikael Rinne

15.35  MSc in Advanced Energy Solutions
      •  Prof Ville Vuorinen
The EU is committed to a carbon neutral Europe by 2050, while Finland’s respective target is already in 2035.

To reach this goal, energy conversion processes need to be designed, re-designed or improved and understood based on natural sciences and interaction between different disciplines.
Energy Conversion Group at Aalto (5 prof. + 45 researchers)

1) Carbon neutral energy

2) Energy storage into fuels and chemical compounds

3) Clean combustion

4) Computational fluid dynamics

Figure: Simulation of biofuel injection
Fluid dynamics: Broad range of applications

Reference: https://pof.tnw.utwente.nl/research/turbulencebubbles/windles

Prof. V. Vuorinen CFD team’s competence: Scale-resolved fluid dynamics simulations, reactive flow, heat transfer, spray assisted multi-fuel ignition, multiphase flow.

Non-premixed sprays (LES+FGM)

Premixed flames (LES+G-eqn)

Non-premixed, Tri-/dual-fuel (LES+finite rate chem.)

Methanol & P2X (DNS)

Kahila et al. (2018)

Ghaderi et al. (2018)

Spray ignition

Gadalla et al. (2021)

H₂ flame

Morev et al. (2022)

Izbassarov et al. (2021)

Keskinen et al. (2018)

Laurila et al. (2019)

Vuorinen et al. (2020)

Peltonen et al. (2021)

Heat transfer (LES+novel wall models)

Biofuel atomization (LES+VOF)

Airborne virus & COVID-19 (DNS)

Marine hydrodynamics (LES/DES/RANS+VOF)
Wind power in Finland

About wind power in Finland

In Finland, wind power construction began later than in many other European countries. However, from 2012 to 2013, wind power construction has gained momentum and national construction and production statistics have been broken year after year.

At the end of 2019, there were 754 installed wind turbine generators, with a combined capacity of 2284 MW. They generated 7% of Finland's electricity consumption in 2019.

2284 MW
In 2019, there were 754 installed wind turbine generators, with a combined capacity of 2284 MW.

30 TWh by 2030
Fluid dynamics: CFD simulation of a wind park

Reference: https://pof.tnw.utwente.nl/research/turbulencebubbles/windles
Green hydrogen
https://p2x.fi/en/

We change the world to become cleaner – together

Producer of green hydrogen and forerunner of Power-to-X technology in Finland

As a developer of emission-free welfare society we are a forerunner of energy future – our vision is to produce green hydrogen and refine it further into synthetic fuels in a cost-effective manner
Fluid dynamics, heat transfer, combustion and thermodynamics: Crucial to many industries e.g. Wärtsilä’s marine engine products operating on carbon free fuels (ammonia, hydrogen). Below: Smart Technology Hub in Vaasa

Figure 2: Overview of Kera area ecosystem and its components. Smart poles will also be located in this environment. (Visuals made of Aalto University Design Factory team)

(a) Open bench to view the inside structure
(b) Normal view, hidden structure
(c) Close up view, bench surface and storage tank walls missing

Figure 21: Melting of PCA28 documented with a 4 minute interval
Figure 22: Melting of decanoic acid documented with a 4 minute interval

Figure 37: LHTES bench heating concept for a smart bus stop. Visualizations made by Aalto University Design Factory team
Major: Energy conversion processes

Science based solutions:
Mathematics, Physics, Chemistry, IT →
Fluid Dynamics, Thermodynamics, Heat transfer →
Computational Fluid Dynamics, Process Simulation, Modeling, Experiments, Optimization...

Flexibility in major studies:
Mandatory 36 ECTS
Advanced studies 30 ECTS divided into logical study paths
Rough outline of EC major

The major studies (66 cr) are divided into:

**Compulsory:** programme common courses (16 cr), major common courses (20 cr)

**Advanced studies:** (30 cr).

**Example study paths:**
1) Conversion and Storage, 2) Methods and 3) Systems and Technologies.

**Learning outcomes**
1) Natural phenomena and energy
2) Holistic view on energy systems
3) Analysis and evaluation skills
4) Use science for sustainability
The idea of the study paths is to show the students what kind of career options would be possible from this major, and what kind of courses would be useful in obtaining the required core competence. For all study paths, all AAE students will take the following courses, in total 16 credits.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAE-E1000</td>
<td>Introduction to Advanced Energy Solutions</td>
<td>I-II</td>
<td>1. year</td>
</tr>
<tr>
<td>ELEC-E8422</td>
<td>An Introduction to Electric Energy</td>
<td>I-II</td>
<td>1. year</td>
</tr>
<tr>
<td>31C01300</td>
<td>Energy and Environmental Economics</td>
<td>V</td>
<td>1. year</td>
</tr>
</tbody>
</table>

The following Major Common courses, in Sustainable Energy Conversion major are mandatory for everyone, 20 credits.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEC-E1020</td>
<td>Fluid Dynamics</td>
<td>I</td>
<td>1. year</td>
</tr>
<tr>
<td>EEN-E1020</td>
<td>Heat Transfer</td>
<td>II</td>
<td>1. year</td>
</tr>
<tr>
<td>EEN-E1030</td>
<td>Thermodynamics in Energy Technology</td>
<td>I-II</td>
<td>1. year</td>
</tr>
<tr>
<td>AAE-E2005</td>
<td>Thermochemical Energy Conversion L</td>
<td>III-IV</td>
<td>1. year</td>
</tr>
</tbody>
</table>

These above-mentioned courses form a solid basis for three different study paths, introduced below.
Study path: Conversion and Storage

The Conversion and Storage study path is aimed at students who are keen on understanding different processes in energy conversion and storage technologies, especially renewable energy. Students who study this path will become experts able to work in the energy and process industry as technical experts. This study path provides a deep understanding of the processes and gain an ability to improve process operation, maximize process efficiencies and to understand theoretical limitations. A typical job in Finland would be in energy companies such as Fortum, ST1 or Helen.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Semester</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAE-E3090</td>
<td>Renewable Energy Engineering</td>
<td>III-IV</td>
<td>1. year</td>
</tr>
<tr>
<td>CHEM-E4255</td>
<td>Electrochemical Energy Conversion</td>
<td>II</td>
<td>1. or 2. year</td>
</tr>
<tr>
<td>AAE-E3100</td>
<td>Energy Carriers L</td>
<td>I</td>
<td>2. year</td>
</tr>
<tr>
<td>AAE-E3070</td>
<td>Electrical Energy Storage Systems L</td>
<td>IV-V</td>
<td>1. year</td>
</tr>
<tr>
<td>AAE-E3080</td>
<td>Thermal Energy Storage Systems L</td>
<td>I</td>
<td>2. year</td>
</tr>
<tr>
<td>AAE-E3120</td>
<td>Circular Economy for Energy Storage L</td>
<td>I-II</td>
<td>2. year</td>
</tr>
<tr>
<td>EEN-E1040</td>
<td>Measurement and Control of Energy Systems</td>
<td>I-II</td>
<td>1. or 2. year</td>
</tr>
<tr>
<td>EEN-E3002</td>
<td>Power Process Simulation</td>
<td>I-IV</td>
<td>1. year</td>
</tr>
<tr>
<td>EEN-E3005</td>
<td>Exercises in Energy Technology</td>
<td>I-V</td>
<td>1. or 2. year</td>
</tr>
<tr>
<td>AAE-E3000</td>
<td>Advanced Energy Project</td>
<td>I-II</td>
<td>2. year</td>
</tr>
</tbody>
</table>
Study path: Methods

The Methods study path is aimed at students who are motivated in learning concrete R&D design using experimental and/or simulation methods. The students learn various measurement and simulation methods applying fluid dynamics, heat transfer and thermodynamics in practice. The study path enables R&D work in industry or research. For example, the path offers a possibility to become an expert in the emerging R&D topics involving energy process simulation and CFD modeling. A typical career opportunity in Finland would be in simulation companies such as Elomatic, Universities, VTT, and boiler and component manufacturers such as Andritz, Valmet, Oilion and Sumitomo Foster Wheeler.

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEN-E1040</td>
<td>Measurement and Control of Energy Systems</td>
<td>I-II</td>
<td>1. or 2. year</td>
</tr>
<tr>
<td>EEN-E3002</td>
<td>Power Process Simulation</td>
<td>IV-V</td>
<td>1. year</td>
</tr>
<tr>
<td>EEN-E2001</td>
<td>Computational Fluid Dynamics</td>
<td>III-IV</td>
<td>1. year</td>
</tr>
<tr>
<td>AAE-E3030</td>
<td>Numerical Modelling of Multiphase Flows</td>
<td>IV-V</td>
<td>1. year</td>
</tr>
<tr>
<td>MEC-E2010</td>
<td>Computational Fluid Modelling L</td>
<td>I-II</td>
<td>2. year</td>
</tr>
<tr>
<td>EEN-E2004</td>
<td>Mass Transfer</td>
<td>III-IV</td>
<td>1. year</td>
</tr>
<tr>
<td>CHEM-E7190</td>
<td>Process Dynamics and Control P</td>
<td>II</td>
<td>2. year</td>
</tr>
<tr>
<td>CHEM-E6115</td>
<td>Thermodynamics of Modeling and Simulation</td>
<td>III-IV</td>
<td>1. year</td>
</tr>
<tr>
<td>EEN-E3005</td>
<td>Exercises in Energy Technology</td>
<td>I-V</td>
<td>1. or 2. year</td>
</tr>
</tbody>
</table>
**Study path: Systems and Technologies**

The Systems and Technologies study path is a perfect fit for a student who wants to work on developing and analyzing renewable technologies, and understand the operation of power plants, factories and energy systems as a whole. It is possible to become an expert in wind, solar or bioenergy applications. A typical job in Finland would be in renewable energy companies such as ST1 or Helen. There is a high demand for R&D experts on wind and solar power installations in various SME’s. Also, developers for other sustainable bioenergy applications are constantly needed.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Years</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM-E1100</td>
<td>Plant Biomass</td>
<td>I-II</td>
<td>2.</td>
</tr>
<tr>
<td>EEN-E1010</td>
<td>Power Plants and Processes</td>
<td>I-II</td>
<td>1.or 2.</td>
</tr>
<tr>
<td>EEN-E3006</td>
<td>Energy Markets</td>
<td>I</td>
<td>1.or 2.</td>
</tr>
<tr>
<td>PHYS-E0483</td>
<td>Advances in New Energy Technologies</td>
<td>III-IV</td>
<td>1.</td>
</tr>
<tr>
<td>PHYS-E6570</td>
<td>Solar Energy Engineering</td>
<td>III-IV*</td>
<td>1.or 2.</td>
</tr>
<tr>
<td>PHYS-E6571</td>
<td>Fuel Cells and Hydrogen Technology</td>
<td>III-IV*</td>
<td>1.or 2.</td>
</tr>
<tr>
<td>PHYS-E6572</td>
<td>Advanced Wind Power Technology</td>
<td>I-II*</td>
<td>1.or 2.</td>
</tr>
<tr>
<td>21E16100</td>
<td>Energy Business and Innovation</td>
<td>V</td>
<td>1.</td>
</tr>
<tr>
<td>EEN-E3005</td>
<td>Excersises in Energy Technology</td>
<td>I-V</td>
<td>1.or 2.</td>
</tr>
<tr>
<td>AAE-E3000</td>
<td>Advanced Energy Project</td>
<td>I-II</td>
<td>2.</td>
</tr>
</tbody>
</table>
Building Technology Master’s programme!
Department of Civil Engineering
### Master’s programmes in School of ENG

<table>
<thead>
<tr>
<th>Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Energy Solutions (AAE)</td>
</tr>
<tr>
<td><strong>Building Technology (CIV)</strong></td>
</tr>
<tr>
<td>Geoengineering (GEO)</td>
</tr>
<tr>
<td>Geoinformatics (GIS)</td>
</tr>
<tr>
<td>International Design Business Management (IDBM ENG)</td>
</tr>
<tr>
<td>Mechanical Engineering (MEC)</td>
</tr>
<tr>
<td>Real Estate Economics (REC)</td>
</tr>
<tr>
<td>Spatial Planning and Transportation Engineering (SPT)</td>
</tr>
<tr>
<td>Urban Studies and Planning (USP)</td>
</tr>
<tr>
<td>Water and Environmental Engineering (WAT)</td>
</tr>
</tbody>
</table>

**Aalto BSc in Engineering**
- with major in Structural and Mechanical Engineering

**Aalto BSc in Computational Engineering**

**BSc from outside Aalto in Finland**, for example UAS

**BSc from outside Finland**
CIV: Students starting 2022

50 students from Aalto ENG Bachelor program
34 students coming from outside Aalto
  • Different nationalities
  • BSc degree from Finnish polytechnics/universities

Exchange students
Building Technology Master’s programme (CIV)

- **Degree:** Master of Science (Technology)
- **Size:** 120 ETCS
- **Duration:** 2 years full-time
- **Language:** English
- **Organizer:** Department of Civil Engineering
Building Technology Master’s programme (CIV)

• Creating safe and healthy built environments
• Combining the global needs for energy efficiency and sustainability with the characteristics of a good living environment
Building Technology Master’s programme (CIV)

The programme deals with
• Design
• Construction
• Use and maintenance of civil engineering structures, such as buildings and bridges

The programme involves
• Structural engineering
• Building performance
• Construction management
• Production and maintenance
• Structures and architecture
Professional knowledge and skills

... for the future careers in industry, research, education or authority.

Based on the individual selections, the students can learn:

• Strong skills in design, construction, use, and maintenance of complex civil engineering structures, such as buildings and bridges
• Extensive analytical skills to evaluate impacts and efficacy of different propositions: e.g. the functionality, lifecycle and sustainability of buildings and structures
• A visionary and proactive mindset to lead and manage various engineering projects: e.g. management and communication skills to enhance collaboration between experts
• An in-built sustainable approach to their profession: wellbeing of environment, society and people as the starting point for successful civil and structural engineering
Working life skills

- Analytical, logical and critical thinking
- Creative problem solving
- Multidisciplinary teamwork and collaboration
- Communication for scientific and technical professionals

The aspects of professional ethics and social and environmental responsibility are integrated into the education of the programme.
Sustainable development goals (SDGs)

Closest to Building Technology

1. No Poverty
2. Zero Hunger
3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace, Justice and Strong Institutions
17. Partnerships for the Goals
Master’s degree 120 cr

- Major studies 60 cr
  - Common studies 30 cr
  - Advanced studies 30 cr
- Elective studies 30 cr
- Master’s Thesis 30 cr
Major subject

• Building Technology Master’s programme has only one Major subject: Building Technology.

• We do not provide minors for our own students.
Studypaths

https://into.aalto.fi/display/enciv/Study+Paths

• Aging Management of Structures
• Analysis and Simulation in Civil Engineering
• Bridge Engineering
• Building Physics
• Construction Management
• Design of Concrete Structures
• Design of Steel Structures
• Design of Wooden Structures
• Fire Safety Engineering
• Indoor Environment
Geoengineering
Geoengineering at Aalto

- Focus in geomaterials, mechanics and construction.
- Significant part of built infrastructure: foundations, roads, tunnels and mining.
- Entire life cycle of the geotechnical structure: research - design - construction - maintenance - recycling.

http://sundstroms.fi
Geoengineering

- Excellent job prospects
- World class education
- Exceptional community

Research tunnel under Aalto campus

VR applications

https://youtu.be/fmIlp5T9fQA

Continuum and Discontinuum methods for modelling

Laboratory facilities to verify numerical models

Aalto-yliopisto
Aalto-universitetet
Aalto University
Challenges

Wojciech Sołowski
Behaviour of complex engineering structures

3D modelling of the deformation history of Pisa Tower and future predictions
Safety of nuclear waste storage

Finland is most likely the first country to start final disposal of spent nuclear fuel (2025).

Safety analysis requires complex modelling of the behavior of engineered and geological structures.

Figures: www.posiva.fi
Landslides and large deformations analyses

St. Monique Landslide simulation

Fall cone test

Quickness test
Challenge: Heat storage

- High water storage temperature, 140°C => high thermal expansion & high rock stress & deformations
- Volume ~ 1Mm³
- Capacity 90 GWh / corresponding 65,000 t CO₂-equiv./year
- Scheduled to be commissioned in 2026.

https://www.vantaanenergia.fi/lampoverkko-on-ilmaisutoiminnon-energian-jakelukanava/

Vantaan Energia
Challenge: Seawater heat recovery

To replace Salmisaari district heat plant (coal) in Helsinki

- To replace Salmisaari district heat plant (coal) in Helsinki
- To locate the heat pump plant in existing energy production underground facilities.
- Based on year-round use of seawater.
- Requires seawater of at least +2°C heat source (coldest season).
- Requires a seawater intake far away from plant (tunnel)
- Outside the winter, the shore closer to the intake of warmer surface water is used
- The development is scheduled to begin 2022.

Challenge: wind turbines and off-shore engineering
Challenge: sustainability, recycling and reuse of materials. Maintenance of roads

Hot In-Place Recycling (HIR): Remixing

Lapland firm wins US award for road maintenance tech

The award recognised a joint project involving the Rovaniemi firm Roadscanners and the Finnish Transport Agency.
Challenge: High speed railway

Finland to establish new companies to manage major rail projects

FINLAND’s Ministerial Economic Affairs Committee has given the Ministry of Transport and Communications approval to establish new companies to manage the implementation of two major rail projects.
Geoengineering

- We teach rock engineering, geotechnics and highway engineering
- We are a small programme: we take around 35 students each year
- Around half of the students is joining us from outside Aalto
Programme structure

• Two years of study
• Three study paths
  (you can choose more than one)
• 120 credits
• Typical student:
  - Summer job
  - Part time work in 2nd year
  - Industry sponsored MSc thesis
    (with fully paid salary)
  - Full time job immediately after
    finishing the studies
Geoengineering at Aalto 2022 - study paths

- Engineering
- Geology

Geotechnical Engineering

- Geology
- Material sciences
- Physics
- Mechanics
- Chemistry
- IT and economics

Soil
Groundwater
Bedrock

Separate master’s program EMC(*) for mining

(*) EMC - European Mining Course
Master’s Programme in Geoengineering

**Common studies (30 cr)**

**Obligatory courses (5 cr each)**
- Engineering Geology
- Geotechnics
- Structural Design of Roads
- Rock Excavation
- Building Materials Technology (CIV)
- Finite Element Method

**Elective studies (30 cr)**
- Include also “Advanced studies” (recommendation)
- Exchange studies warmly recommended!

**Master’s thesis (30 cr)**
- See instructions in Aalto Into
  [https://into.aalto.fi/display/engeo/Completing+your+master%27s+thesis](https://into.aalto.fi/display/engeo/Completing+your+master%27s+thesis)

**Advanced studies (30 cr)**

**Student selects 6 courses (5 cr each)**
- Advanced Soil Mechanics
- Bituminous Materials and Mixtures
- Economic Geology and Mineral Economics
- Foundation Eng. and Ground Improvement
- Fundamentals of Structural Design (CIV)
- Geometric Design of Roads
- Numerical Methods in Geotechnics
- Project Course in Geoengineering
- Reinforced Concrete Structures (CIV)
- Road Maintenance and Rehabilitation
- Rock Construction
- Rock Mechanics
- Seminar in Geoengineering
- Special Assignment in Geoengineering
- Design Process Management (CIV)
Minor in Geoengineering and mineral based materials

Examples of course packages (min 25 ECTS)

<table>
<thead>
<tr>
<th>Geomaterials</th>
<th>Geotechnical</th>
<th>Highway Engineering</th>
<th>Rock Engineering, Mining and Mineral Resource Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV-E1010 Building Materials Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEO-E2050 Bituminous Materials and Mixtures</td>
<td>GEO-E1050 Finite Element Method</td>
<td>GEO-E3030 Road Maintenance and Rehabilitation</td>
<td>GEO-E2040 Rock Construction</td>
</tr>
</tbody>
</table>

GEO-E2090 Project course in Geoengineering

https://into.aalto.fi/pages/viewpage.action?pageId=53681500
European Mining Course (EMMEP-EMC)

- International Master's Programme in Mining
- Studies at Aalto, Aachen RWTH and Delft TU and Montän Universität Leoben (start 2023)
- Sought after professionals in resource engineering and in construction

https://www.emmep.org/2022%20EMC

Interested to join?
Contact mikael.rinne@aalto.fi
Minor in Mining and Minerals Engineering

Select 5 courses, total of 25 cr.

**ENG-Courses**
- GEO-E1040 Rock Excavation, (III).*
- GEO-E1010 Engineering Geology, (IV).*
- GEO-E3020 Field Experience and Project in Hard Rock Mining, (II).  
  Pre-requisite GEO-E2030, CHEM-E6140.

**CHEM-courses**
- CHEM-E6130 Metal Recycling Technologies, (II). **
- CHEM-E6145 Unit Operations in Mineral Processing and Recycling, (III-IV) (pre-requisite CHEM-E6140)
- CHEM-E6235 Circular Economy for Materials Processing, (IV-V).
- CHEM-E6215 Circular Economy Design Forum, (IV).

(*) Student studying the MSc programme Geoengineering cannot include this course in the Minor (already a mandatory course).
(**) Student with the major in Sustainable Metals Processing can not include this course in the Minor. Each course 5 cr.
Exchange and internship possibilities

Summer jobs and part-time employment in 2\textsuperscript{nd} year of studies is quite typical

Wide range of universities for exchange studies (recommended 2\textsuperscript{nd} year), including Nordics, Europe, South Korea, China
Career opportunities

Close links to industry:
- lack of monotony!
- new technologies!
- Large investments in infrastructure
- Three times more designers retire than is coming to the market
Student life

• Very closely knit community, between students, teachers and industry

• Social network for life, especially if you stay in Finland

• Aalto students life is among best in the country
  • Work hard, play hard

• Studies can be challenging, when you decide to work during the studies. However, thanks to great community, the students tend to cope well

Student club:
https://mkr.ayy.fi/?lang=en
Geotechnical and rock engineering club Maa- ja kalliorakentajat ry
Study Geoengineering and lead the change for the sustainable future in construction!

Professor Wojciech Sołowski
Geotechnical Engineering Programme director

Professor Mikael Rinne,
Rock Mechanics

Professor Leena Korkiala-Tanttu,
Geotechnical Engineering

Prof. Augusto Cannone Falchetto
Highway Engineering

Professor Jussi Leveinen,
Engineering Geology
See you soon!

aalto.fi
Mechanical Engineering

mechanics across multiple length scales
Mechanical Engineering at Aalto

RESEARCH
Product Development
Mechatronics
Production Engineering
Engineering Materials
Solid Mechanics
Marine Technology
Arctic Technology

INFRASTRUCTURE
Design Factory
Experimental co-creation platform
ADDLAB
Digital design and manufacturing, eg. 3D printing
Aalto Ice and Wave Tank
40m x 40m basin
Industrial Internet Campus
Experimentation of Industrial Internet, IoT, AI
Examples of engineering professions

**Systems engineer**
Understanding and designing complex systems of different scales, from atomic to global

**Entrepreneurial engineer**
Creating innovative and competitive products, processes and services

**Engineering scientist**
Conducting basic research to address compelling global challenges such as energy and sustainability

**Engineering manager**
Leading projects and businesses
Mechanical Engineering Programme

To excel as an engineer,

• You need both creativity and a rigorously analytical mindset,
• You understand the principles and methods of mechanics in engineering,
• You know how to solve engineering problems in your area of specialization,
• You can justify your choices and methods, communicate clearly, and collaborate effectively,
• You appreciate the economic, environmental, and societal context in which your work is important.
Mechanical Engineering Programme

In MEC, every student selects a specialization and builds up their own professional identity. There is a lot of options to choose.

The Department of Mechanical Engineering recommends a number of Study Paths within seven Topic Groups, see into.aalto.fi

But you are free to select your own course combination also.
Mechanical Engineering Programme

**Common studies**
(31 cr.)

**Advanced studies**
(30 cr.)

**Electives**
(29 cr.)

**M.Sc. Thesis**
(30 cr.)

**Topic Groups**
- Mechanical Engineering
- Production Engineering
- Product Development
- Engineering Materials
- Mechatronics
- Marine Technology
- Fluids
- Arctic Technology
- Solid Mechanics
Common Studies – 31 cr

1. Mechanical Engineering in Society (5 cr) and an integrated course on Communications Skills (1 cr) are compulsory.
2. Select 25 cr from the list of common courses, see Into.
3. Should be completed during the first year.
4. The common courses can be included in advanced studies also.
5. It is recommended that the common studies include a project course: *Machine Design Project*, *Principles of Naval Architecture*, or *Modelling in Applied Mechanics*. If not, then a project course must be included in advanced studies or elective studies.
Advanced Studies – 30 cr

1. Select 30 credits from the courses listed at Into.
2. The Department recommends a number of Study Paths within seven Topic Groups, see into.aalto.fi, but you are free to select your own course combination also.
3. Course-specific prerequisites must be satisfied.
4. Common studies courses can be included in advanced studies.
Elective Studies – 29 cr

1. You can choose courses at Aalto, at other universities in Finland, or at our partner universities abroad.
2. You can take additional mechanical engineering courses. Consult the Study Paths for suggestions.
3. You can complete a minor. For a list of minors at Aalto, see Into.
4. Foreign language studies (min 3 cr) are a compulsory, if they have not been part of the BSc degree. For international students, Finnish and Swedish language courses are highly recommended.
5. You can include 1-5 credits of practical training.
Thesis – 30 cr

1. The master’s thesis is written on a topic related to the Advanced Studies, as agreed with a supervising professor.

2. Professors provide thesis topics that are related to their research activities. You can also suggest your own topic, if you find one at the industry, at a research institute, or elsewhere.

3. The recommended time of the thesis project is the second year spring.