Master's Programme in Advanced Materials for Innovation and Sustainablitity (EIT Raw Materials)

Curriculum 2018-2020

Changes to curriculum 2018 - 2020

Curriculum - First year at Aalto (2019-2020)

Autumn semester 2019 (30 ECTS)

Course code	Course name	Credits	Teaching period(s)	Comment
Compulsory courses (30 ECTS):				
LC-xxxx	Mandatory foreign language	3	I-II	Compulsory degree requirement, both oral and written requirements. Elective studies.
25E50000	Venture Ideation	6	I	Innovation and Entrepreneurship Minor
PHYS-E0424	Nanophysics	5	I-II	Major
PHYS-E0425	Innovation and entrepreneurial approach to materials and technology	8	I-II	Innovation and Entrepreneurship Minor
PHYS-E0426	Inno Project I (autumn part)	3	I-II	Innovation and Entrepreneurship Minor
PHYS-E0417	Experimental methods in physics	5	I-II	Major

Spring semester 2020 (30 ECTS)

Course code	Course name	Credits	Teaching period(s)	Comment
Compulsory courses (20 ECTS):				
PHYS-E0525	Microscopy of Nanomaterials	5	III-IV	Major
PHYS-E0428	Inno-Mission Internship	9		Innovation and Entrepreneurship Minor
PHYS-E0426	Inno Project I (spring part)	3	III-IV	Innovation and Entrepreneurship Minor

PHYS-E0429	Summer Camp I: Advanced Functional Materials: From Science to Technology and from Innovation to Entrepreneurship	3		Innovation and Entrepreneurship Minor
Select two optional courses (10 ECTS):				
PHYS-E0423	Surface Physics	5	III-IV	Major. Every other year. Lectured in spring 2020.
PHYS-E0422	Soft condensed matter physics	5	III-IV	Major
PHYS-E0526	Microscopy of nanomaterials, laboratory course	5	IV-V	Major
PHYS-E0421	Solid-state physics	5	IV-V	Major
CHEM-E5115	Microfabrication	5	IV-V	Major
PHYS-E6570	Solar energy engineering	5	III-VI	Major. Every other year. Lectured in spring 2020.
CHEM-E5145	Materials for Renewable Energy	5	III-IV	Major
PHYS-E0412	Computational Physics	5	III-IV	Major
PHYS-E6571	Fuel Cells and Hydrogen Technology	5	III-IV	Major. Every other year. Lectured in spring 2019.
CHEM-E6215	Circular Economy Design Forum	5		Major

Curriculum - Second year at Aalto (2019-2020)

Autumn semester 2019 (30 ECTS)

Course code	Course name	Credits	Teaching period(S)	Comments
Compulsory courses (25 ECTS):				
LC-xxxx	Mandatory foreign language	3	I-II	Compulsory degree requirement, both oral and written requirements. Elective studies.
25E50000	Venture Ideation	6	I	Innovation and Entrepreneurship Minor
PHYS-E0424	Nanophysics	5	I-II	Major
PHYS-E0425	Innovation and entrepreneurial approach to materials and technology	8	I-II	Innovation and Entrepreneurship Minor

PHYS-E0427	Inno-project II	3	I-II	Innovation and Entrepreneurship Minor
Select one optional course (5 ECTS):				
PHYS-E0417	Experimental methods in physics	5		Major
PHYS-E6572	Advanced wind power technology	5		Major. Every other year. Lectured autumn 2018
PHYS-E0541	Special Course in Physics: Gas phase synthesis of nanomaterials for selected applications	4		Major. Lectured autumn 2019.
	AND			
PHYS-E0544	Individual Studies in Physics	1		Major
CHEM-E5140	Material Characterization, laboratory course	5		Major
AAN-C2007	Product Sustainability	5		Major

Spring semester 2020 (30 ECTS)

Course code	Course name	Credits	Teaching period(S)	Comments
PHYS.thes	Master's Thesis	30	III-V	

PHYS-E0412: Computational Physics, 5 cr

Teachers: Ville Havu
Status of the Course:
Engineering Physics major, alternative course
Optional course of the Advanced Materials for Innovation and Sustainability major.
Engineering Physics minor, alternative course
Level of the Course:
The course is only for students who have completed their Bachelor's Degree.
Teacher in charge:
Ville Havu, Ilja Makkonen (2018-2019)
Ville Havu, Emppu Salonen (2019-2020)
Teaching Period:
III - V Spring (2018-2019, 2019-2020)
Workload:
Contact teaching: 48 hrs
Independent work: 85 hrs
Learning Outcomes:
After completing the course, the student
can identify and describe basic models and simulation techniques that are frequently used to solve physical problems in various fields of computational physics, such as quantum, statistical, condensed matter or materials physics,
is familiar with the basic operating principles of pseudo random number generators and able to choose one and use it appropriately
can apply importance sampling Monte Carlo simulations and the Metropolis algorithm for numerical integration and sampling in physical applications
can describe the basic principles of stochastic simulations in statistical physics and apply them to select models and problems
can describe the basic principles of molecular dynamics simulations and implement and run simple simulations
can describe and categorize models and techniques used in computational single-particle and manybody quantum physics
can implement a solver for a physical problem governed by a partial differential equation
can choose between different spatial discretizations, methods in linear algebra and time propagation schemes based on the physical properties of the underlying problem
can describe modern computing architectures and programming tools for parallel high-performance computing
Content:
Familiarizing with various models appearing in computational quantum, statistical condensed matter and materials physics. Random number generators, stochastic simulation techniques, importance sampling Monte Carlo and the Metropolis algorithm. Molecular dynamics simulations. Basis function and finite-difference discretizations of equations arising in physics, direct and iterative methods of linear algebra to solve discretized equations, explicit and implicit time propagation schemes for time-dependent physical problems.
Assessment Methods and Criteria:
Assignments
Study Material:
Lecture notes and additional supporting material
Substitutes for Courses:
This course will replace the course Tfy-3.4423
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0412
Grading Scale:
0-5
Registration for Courses:

registration via WebOodi.
Language of Instruction:
English

PHYS-E0417: Experimental Methods in Physics, 5 cr

Teachers: Mika Sillanpää
Status of the Course:
Optional course of the Engineering Physics long major.

Compulsory course of the Advanced Materials for Innovation and Sustainability major.
Level of the Course:
The course is only for students who have completed their Bachelor's Degree
Teaching Period:
I - II Autumn (2018-2019, 2019-2020)
Workload:
Lectures / contact hrs 36 + 24 h (3 + 2)

Preparing for lectures 35 h

Assignment work (group+independent) 40 h
Learning Outcomes:
After the course student can

Explain how various physical quantities are transduced into electrical variables.

Design basic active electronic circuits for measurements.

Explain the basic working principles of the most common temperature, pressure and displacement sensors as well as the most common vacuum pumps and cryogenic equipment.

Design a simple filtering circuit with both passive and active components, and explain the basic working principle of phase-sensitive detection.

Explain how to protect the measurements from resistive, capacitive and inductive coupling of noise.

Apply the concepts of amplifier noise and measurement sensitivity in order to figure out if a given quantity is measurable.

Apply concepts of microwave techniques to design basic microwave measurement systems.

Design an advanced experimental setup dedicated for sensitive measurements in basic research.
Content:
The course reviews methods, practices and data processing needed in experimental physics research. Topics addressed include common sensors, amplifiers, filters, measurement systems, vacuum technology, cryogenic techniques, thermometry and computer-aided experiments and data analysis.
Assessment Methods and Criteria:
Participation in teaching and group assignments.
Substitutes for Courses:
This course will replace the course Tfy-3.4411 Experimental Methods in Physics.
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0417
Grading Scale:
0-5
Registration for Courses:
Registration via WebOodi.
Language of Instruction:
English

PHYS-E0421: Solid-State Physics, 5 cr

Teachers: Martti Puska
Status of the Course:
Optional course of the Engineering Physics major.
Optional course of the Advanced Materials for Innovation and Sustainability major. Optional course of the

Engineering Physics minor.
Level of the Course:
Master’s level
Teaching Period:
IV-V Spring (2018-2019, 2019-2020)
Workload: Contact teaching includes lectures and exercises totally 48 h.
Independent work: 76 h
Learning Outcomes:
The student obtains on different traditional fields of materials physics the basic knowledge about materials' ionic and electronic properties, materials-related phenomena, and models used to describe them. Thereafter, she or he can apply this knowledge to follow broadly the modern materials research and become a researcher on a particular materials physics' field based on experimental or theoretical (computational) methods.
Content:
Selected topics in materials physics: Electron dynamics in periodic solids, physics of semiconductors, lattice defects, dielectric properties of solids, magnetism. The last two topics include also interaction of materials with electromagnetic fields.
Assessment Methods and Criteria:
Lectures with pre-assignments, exercise sessions with problem solutions to be handed back. Grading is based on two midterm exams as well as on returned pre-assignments and exercise problem solutions. Alternatively, grading is based solely on one final exam.
Study Material:
S. Elliott: The Physics and Chemistry of Solids
Substitutes for Courses:
This course replaces the course Tfy-3.4311 Materials Physics.
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0421
Prerequisites:
PHYS-C0240 Materiaalifysiikka
Grading Scale:
0-5
Registration for Courses:
Registration via WebOodi.
Language of Instruction:
English

PHYS-E0422: Soft Condensed Matter Physics, 5 cr

Teachers: Jaakko Timonen, Robin Ras
Status of the Course:
Optional course of the Engineering Physics major.
Optional course of the Advanced Materials for Innovation and Sustainability major. Optional course of the Engineering Physics minor.
Level of the Course:
Master’s level
Teaching Period:
III - IV Spring (2018-2019, 2019-2020)
Workload:
Contact teaching: 48 h
Independent work: 79 h
Exam: 3 h
Learning Outcomes:
After taking the course, the students will be able to
- Define soft condensed matter, explain how it differs from ordinary crystalline solids and isotropic liquids, give examples of typical soft matter systems and their characteristic physicochemical properties.
- Define, identify and give examples of colloidal matter; decribe typical features of colloids such as Brownian motion and Tyndall effect; describe different interparticle interactions acting between colloidal particles - especially van der Waals forces and electrostatic double layer forces

- Describe how physical properties of polymers are affected by molecular weight, crystallinity and temperature.
- Describe different experimental and theoretical methods for characterizing rheological properties of soft matter. More specifically, in the case of polymeric materials, the students will be able to explain how macroscopically observed viscoelastic behaviour is related to the molecular-scale structure and dynamics of the materials.
- Explain the basic thermodynamic concepts related to solutions, such as free energy of mixing, osmotic pressure, and chemical potential.
- Explain the physical basis of surface tension, capillarity and wetting phenomena, and determine equilibrium states for given simple systems.
- Explain the thermodynamic and molecular-scale basis of the hydrophobic effect and molecular self-assembly, and describe the molecular-scale structural features of various self-assembled surfactant aggregates. Based on given experimental data on simple surfactant molecules, the student will be able to deduce the types of aggregates formed, and evaluate the thermodynamics (i.e., changes in free energy, enthalpy, and entropy, as well as temperature dependence) of the aggregation processes.

Content:

- General features of soft condensed matter and basic soft matter systems
- Colloids: Brownian motion, interparticle interactions
- Polymer physics: chain conformation and glass transition, polymer self-assembly
- Flow and deformation of soft condensed matter, viscoelastic behaviour
- Phase transitions in soft condensed matter, theoretical models of simple solutions
- Surface tension, wetting, capillarity, superhydrophobicity
- Hydrophobic effect and surfactant self-assembly

Assessment Methods and Criteria:

Exercises, project work, exam.

Study Material:

Soft Matter Physics by Masao Doi

Course Homepage:

https://mycourses.aalto.fi/course/search.php?search=PHYS-E0422

Prerequisites:

B.Sc level physics courses

Grading Scale:

0 - 5

Language of Instruction:

English

PHYS-E0423: Surface Physics, 5 cr

Teachers: Peter Liljeroth

Status of the Course:

Optional course of the Engineering Physics long major.
Optional course of the Advanced Materials for Innovation and Sustainability major.

Level of the Course:

The course is only for students who have completed their Bachelor’s Degree

Teaching Period:

Not lectured (2018-2019)

III- IV (2019-2020)

Lectured every other year.

Workload:

36 + 24 (3 + 2)

Learning Outcomes:

The student will be familiar with the concepts and experimental techniques in surface physics and be able to follow scientific literature on the topic. The student will also get an overview of the cutting-edge topics in

condensed-matter physics involving surfaces.
Content:
Concepts and techniques in surface science. Atomic-scale imaging and nanostructure manipulation. Electronic and structural properties of surfaces. Applications in surface processes, including catalysis, etching and thinfilm growth.
Assessment Methods and Criteria:
Topical essay, short presentation, and an exam
Study Material:
P. Hofmann "Surface Physics: An Introduction", ebook, ISBN 978-87-996090-0-0 (http://www.philiphofmann.net /Philip_Hofmann/SurfacePhysics.html).
Substitutes for Courses:
Tfy-3.4331 Surface Physics
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0423
Grading Scale:
0-5
Registration for Courses:
Registration via WebOodi.
Language of Instruction:
English

PHYS-E0424: Nanophysics, 5 cr

Teachers: Sebastiaan van Dijken

Status of the Course:

Optional course of the Engineering Physics long major.

Compulsory course of the Advanced Materials for Innovation and Sustainability major.
Level of the Course:
The course is only for students who have completed their Bachelor's Degree
Teaching Period:
I - II Autumn (2018-2019, 2019-2020)
Workload:
36 + 24 (3 + 2)
Learning Outcomes:
After the course, the student will have a good overview of research topics within the field of nanophysics and their relevance for current-day and future technologies. The student will also know about nanofabrication techniques (top-down/bottom-up) and methods for nanomaterials and device characterization.
Content:
Each lecture in this course discusses a different nanophysics topic from an experimental and technology perspective. Topics include introductions to lithography techniques, nanostructure self-organization, characterization methods (diffraction, microscopy, spectroscopy), the physics of carbon nanotructures and other low-dimensional materials, the effect of dimensionality and size on electronic and magnetic phenomena, other low-dimensional materials, the effect of dimensionality and size on electronic and magnetic phenomena, and spintronics. Recent articles on the subjects will be provided and actively discussed in class. During one of the lectures, we will visit a nanotechnology company in Finland. At the end of the course, each student will give a short presentation and write an essay on a nanophysics topic of his/her choice.
Assessment Methods and Criteria: Topical essay and short presentation.
Substitutes for Courses: Tfy-3.4343 Nanophysics
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=PHYS-E0424
Grading Scale: 0-5
Registration for Courses: Registration via WebOodi.
Language of Instruction: English

PHYS-E0425: Innovation and entrepreneurial approach to materials and technology, 8 cr

Teachers: Janne Halme, Robin Ras
Status of the Course:

Optional Master's course in Advanced Materials for Innovation and Sustainability major
Level of the Course:

Master's level
Teaching Period:

I-II Autumn (2018-2019, 2019-2020)
Workload:
The work is divided into contact teaching and coaching, small group activities and independent study by the student.

30h (2x2h/wk): Contact teaching and coaching

110h: Group work

76h: Independent study
Learning Outcomes:
This course sets out with generic content to examine creative thinking and the ability to evaluate new ideas for solving problems that could be resolved through the development and use of functional materials by large companies and for everyday use.
Following a short introduction to functional materials, students will work in a group project with the mandate to review the existing cutting-edge research on the physics and chemistry of nanomaterials, to evaluate the society's need for relevant material functionalities, and employ creativity techniques, design thinking, and effectuation thinking principles originating in the entrepreneurship discipline to design next-generation of functional materials, to develop novel fabrication processes for functional materials as well as to conceive new uses of functional materials in ways that solve actual, big problems for society or communities. Following the completion of the course the students will be able to develop the following knowledge and skills:

- Develop their knowledge on creativity and opportunity recognition techniques
- Develop their knowledge in processes through which they can involve market trends and end-user needs and wants in developing functional materials and designing their use
- Develop their creativity and opportunity recognition skills by working on a real problem
- Develop their ability to identify the consequences of decisions and plans regarding the development of functional materials in their commercial use and in their potential to resolve everyday problems
- Develop their ability to think beyond boundaries and challenge existing practices in developing and using functional materials and generate new ideas
- Develop their ability to use integrate technical knowledge and market trends in developing new insights in the use of functional materials
- Develop project management and team work skills in teams with heterogeneous background
- Develop their ability to use cutting-edge research method and techniques in creating new value by reconceptualizing the use of certain functional material to solve problems and by developing business models that can demonstrate how this value could be created.
- Develop market research skills
- Develop their skills in planning, executing and reporting laboratory work
- Develop their presentation skills in delivering presentations for research and commercial audiences

Content:
The objective of the course is to enable students to provide a fundamental understanding of the use of functional materials and materials properties in creating value for solving an existing problem. By being involved in a group project that spans over several months the students will have the opportunity to link the project management process of working in the field of functional material with business and commercialization aspects. The course introduces basic background on the field of functional materials, and core frameworks on opportunity recognition and value creation in the entrepreneurship discipline (effectuation, business models, design thinking, creativity). Building on this knowledge content, students will be then asked to identify a real problem and explore how (exiting, modified, recombined or new) functional materials can resolve these problems. During this phase of the project the students will work in groups to

integrate cutting-edge research in the field of functional materials with market trends, primary research with industry experts, end users, companies and third parties (governmental organizations, universities etc.) addressing the identified problem to inform its solution. In the next phase of the project, the students will work in the lab to incorporate the knowledge from the primary market research to advance/modify/combine or develop new functional materials to address the problem. In the third phase of the project the students will be coached on developing a business model that captures the value that their solution creates, as well as a plan on how their solution could be commercialized (i.e., licensed, spun out as a startup, sold as IP to existing company). More primary research and engagement with end users and industry experts will be required to validate the students' solutions. During the course the students will attend: teaching sessions to be introduced to the core content of the course, workshops and coaching sessions through which the students will practice work life practices and basics of project work (planning, schedule, targets).

Assessment Methods and Criteria:

The course includes contact lectures where the teachers or invited lecturers provide knowledge and insight to the topics related to the group work. Also coaching and supervision take place in the group works. Mostly the course includes group work and individual work where the groups look for solutions to problems from material and technology points of views connected to innovation and entrepreneur mindset. The students will do customer interviews, development work and demos in order to find options for solutions, test and analyze them. A special attention is placed on innovation, business and entrepreneur mindset and tools to look for commercial utilization of the solutions.

The group project, group's blog and an individual reflective essay summarizing the detailed reflection journal (self-assessment diary) are requested for new skills and challenges in creating values.

Assessments are project planning (10%), intermediate reporting and pitching in discharge sessions (30%), final pitching and report (30%), self-assessment diary (20%) and the blog (10%). The performance of each student in all sectors are evaluated and assessed individually. The grade of the group work assessed is the same for all group members.

Study Material:

Literature will be informed and/or provided in the course.

Prerequisites:

Basics courses completed on chemistry, physics and material science.

Grading Scale:

0-5

Registration for Courses:

Registration via WebOodi.

Language of Instruction:

English

PHYS-E0426: Inno-Project I, 6 cr

Teachers: Janne Halme, Robin Ras

Status of the Course:

Compulsory course in Advanced Materials for Innovation and Sustainability major

Level of the Course:

Master's level

Teaching Period:

I-IV Autumn and Spring (2018-2019, 2019-2020)

Learning Outcomes:

This course aims to address directly one of the main objectives of the EIT-AMIS Masters program by preparing graduates to plan and prepare for their professional career as entrepreneurially minded scientists and researchers, while developing and leveraging their complementary competences. The course draws heavily on a learning-by-doing pedagogical approach, which is reflected on how the course is designed and how students are assessed. Under completion of the course the student will be able to develop the following knowledge and skills:

• Ability to work collaboratively in using and analyzing advanced materials for a given functional application

• Develop knowledge and expertise from the application of new research methods, processes and techniques in using and analyzing advanced materials for a given functional application
• Develop knowledge and expertise in developing business models from the commercialization process of new technologies within a University
• Ability to identify immediate consequences of plans and decisions in developing business solutions from technological innovations
• Develop expertise and capabilities in managing resources needed to commercialize new technologies
• Develop knowledge and expertise in understanding the boundary conditions and constrains of the commercialization process within existing companies
• Develop knowledge on the legal requirement in patenting intellectual property
• Develop experience in liaising with the commercialization support services of various academic institutions

Content:
The course is followed by PHYS-E0427 Inno-Project II (3 cr). Together, these two courses will run two years on a scientific project with the intension to develop a patent around it or commercialize it while still being employed as researchers from their hosting Universities. In the first year (Inno-Project I), the students will be allocated in small, cross-country, multidisciplinary teams and will primarily focus on the scientific development of the project. Each project will be supervised by an academic supervisor, and it will result in a scientific paper, while the process of developing the paper will be documented in a Wiki platform. In the second year (Inno-Project II), the project's focus will be on commercialization and patenting side of their project where they will be actively seek support from the local Technology Transfer Offices or the Commercialization offices of the Universities. During the second year the groups will be supervised and mentored by Professors of Practice with entrepreneurship knowledge or professors from the partnering universities that have patented or commercialized their scientific invention. This phase of the project will result in writing up a business case report on the commercial value of the project results, and the application for a patent of the relevant technology. The process of this phase of the project will also be documented in a Wiki platform. During the two years, group members will be monitored by the responsible tutor on their progress by utilizing VLE communication platforms (Wiki, skype etc).

Assessment Methods and Criteria:
• Application process for the project – Motivation letter outlining their competences
• Scientific paper
• Wiki entries
• Business case and patent application

Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0426

Grading Scale: 0-5, may be graded with pass/fail
Language of Instruction: English
Further Information:
Only for the students of Advanced Materials for Innovation and Sustainability major.

PHYS-E0427: Inno-Project II, 3 cr

Teachers: Janne Halme, Robin Ras
Status of the Course:
Compulsory course in Advanced Materials for Innovation and Sustainability major
Level of the Course:
Master's level
Teaching Period:
I-II (2018-2019, 2019-2020)
Learning Outcomes:
This course aims to address directly one of the main objectives of the EIT-AMIS Masters program by preparing graduates to plan and prepare for their professional career as entrepreneurially minded scientists and researchers, while developing and leveraging their complementary competences. The course draws heavily on a learning-by-doing pedagogical approach, which is reflected on how the course is designed and how students

are assessed. Under completion of the course the student will be able to develop the following knowledge and skills:

- Ability to work collaboratively in using and analyzing advanced materials for a given functional application
- Develop knowledge and expertise from the application of new research methods, processes and techniques in using and analyzing advanced materials for a given functional application
- Develop knowledge and expertise in developing business models from the commercialization process of new technologies within a University
- Ability to identify immediate consequences of plans and decisions in developing business solutions from technological innovations
- Develop expertise and capabilities in managing resources needed to commercialize new technologies
- Develop knowledge and expertise in understanding the boundary conditions and constrains of the commercialization process within existing companies
- Develop knowledge on the legal requirement in patenting intellectual property
- Develop experience in liaising with the commercialization support services of various academic institutions

Content:

This course follows the course PHYS-E0426 Inno-Project I (6 cr). Together, these two courses will run two years on a scientific project with the intension to develop a patent around it or commercialize it while still being employed as researchers from their hosting Universities. In the first year (Inno-Project I), the students will be allocated in small, cross-country, multidisciplinary teams and will primarily focus on the scientific development of the project. Each project will be supervised by an academic supervisor, and it will result in a scientific paper, while the process of developing the paper will be documented in a Wiki platform. In the second year (Inno-Project II), the project's focus will be on commercialization and patenting side of their project where they will be actively seek support from the local Technology Transfer Offices or the Commercialization offices of the Universities. During the second year the groups will be supervised and mentored by Professors of Practice with entrepreneurship knowledge or professors from the partnering universities that have patented or commercialized their scientific invention. This phase of the project will result in writing up a business case report on the commercial value of the project results, and the application for patent of the relevant technology. The process of this phase of the project will also be documented in a Wiki platform. During the two years, group members will be monitored by the responsible tutor on their progress by utilizing VLE communication platforms (Wiki, skype etc).

Assessment Methods and Criteria:

Application process for the project – Motivation letter outlining their competences

Scientific paper

Wiki entries

Business case report and patent application

Course Homepage:

https://mycourses.aalto.fi/course/search.php?search=PHYS-E0427

Grading Scale:

0-5, may be graded with pass/fail

Language of Instruction:

English

Further Information:

Only for the students of Advanced Materials for Innovation and Sustainability major.

PHYS-E0428: Inno-Mission Internship, 9 cr

Teachers: Janne Halme, Robin Ras

Status of the Course:

Compulsory course in Master's Programme in Advanced Materials for Innovation and Sustainability

Level of the Course:

Master's level

Teaching Period:

Spring / summer

Learning Outcomes:

This course aims to address directly one of the main objectives of the EIT-AMISMasters program by preparing graduates to plan and prepare for their professional career in the commercialization, R&D, Innovation, or New Business Development functions of companies, while collaborating closely with industrial partners. The course draws heavily on a learning-by-doing pedagogical approach, which is reflected on how the course is designed and how students are assessed.

Under completion of the course the student will be able to develop the following knowledge and skills:

• Ability to work on developing a solution-focused approach in translating innovations into feasible business solutions

• Ability to identify immediate consequences of plans and decisions in developing business solutions from technological innovations

• Development of expertise and capabilities in managing resources needed to commercialize new technologies

• Develop knowledge and expertise in research methods, processes and techniques employed in leading companies in the raw materials sector in developing new technologies

• Develop knowledge and expertise in methods and processes employed in leading companies in the raw materials sector in commercializing new technologies and developing new business solution or activities

• Develop knowledge and expertise in developing business models from the commercialization process of new technologies

• Develop knowledge and expertise in understanding the boundary conditions and constrains of the commercialization process within existing companies

• Develop knowledge of the professional role of innovation, R&D, or New Business Development manager involves as a career path option

Content:

The course is designed to allow individual students to work for approximately 3 months period at the premises of a company on a specific company-related project. The project objectives will be selected in advance between the local parenting company and the local partnering university, and it will directly address an innovation need of the parenting company in the area of modern materials. The student will be working under the supervision of a local manager, preferably in the R&D, Innovation, or New Business Development divisions of the partnering company who will act as mentor to the student by advising the students in developing technical, as well as business and career skills and expertise. Further, the student will be supervised by an academic teacher from the local partnering university on developing the technical side of the company project. The student will develop the above mentioned learning outcomes through the hands-on engagement in the company- related project, through 3x 1 hour mentoring meetings with their company supervisor (one each month), through 2x 1hour mentoring meeting with their academic supervisor (at the beginning and at the end of the internship), and through maintaining a weekly learning log of their internships where they will need to identity the new technical- and innovation-related knowledge and skills they acquire as the project evolves.

At the end of the course, the students will present or report the outcomes of their project to the partnering company, and submit a thorough reflective essay (2000 words) of their internship experience.

Assessment Methods and Criteria:

• Application process for the internship – Motivation letter to enroll in the internship

• Company presentation or report

• Short Weekly learning logs

• Reflective essay

• Development of Linkedin profile and uploading a brief description of this project and internship

Course Homepage:

https://mycourses.aalto.fi/course/search.php?search=PHYS-E0428

Grading Scale:

0-5, may be graded with pass/fail

Language of Instruction:

English

Further Information:

Only for the students of Master's Programme in Advanced Materials for Innovation and Sustainability.

PHYS-E0429: Summer Camp 1: Advanced Functional Materials: From Science to Technology and from Innovation to Entrepreneurship, 3 cr

Teachers: Janne Halme, Robin Ras

Status of the Course:
Compulsory course in Advanced Materials for Innovation and Sustainability major
Level of the Course:
Master's level
Teaching Period:
summer
Learning Outcomes:
The aim of the Summer Camp is to:
Develop the students' knowledge on creativity and innovation techniques upon hands-on practices for case studies provided by companies
Develop their knowledge on employing a concept of Design Thinking with an entrepreneurial toolbox for comprehensive problem-solving approaches to result in innovative products/services
Develop and utilize their knowledge on advanced materials and technologies to bring added value to products/services having sustainability in product and market wises
Learn to communicate, work and innovate in close relation and collaboration with students and industrial representatives upon intensive brainstorming
Create interfaces with other students and company representatives that are vital for team belonging, entrepreneurial mindset and networking
Develop presentation and communication skills via management and team working and pitching for academic and commercial audiences.
AMIS Summer School is also an important networking event for students with academic staff and companyrepresentatives. The students have an opportunity to initiate discussions about thesis topics too with company and start-up representatives.
Content:
The programme includes lectures, presentations, group work and hands—on activities. The Summer Camp program is built around students working on commercialization of technologies and products in Europe. The technologies or products that the students work on are provided by case companies operating in some of the industries covered by the Raw materials KIC.
The overall program consists of 4 parts:
Innovation and Entrepreneurship pre-study on-line module. The module is implemented based on the I&E Online learning material of EIT Digital. Workload 10 hours, 1-2 calendar weeks.
Case pre-study. The backbone of the studies is formed by the commercialization cases presented by the case companies. In the pre-study, the students analyze their local/domestic market for five of the cases. Workload 15 hours, 1-2 calendar weeks.
One week intensive study session at Aalto. Based on the customer and market input gathered in the Case pre-study, the student teams define initial solution to the company cases. Workload 40 hours, 1 calendar week.
Concept validation and final report. In this phase, the students do validation of the concept withpotential customers in their local/domestic market. The results of the validations are compiled by each team into final report to the case company, 15 hours, 1-2 calendar weeks.
Assessment Methods and Criteria:
Online learning assignments, case pre-study assignments, summer camp pitch, final report
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0429
Grading Scale:
0-5, may be graded with pass/fail
Language of Instruction:
English

Further Information:
Only for the students of Advanced Materials for Innovation and Sustainability major.

PHYS-E0525: Microscopy of Nanomaterials, 5 cr

Teachers: Janne Ruokolainen, Hua Jiang
Status of the Course:
Compulsory course of the Advanced Materials for Innovation and Sustainability major.
Optional course of the Engineering Physics long major.
Level of the Course:
Master's level
Teaching Period:
III - IV Spring (2018-2019, 2019-2020)
Workload:
24 + 24 (2 + 2)
Content:
The course gives basic knowledge of the microscopy of materials nanoscale structures - including soft and hard materials. Lectures will concentrate on transmission electron microscopy (TEM), cryo-electron microscopy, high resolution imaging, electron diffraction and analytical microscopy by using elemental analyses (EDX, EELS).
Additionally scanning electron microscopy (SEM), atomic force microscopy (AFM) and methods to prepare samples are lectures.
Study Material:
to be announced
Substitutes for Courses:
This course replaces the course Tfy-125.4313 Microscopy of Nanomaterials.
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0525
Grading Scale:
0-5
Registration for Courses:
Registration via WebOodi.
Language of Instruction:
English

PHYS-E0526: Microscopy of Nanomaterials, laboratory course, 5 cr

Teachers: Hua Jiang, Janne Ruokolainen
Status of the Course:
Optional course of the Advanced Materials for Innovation and Sustainability major.
Optional course of the Engineering Physics long major.
Level of the Course:
Master's level
Teaching Period:
IV - V Spring (2018-2019, 2019-2020)
Workload:
0 + 48 (0 + 4)
Content:
As practical exercises nanostructured materials are studied with various microscopy methods. Course includes all the basic sample preparation methods for both hard and soft materials and practical microscopy exercises by using transmission electron microscopy (TEM), scanning electron microscopy (SEM) and atomic force microscopy (AFM).
Substitutes for Courses:
This course replaces the course Tfy-125.4314 Microscopy of Nanomaterials, laboratory course.
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E0526

Grading Scale:

0-5

Registration for Courses:

Number of students participating to the course will be limited (approx. 12). The students are selected to the course based on their applications. Instructions on how to apply to this course can be found from the lecture notes of the course PHYS-E0525 Microscopy of Nanomaterials.

Language of Instruction:

English

PHYS-E6570: Solar Energy Engineering, 5 cr

Teachers: Janne Halme

Status of the Course:

Optional course of the Engineering Physics long major.

Optional course of the Advanced Materials for Innovation and Sustainability major.

Level of the Course:

Master's level

Teaching Period:

Not lectured (2018-2019)

III - IV (2019-2020)

Lectured every other year.

Workload:

42 h contact teaching, 88 h self-study

Learning Outcomes:

The goal is to understand the physics and technology of solar energy utilization, including thermal and electric applications, at a level adequate for needs found in practical or academic environments.

After the course, students will be able to

Estimate the available solar radiation based on physical, geographical and atmospheric factors

Explain the daily and seasonal variation of solar irradiance and how they affect the design of photovoltaic and solar thermal systems

Evaluate the effect of solar tracking and concentration on the amount of collected radiation

Explain the working principle of photovoltaic cells and solar thermal collectors (below 'devices') in terms of the underlying physical phenomena and device structure

Name the most important performance loss mechanisms, and explain how they depend on the materials and structural properties of the devices

Describe and analyze the performance characteristics and energy conversion efficiency of the devices through a physical model, and use it to interpret experimental results

Design and size photovoltaic and solar thermal systems with or without local energy storage

Use central tools of solar energy engineering, such as solar angle calculations, meteorological irradiance databases, solar collector performance models, current-voltage models of photovoltaic cells, optical and thermal models, etc., which solar energy utilization is often based on.

Content:

Physical foundations and practical applications of solar energy. Solar radiation and its attenuation, radiation components, measuring and assessing solar radiation solar angles, tracking systems, interactions with materials, wavelength selective materials, solar thermal collector, HWB equation, photovoltaic effect, solar cell, equivalent circuit, concentrated solar radiation, CSP plants, solar energy systems and their components, assessing performance.

Assessment Methods and Criteria:

Exercises, homework, and two mid-term exams. The mid-term exams may be replaced with a final exam.

Study Material:

Duffie, Beckman: Solar Thermal Engineering Processes. Selected E-books and online materials on photovoltaics. Lecture notes and other supporting material.

Substitutes for Courses:

Replaces the course Tfy-56.4323 Solar Energy Engineering.

Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E6570
Grading Scale:
0-5
Registration for Courses:
Registration via WebOodi.
Language of Instruction:
English
Further Information:
Docent Janne Halme, Prof. Peter Lund
2 graduate students as course assistants
A short "Master Class"-course on "Planning and simulation of a photovoltaic system with a software tool" (PHYS-E0581 Independent assignment, 1-2 cr) on solar energy applications and planning will be organized after this course during period V in which the basics from PHYS-E6570 will be applied to real-case conditions. More information on this course will be given separately.

PHYS-E6572: Advanced Wind Power Technology, 5 cr

Teachers: Hannele Holttinen
Status of the Course:
Optional course of the Engineering Physics long major.
Optional course of the Advanced Materials for Innovation and Sustainability major. **Level of the Course:**
Master's level
Teaching Period:
I - II Autumn (2018-2019)
Not lectured (2019-2020)

Lectured every other year.
Workload:
Lectures 24h, homework 40h, independent studies 60h.
Learning Outcomes:
Understanding the principles of wind power, technologies, and practical applications. Able to make feasibility studies of wind power projects. Understand how wind power functions in energy system and markets. Understand the limitations of wind power. Using planning and modelling tools for wind power (e.g. production estimates). Understand environmental impacts from wind power.
Content:
Basics of wind power, wind power technology, wind power production, life-cycle of wind projects, large-scale wind power, integration and interfacing with grid, wind power in the electricity market, offshore wind power, measurement technology, wind power projects - production estimates and environmental analyses, technology trends; use of modelling tools (e.g. WASP).
Assessment Methods and Criteria:
Exam; passing threshold typically 50% of maximum points
Course Homepage:
https://mycourses.aalto.fi/course/search.php?search=PHYS-E6572
Prerequisites:
Bachelor level studies in engineering or science.
Grading Scale:
0-5
Registration for Courses:
Registration via WebOodi.
Language of Instruction:
English
Further Information:
Doc. Hannele Holttinen, VTT (hannele.holttinen[at]vtt.fi)
Prof. Peter Lund

CHEM-E5115 Microfabrication, 5 cr

Teachers: Samuli Franssila

Status of the Course	Elective course in the following majors: Functional materials Advanced materials and photonics Micro- and nanosciences Biosensing and bioelectronics
Level of the Course	Master-level
Teacher in charge	prof. Sami Franssila Other teachers: Dr. Victor Ovchinnikov
Teaching Period	IV-V
Workload	1 hour of lectures/week = 12 h 2 hours of exercises/week = 24 h Homework for weekly exercises = 75 h Preparation for exam = 20 h Exam = 4 h
Learning Outcomes	The student is able to design fabrication processes for simple silicon microdevices, and able to analyze fabrication processes of complex silicon microdevices.
Content	Silicon and thin film materials. Unit processes in microfabrication: lithography, etching, deposition, oxidation, doping, polishing, bonding. Process integration of CMOS and MEMS devices. Cleanrooms, process equipment, yield and reliability. Lab demo.
Assessment Methods and Criteria	Exercises and quizzes 60%; exam 60% (bonus possibility). The student must achieve at least 40% of maximum points both in exam and in exercises
Study Material	Sami Franssila: Introduction to Microfabrication, 2nd edition, John Wiley & Sons, 2010. Available electronically via Aalto library. (1st edition can be used).
Substitutes for Courses	S-69.3103 Semiconductor technology II (5 cr), MT-0.6031 Microsystems (3 cr), MT-0.6061 Microfabrication (5 cr).
Course Homepage	https://mycourses.aalto.fi/course/search.php?search=CHEM-E5115
Prerequisites	Useful previous studies: Bachelors-level physics, chemistry, materials science, electronics. Important concepts: crystal structure, unit cell, defects, doping, diffusion, Arrhenius, diffraction. Semiconductor technology a plus.
Grading Scale	0-5. 60% based on exercises and quizzes; 60% on exam (bonus possibility).
Registration for Courses	WebOodi The course is primarily intended for students majoring in the following subjects: Functional materials Advanced materials and photonics Micro- and nanosciences Biosensing and bioelectronics If more than 40 students enrol, students in abovementioned majors have priority.
Language of Instruction	English
Further Information	The course is primarily intended for students majoring in the following subjects: Functional materials Advanced materials and photonics Micro- and nanosciences Biosensing and -electronics If more than 40 students enrol, students in abovementioned majors have priority.

CHEM-E5140 Materials Characterization, laboratory course, 5 cr

Teachers: Roman Nowak

Status of the Course	Compulsory for Functional materials students.
Level of the Course	Master Studies
Teacher in charge	Prof. Roman Novak Other teachers: Dr. Annukka Santasalo-Aarnio
Teaching Period	I - II
Workload	5 cr = 135 h Contact teaching 12 weeks *2 h =24 h Laboratory sessions, 5*4 h Independent work 41 h Reporting 5*10 h
Learning Outcomes	After passing this course the student can exploit most common materials characterization methods to characterize the structure and properties of materials. The student knows the capabilities and limitations of major materials and surface characterization techniques: Optical microscopy, nanoindentation, Raman, ellipsometry, XRF, XRD, AFM, TEM, SEM, EDS, WDS, XPS.
Content	Weekly seminars, 5 laboratory projects.
Assessment Methods and Criteria	Seminars, laboratory exercises, written reports.
Study Material	Yang Leng, "Materials Characterization : Introduction to Microscopic and Spectroscopic Methods", Wiley-VCH, 2013
Substitutes for Courses	MT-0.3101 Materiaalitutkimusmenetelmät (5 op).
Course Homepage	https://mycourses.aalto.fi/course/search.php?search=CHEM-E5140
Prerequisites	BSc Laboratory safety course CHEM-A1010 or CHEM-E0140 (or alternatively, laboratory safety as part of courses CHEM-A1000 or CHEM-E0100 taught before Academic Year 2017-2018) must have been passed before performing any laboratory works in this course.
Grading Scale	Fail, 1 - 5.
Registration for Courses	WebOodi
Language of Instruction	English

CHEM-E5145 Materials for Renewable Energy P, 5 cr

Teachers: Mikhail Gasik

Status of the Course	Elective course for Functional Materials (CHEM) and Majors in the Energy Masters, but student with various disiplines are welcome. Offered also for Doctoral students.
Level of the Course	Master studies, 1./2. year, also for doctoral studies
Teacher in charge	Prof. Michael Gasik Other teachers: Dr. Annukka Santasalo-Aarnio
Teaching Period	III-IV
Workload	5 cr = 135 h Workshops 24 h Group work 30 h Independent work and reflection 65 h Projects presentation 3 * 2 h

Learning Outcomes	At the end of this course the students are able to: • Recognize state-of-the-art materials currently used in renewable energy systems • Identify common degradation mechanisms in these applications • Develop new material solutions and eco-design • Share the expertise of ones field in a heterogeneous team • Justify material selection with scientific argumentation
Content	At this course the students learn how materials behave at circumstances relevant for the renewable energy systems (solar cells, wind turbines, electrolysers, hydrogen storage, fuel cells, batteries) and develop thinking to produce new material solutions and eco-designs for these applications.
Assessment Methods and Criteria	Workshops, flip the class room and innovation projects.
Study Material	Ed. Zhang, Jiujun, Zhang, Lei, Liu, Hansan , "Electrochemical Technologies for Energy Storage and Conversion", Wiley-VCH, 2012. M. Gasik, Materials for fuel cells, Woodhead Publishing Limited, 2007. Scientific articles and news paper clips.
Substitutes for Courses	MT-0.6141 Erikoismateriaaliratkaisut P (5 cr)
Prerequisites	BSc
Grading Scale	Fail, 1 - 5.
Registration for Courses	WebOodi
Language of Instruction	English
Further Information	Forms a continuum with other energy courses of the CHEM school: CHEM-E4255 Electrochemical energy conversion (recommended participation before this course) and CHEM-E5215 Materials for Nuclear Power Plants.

25E50000 Venture Ideation, 6 cr

Teachers: Myrto Chliova

Status of the Course	MSc, specialisation studies in the Entrepreneurship Master's programme. The course is a mandatory course in the programme studies and in the minor studies in Entrepreneurship and Innovation Management; also an AVP-course
Level of the Course	Advanced specialisation studies
Teaching Period	I (autumn 2017); the course is taught once in each year in Töölö Campus
Workload	Contact hours 20 h (lectures and two gate presentations) Group work assignments 105 h Individual assignment 35 h
Learning Outcomes	At the end of this course, students are expected to be able to: 1. Recognize key concepts in entrepreneurship and innovation 2. Identify, create and evaluate entrepreneurial opportunities 3. Develop and promote entrepreneurial and innovative solutions in their own life and work 4. Reflect on and discuss the possibilities and limitations of entrepreneurship and innovation Students will learn how to create a critical mass of business ideas, identify the most promising idea and translate the idea into a convincing business model. Based on a combination of pragmatic experiences and insights from research, students will also develop an ability to apply practical tools and theoretical frameworks that relate to team building, creative innovation, business modelling, and presenting a business idea. After completing the course successfully, students will not only have a fundamental knowledge of the venture ideation process and how to pitch a business idea, but also a workable business opportunity that can be developed further, for instance, through the follow-up course Venture Formation (25E44000), available only to the top teams graduating from Venture Ideation.
Content	The course offers a unique opportunity for students to work in multi-disciplinary teams and to discover through experiential learning how to create, test and pitch a business idea. The course contains lectures, sessions by guest speakers from the Aalto entrepreneurship ecosystem and beyond, hands-on practice of entrepreneurial skills, as well as the development of an entrepreneurial idea and "pitch". Themes covered include team building, opportunity identification

	and creation, design thinking, customer development, business and revenue model development, funding and presentation skills.
Assessment Methods and Criteria	Team assignments 75% - Individual assignments 25%. Also, a peer evaluation will be used to adjust individuals' grades on the team assignments.
Study Material	The required readings comprise of articles and book chapters that will be available through the MyCourses platform. Buying or renting a textbook is optional; either one of the following textbooks are recommended: 1. Barringer B. R. and Ireland D. (2012) Entrepreneurship: Successfully launching new ventures. Pearson. 2. Spinelli S., Adams R. and Timmons J. A. (2015) New Venture Creation: Entrepreneurship in the 21st Century. McGraw Hill Higher Education.
Substitutes for Courses	The course replaces the course 25E48000 Introduction to New Venture Creation Process.
Course Homepage	https://mycourses.aalto.fi/course/search.php?search=25E50000
Grading Scale	0 (fail) to 5 (excellent)
Registration for Courses	Registration via WebOodi ends 7 days before the period starts.
Language of Instruction	English
Further Information	The maximum number of students admitted to the course is 100. Priority is given to degree students in (1) MSc Entrepreneurship (major or minor) (2) Aalto MSc Advanced Material for Innovation and Sustainability (3) CEMS (4) Aalto internal mobility (Aalto Ventures Program) (5) other Aalto degree students. Completion of a pre-assignment is a prerequisite for successful admission. See course homepage in MyCourses for the deadline and instructions of the pre-assignment. This course requires physical presence and active participation in teamwork and is not designed for distance learning.

Teaching periods 2018–2019 and 2019–2020 in Aalto University

Teaching is divided into periods. In Periods I to IV, the last week is always an evaluation week, in which a variety methods are employed to assess learning. There are in addition two separate evaluation periods in autumn term mainly for organising examinations. Courses that are compulsory for a degree and that are taught and assessed only once a year should generally not be held between 1 June and 31 August.

The organisation of teaching in Mikkeli for the Bachelor's Programme in International Business comprises 15 course modules lasting three weeks each.

ACADEMIC YEAR 2018–2019

Autumn term 2018

Teaching and evaluation periods Evaluation week is always the final week of the period.	**Dates**	**Week numbers**
Summer teaching period	1 Jun – 31 Aug 2018	22–35
First evaluation period and orientation*	3 Sep – 7 Sep 2018	36
Period I and evaluation week	10 Sep – 26 Oct 2018	37–43
Period II and evaluation week	29 Oct – 14 Dec 2018	44–50
Second evaluation period	17 Dec 2018 – 4 Jan 2019	51–1

*) Opening of the academic year on Wed 5 Sep 2018.

Spring term 2019

Teaching and evaluation periods	**Dates**	**Week numbers**
Period III and evaluation week	7 Jan – 22 Feb 2019	2–8
Period IV and evaluation week	25 Feb – 12 Apr 2019	9–15
Period V: multimodal period**	15 Apr – 31 May 2019	16–22
Summer courses are subject to separate guidelines.		

**) Multimodal periods are periods in which diverse forms of teaching are implemented, for example:
- Six weeks of teaching, including an evaluation of learning
- Intensive studies of varying lengths
- A project course, beginning as contact teaching and continuing as a summer project

ACADEMIC YEAR 2019–2020

Autumn term 2019

Teaching and evaluation periods Evaluation week is always the final week of the period.	**Dates**	**Week numbers**
First evaluation period and orientation	2 Sep – 6 Sep 2019	36
Period I and evaluation week	9 Sep – 25 Oct 2019	37 – 43
Period II and evaluation week	28 Oct – 13 Dec 2019	44 – 50
Second evaluation period	16 Dec – 3 Jan 2020	51 – 1

Spring term 2020

Teaching and evaluation periods	**Dates**	**Week numbers**
Period III and evaluation week	6 Jan 2020 – 21 Feb 2020	2 – 8
Period IV and evaluation week	24 Feb – 10 Apr 2020	9 – 15
Period V: multimodal period**	13 Apr – 29 May 2020	16 – 22
Summer courses are subject to separate guidelines.		

**) Multimodal periods are periods in which diverse forms of teaching are implemented, for example:
- Six weeks of teaching, including an evaluation of learning
- Intensive studies of varying lengths
- A project course, beginning as contact teaching and continuing as a summer project