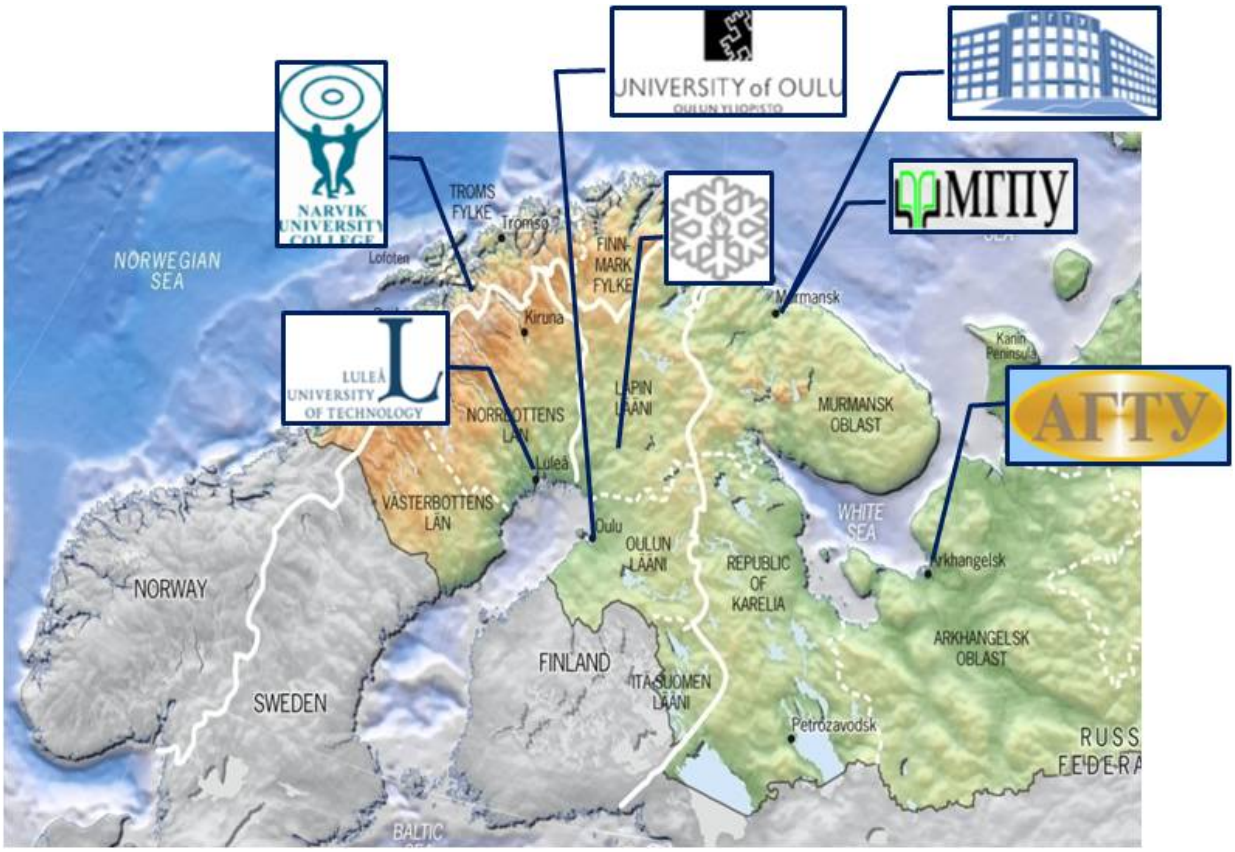
Barents Cross Border University

Master's Programme in Environmental Engineering

STUDY GUIDE 2009 – 2011



Map: Hugo Ahlenius, UNEP/GRID-Arendal *http://maps.grida.no/go/graphic/barents_region_topography_and_bathymetry3*

Barents Cross Border University
Master's Programme in Environmental Engineering

Study Guide 2009 - 2011

University of Oulu, Finland
Narvik University College, Norway
Luleå Technical University, Sweden
Arkhangelsk State Technical University, Russia
Murmansk State Technical University, Russia
Pomor State University, Russia

CONTENTS

1 INTRODUCTION TO BARENTS CROSS BORDER UNIVERSITY (BCBU)

The Barents Cross Border University (BCBU) project is based on the co-operation between universities in Northern Finland and Northwest Russia. This co-operation initiative is founded on the mutual interests of the partner universities, as well as in the principles and aims of the partnership programmes and of the EU Northern Dimension Policy. The main aim is to develop international multidisciplinary joint Master's programmes. The programmes follow the principles of the Bologna process and the teaching will be in English.

Within the BCBU there are two partner universities in Finland, eight from Russia, and five associate partners from other countries. The BCBU partners from Finland are the University of Oulu and the University of Lapland in Rovaniemi. From Russia, the partners are Archangelsk State Technical University, Pomor State University, and Northern State Medical University in Archangel, Petrozavodsk State University and the Karelian State Pedagogical University in Petrozavodsk, and Murmansk State Technical University, Murmansk State Pedagogical University, and Murmansk Humanities Institute in Murmansk. The BCBU associate partners are Narvik University College (Norway), Luleå University of Technology (Sweden), the University of The Southern Denmark (Denmark), the Centre for Health Education (Greenland), and University of Manitoba (Canada).

Together, BCBU partners collaborate to provide four two-year cross border Master's degree programmes on the fields of social work, environmental engineering, information systems, and circumpolar health and well-being. Master's Programme on Comparative Social Work is coordinated by the University of Lapland. Barents Environmental Engineering, Information Systems, and Health and Wellbeing in Circumpolar Areas, for one, are coordinated by the University of Oulu. The combination of partner universities in each programme is based on former cooperation and expertise in special branches of the participating universities. The study programmes are in the central fields of the EU Northern Dimensions priorities and the language of study in all programmes is English.

BCBU offers graduates increased professional and international skills, necessary to improve the personal lives and scale up professional possibilities of the graduates. The needs of international labour market in the Barents region and globally are used as the basis for these studies. In addition, the implementation of these cross border Master's programmes are intended to promote the internationalization of education and research the updating of educational content, and of incorporating international aspects in the educational process.

Further information about Barents Cross Border University project is available at http://bcbu.oulu.fi and about CBCU Master's programmes

- Comparative Social Work: http://www.ulapland.fi/?deptid=26579
- Environmental Engineering: http://bee.oulu.fi
- Information Systems: http://bcbu.oulu.fi/ICT_program
- Circumpolar Health and Well-being: http://arctichealth.oulu.fi/suomi/maisterikoulu

2 MASTER'S PROGRAMME ON ENVIRONMENTAL ENGINEERING

2.1 General information on the partner universities of BEE

The Master's degree Programme on Environmental Engineering (BEE) has been developed and carried out in co-operation with University of Oulu (Finland), Narvik University College (Norway), Arkhangelsk State Technical University (Russia), Pomor State University (Russia), Luleå Technical University (Sweden), Murmansk State Technical University (Russia), and University of Lapland (Finland).

2.1.1 University of Oulu

The University of Oulu (UOulu), Finland, is an international research university, and with its 17 000 students and over 3 000 employees, it is one of the largest universities in Finland. The university provides a high-quality learning environment for both specialists and generalists in it's 50 degree programmes. University has exceptionally wide academic base organised in six faculties: Humanities, Education, Economics and Business Administration, Medicine, Science, and Technology. Special research focus areas of University of Oulu are wireless communication and mobile applications, biotechnology and molecular medicine, and northern and environmental issues.

University of Oulu's main webpage is www.oulu.fi/english/

2.1.2 Narvik University College

Narvik University College (NUC), Norway, is one of 26 State University Colleges in Norway which offers higher education through various study programmes. The number of students attending the NUC accounts for just above 1200 spread out on a number of undergraduate, graduate and postgraduate study programmes in the fields of engineering, health & nursing and business management. The College is organised in 4 departments, called institutes: Department of Building, Production and Engineering Design, Department of Scientific Computing, Electrical Engineering and Space Technology, Department of Applied Sciences, and Department of Health and Nursing Science. Department of Building, Production and Engineering Design focuses on e.g. renewable energy, energy in buildings and energy efficiency. In Environmental Engineering Master's Programme Narvik University College will participate in education.

Narvik University College's main webpage is www.hin.no/index.php?ID=1717

2.1.3 Luleå University of Technology

Luleå University of Technology (LTU), Sweden, is the northernmost university of technology in Scandinavia and it conducts research in the Faculty of engineering and the Faculty of arts and social sciences. Research at the University comprises 70 research subjects in 13 departments and is characterised by multidisciplinary cooperation between the University's research departments and close interaction with trade and industry and society. In Environmental Engineering Master's Programme Luleå Technical University will participate in education.

Luleå University of Technology's main webpage is http://www.ltu.se/english

2.1.4 Arkhangelsk State Technical University

Archangelsk State Technical University (ASTU), Russia, has active cooperation with authorities, industrial companies, scientific-research, educational and cultural institutions in the Arkhangelsk region. It has over 3 000 employees and nearly 14 000 students in which more than 7500 are full-time. Archangelsk State Technical University provides approximately 50 five-year degree programmes for main industrial branches of the region. It has cooperation agreements with 25 universities from 10 foreign countries. In Environmental Engineering Master's Programme Arkhangelsk State Technical University will participate in education.

Archangelsk State Technical University's main webpage is http://www.agtu.ru/english_1

2.1.5 Murmansk State Technical University

Murmansk State Technical University (MSTU), Russia, has 9 faculties and more than 30 departments that train specialists in 28 fields. The main purpose of the University is providing all the branches of industry with well-qualified specialists. It has approximately 4 500 students and nearly 400 employees. Its natural and technical faculty has long trained experts on ecology and environmental management. The University actively develops international cooperation, in particular in implementing joint Russian–Finnish educational projects in environmental engineering. In Environmental Engineering Master's Programme Murmansk State Technical University will participate in education.

Murmansk State Technical University's main webpage is http://eng.mstu.edu.ru

2.1.6 Pomor State University

Pomor State University named after Lomonosov (Pomor), Russia, is a research-oriented educational scientific and innovative university with the whole cycle of education. Pomor State University has 21 faculties, 66 departments, and 27 scientific centres and laboratories hosting over 14000 students and more than 1500 academic staff. The main fields of expertise of Pomor State University are mathematics, regional studies, economics, comparative law, social work, history, and biology. In Environmental Engineering Master's Programme Pomor State University will participate in education.

Pomor State University's main webpage is http://www.pomorsu.ru/eng/

2.2 Orientations in the Environmental Engineering Master's Programme

Barents Environmental Engineering Master's Programme (BEE) is based on environmental, process, and civil engineering. The curriculum is multidisciplinary, including subjects ranging from ethics and legislation to economics and ecology. The program is developed and carried out in international co-operation. The main responsibility for the delivery of the BEE programme is carried out by the Faculty of Technology, Department of Process and Environmental Engineering at the University of Oulu.

The Barents Master's Programme on Environmental Engineering is a two-year program of 120 ECTS, including an exchange period in one of the participating universities in Russia, Norway or Sweden. Programme includes five orientations in BEE partner universities.

Clean production includes studies on reducing the environmental load of process industry, and provides knowledge on how to manage environmental issues within the industry by application of proper methods, tools and technologies. Orientation will start in September 2009 at the University of Oulu, Finland.

Water and environment includes studies on protection and restoration of natural environment, water and soil pollution, water and wastewater treatment, and waste technology. Orientation will start in September 2009 at the University of Oulu, Finland.

Sustainable energy will answer the need to find green energy solutions for the Barents environmental conditions. Strong focus is set on hydro-, wind-, solar- and bio-energy technologies, as well as energy efficiency issues in production, distribution and end-use. Orientation will start in September 2010 at the Narvik University College, Norway and at the University of Oulu, Finland.

Industrial ecology and rational use of natural resources (Environmental technology & management) includes implementation of "Green chemistry" principles in industry for treating environmental problems, control and assessment and control of environmental state, and environmental management. Orientation will start in September 2010 at Arkhangelsk State Technical University, Russia.

Integrated use of water resources provides knowledge on multi-purpose use of water resources, and proper tools and technologies for water and wastewater treatment for industry and municipalities. Orientation will start in September 2010 or 2011 at Murmansk State Technical University, Russia.

Graduating students will be awarded degree qualifications by the university where they are accepted and registered. In 2009, all graduating students are registered at the University of Oulu. In 2010, graduating students will also be accepted and registered at the Narvik University College. The degree qualification of the BEE programme will be a Master of Science in Engineering in the both occasions.

3 UNIVERSITY OF OULU

3.1 Faculty of Technology

At University of Oulu the Faculty of Technology is the largest of the six faculties and the faculty is divided in to the departments. Faculty of Technology contains five departments, which are Department of Architecture, Department of Electrical and Information Engineering, Department of Mechanical Engineering, Department of Process and Environmental Engineering and Department of Industrial Engineering and Management. Faculty administration is managed by Faculty Council, Dean and Vice Dean. Introducing officials are administrative manager and student affairs manager.

Faculty Office

Linnanmaa, YT 103, entrance R
Tel. +358 8 553 1011 (university telephone center) or +358 8 553 2001 / +358 8 553 2002.
Office hours 9:00 – 13:00.

Faculty personnel

Dean:
Leiviskä, Kauko

Vice Dean:
Silvén, Olli

Administrative Manager:
Kuhalampi, Laila

Student Affairs Manager:
Wallin, Eero

Training Issues Planning Officer:
Simi, Outi

Office Personnel:
Runtti, Liisa
Rimpinen, Helena

Degrees possible to award in the Faculty of Technology are Bachelor of Science in Engineering, Master of Science in Architecture, Master of Science in Engineering, and Licentiate in Technology and Doctor of Technology as postgraduate degrees.

3.2 Department of Process and Environmental Engineering

Linnanmaa, tel. +358 8 553 1011 (university telephone center)
Department's webpage: pyo.oulu.fi
Department office: tel. +358 8 553 2326 (Environmental Engineering)
+358 8 553 2300 (Process Engineering)
+358 8 553 2303 (Examination)

Education and research in the department of Process and Environmental Engineering is divided in to eight laboratories (Figure 1). Laboratories in the Department of Process and Environmental Engineering are Fibre

and Particle Engineering Laboratory, Chemical Process Engineering Laboratory, Mass and Heat Transfer Process Laboratory, Laboratory of Process Metallurgy, Control Engineering Laboratory, System Engineering Laboratory, Bioprocess Engineering Laboratory, and Water Resources and Environmental Engineering Laboratory. In addition to these laboratories, teaching and research is also provided by the Industrial Environmental Engineering unit. Also office, student advisors and workshop are part of the department.

Structure of Department of Process and Environmental Engineering

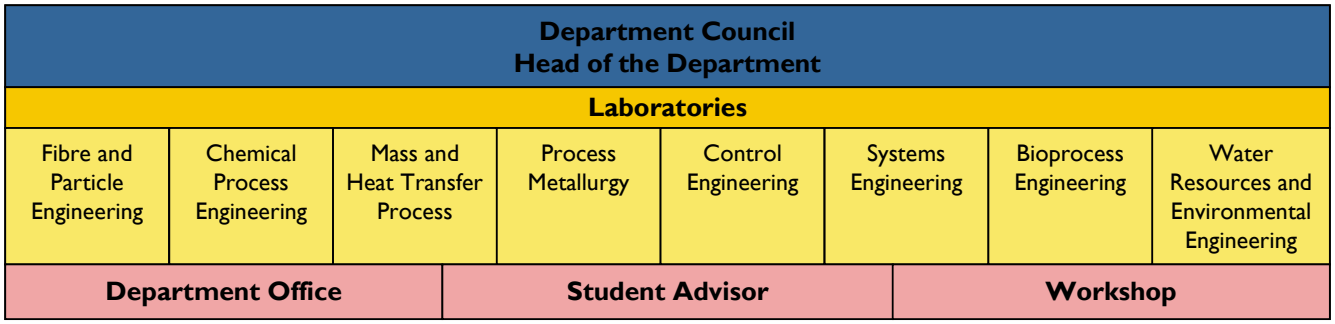


Figure 1. Structure of the Department of Process and Environmental Engineering.

Department Office (rooms PR112 and PR114)
Issues related to Bachelor's and Master's Degrees in the department are taken care of by the office personnel. Office provides forms, advises and guidance related to studies. Studying timetables are prepared by the office personnel.

Student advisors
Student advisors in the department guide in all different issues related to studying. The BEE programme's student advisor Marita Puikkonen (PR326) guides BEE master's programme students and is the key person when you are planning your Personal Study Plan.

Teaching development groups
In the Department of Process and Environmental Engineering is teaching development groups for undergraduate studies (Pokki) and post-graduate studies (Jopokki). Pokki group's leader is Head of the Department and Jopokki group's leader is the Vice Head of the Department.

Personnel in the Department of Process and Environmental Engineering

Head of the Department:
Hiltunen, Jukka

Vice Head of the Department:
Keiski, Riitta

Professors:
Härkki, Jouko; Metallurgy
Keiski, Riitta; Mass and Heat Transfer Process
Klöve, Björn; Water Engineering
Kortela, Urpo; Control and System Engineering
Lakso, Esko; Hydraulic Engineering
Leiviskä, Kauko; Control Engineering
Niinimäki, Jouko; Fibre and Particle Engineering
Tanskanen, Juha; Chemical Process Engineering

Research Professors:
Alasaarela, Erkki; Environmental Engineering

University Lecturers:
Illikainen Mirja; Fibre and Particle Engineering

Lecturers:
Hiltunen, Jukka; System Engineering
Nordman, Timo; Industrial Environmental Engineering

University Teachers:
Heikkinen, Eetu-Pekka; Process Metallurgy
Tanskanen, Pekka; Process Metallurgy

Senior Assistants:
Aaltonen, Harri; Control and Systems Engineering
Ahola, Juha; Chemical Process Engineering
Ainassaari, Kaisu; Mass and Heat Transfer Process
Ikonen, Enso; Systems Engineering
Jaako, Juha; Control Engineering
Juuso, Esko; Process Engineering
Leiviskä, Tiina; Water and Environmental Engineering
Tervaskanto, Manne; System Engineering
Ämmälä, Ari; Fibre and Particle Engineering

Assistants:
Honkanen, Seppo; Automation Engineering
Kangas, Jani; Chemical Process Engineering
Karjalainen, Mikko; Mechanical Process Engineering
Koivula, Minna; Water and Environmental Engineering
Kolli, Tanja; Mass and Heat Transfer Process
Malinen, Ilkka; Chemical Process Engineering
Puikkonen, Marita; Bioprocess Engineering
Ronkanen, Anna-Kaisa; Water and Environmental Engineering
Sorsa, Aki; Process Engineering
Tuomaala, Eero; Heat and Mechanical Engineering
Väisänen, Virpi; Industrial Environmental Engineering

Senior Researchers:
Hillukkala, Tomi; Bioprocess Engineering
Mattila, Olli; Process Metallurgy

Laboratory Managers:
Karjalainen, Tapani; Systems Engineering
Mattila, Riku; Process Metallurgy
Muurinen, Esa; Mass and Heat Transfer Process
Niemistö, Pekka; Chemical Process Engineering
Sallanko, Jarmo; Water and Environmental Engineering
Stoor, Tuomas; Fibre and Particle Engineering

Chief Engineers:
Kujala, Kauko; Water and Environmental Engineering
Yliniemi, Leena; Control Engineering

Student Advisors:
Luhtaanmäki, Saara
Puikkonen, Marita (BEE)

Office Personnel:
Hänninen, Leena
Kallio, Kaisu
Kangasharju, Liisa
Timonen, Hannele
Väisänen, Marja-Leena

Studying at the Department of Process and Environmental Engineering

At the Department of Process and Environmental Engineering is two Bachelor level training programmes: Process Engineering and Environmental Engineering. Master level training programmes at the department are: Process Engineering, Environmental Engineering and Barents Master's Programme on Environmental Engineering. Barents Master's Programme on Environmental Engineering is a part of the Barents Cross Border University (BCBU) project.

At the Faculty of Technology the academic year is divided into two semesters, the autumn semester and the spring semester. During the academic year there are six teaching periods. The periods of the study year 2009 – 2010 are:

1st period	7.9. - 9.10.2009
2nd period	12.10. - 13.11.2009
3rd period	16.11. - 18.12.2009
4th period	11.01. - 12.2.2010
5th period	15.02. - 26.3.2010
6th period	29.03. - 7.5.2010.

The dates for periods during the academic year 2010-2011 will be announced later. Courses arranged by other departments or faculties are taught according to timetables followed by the arranging unit.

Examination method for course passing is informed by the course organizer. Most common examination method is written exam arranged after the course, but the examination method may vary (e.g. seminar, portfolio, etc.). The examinations of the Department last generally four hours and are arranged on Fridays at noon - 4 p.m. List of Department's examination can be found from notice board and Department's webpage http://pyo.oulu.fi/studies/examinations.html. Enrolment to the examination must be done at the latest two days before the examination in WebOodi electronic system (https://weboodi.oulu.fi/).

3.3 Oulu University library

Oulu University library has many units, from which the most important for Environmental Engineering student are main library Pegasus, course book library Cursus and science and technology library Tellus. All these library units are located in Linnanmaa campus. More specific information about e.g. Oulu University library units, opening hours and services is available at www.library.oulu.fi.

4 BEE MASTER'S PROGRAMME CURRICULA

4.1 Structure of Clean Production and Water and Environment orientations

Main modular structure of the curriculum in Clean Production and Water and Environment orientations is presented in Figure 2. In the first year the majoring module and advanced module are mostly same in both orientations. Advanced module of the option prepares the student to the orientation, and the knowledge is further deepened in the supplementary module consisting of three elective modules. Finally, the Master's Thesis work in the second year spring term finishes the master studies.

Master's Degree on Barents Environmental Engineering 120 credits, 2 years

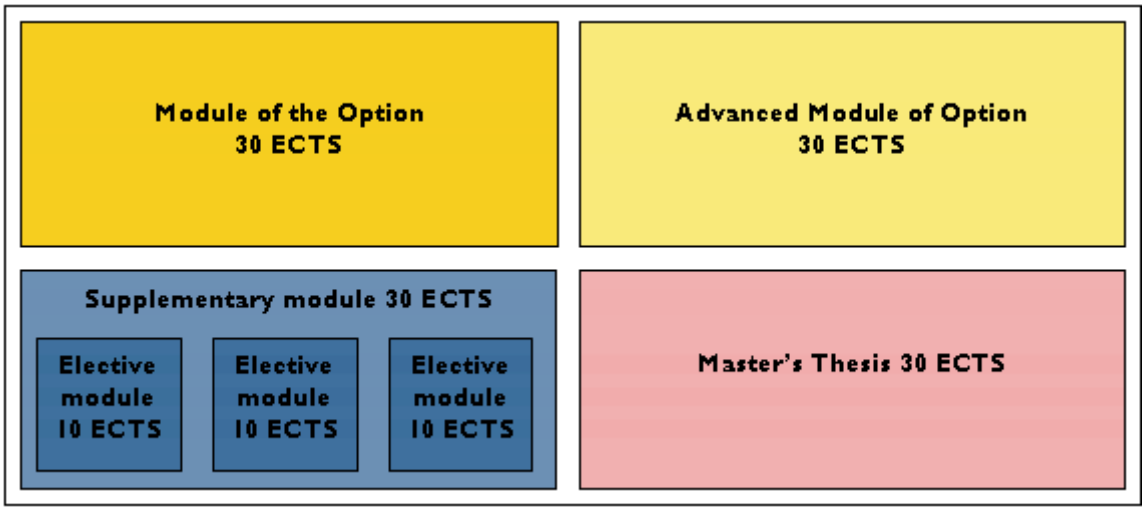


Figure 2. Main structure of Clean Production and Water and Environment orientations in the BCBU Environmental Engineering Master's Programme.

4.2 Clean Production orientation

Module of Clean Production 30 ECTS

Courses of the module are compulsory for all students of the orientation. The module contains courses 'Introduction to the Environmental and Socio-economical Issues of the Barents Region', 'Introduction to the Environmental Legislative Systems of the Barents Region', and 'Sustainable Development' which are arranged jointly with BEE partner universities. The total content of the module is 30 ECTS.

		Credits (ECTS)
488401A	Introduction to the Environmental and Socio-economical Issues of the Barents Region	2
488402A	Sustainable Development	3
488403A	Introduction to the Environmental Legislative Systems of the Barents Region	5
477307S	Research Methodology	5
488203S	Industrial Ecology	5
488109S	Field Measurements in Environmental Engineering	2.5
488110S	Water and Wastewater Treatment	7.5

Advanced Module of Clean Production 30 ECTS

The module contains compulsory and elective studies. Jointly arranged course 'Environmental Issues in the Barents Region' as well as 'Advanced Practical Training' and 'Process Design' are compulsory for students who studying at University of Oulu. Further, 'Introduction to Sustainable Energy' provided by Narvik University College is recommended for all students of the orientation. Module content is approximately 30 ECTS.

		Credits (ECTS)
488405S	Environmental Issues in the Barents Region	5
488002S	Advanced Practical Training	3
477203A	Process Design	5
477041S	Experimental Design	5
477311S	Advanced Separation Processes	4
488104A	Industrial and Domestic Waste Management	5
NUC	Introduction to Sustainable Energy	10

Supplementary Module 3x10 ECTS

In the supplementary studies students select at least one course from each module 1-3. A field course in Russia is compulsory; otherwise the courses are elective. The sum of credits from the three elective modules is approximately 30 ECTS, so that the degree's total content of 120 ECTS must be filled.

		Credits (ECTS)
Module 1 'Process Engineering'		
477206S	Advanced Process Design	6
488204S	Air Pollution Control Engineering	5
Module 2 'Environmental Impact'		
488103A	Environmental Impact Assessment	5
488404A	Global Change	5
ASTU	Field course in Russia	2
Module 3 'Environmental Management'		
555321S	Risk Management	3
721249A	Resource Economics	5
721675S	International Procurement and Logistics	5

Master's Thesis 30 ETCS

The diploma work project contains a compulsory maturity test.

	Credits (ECTS)
Diploma work	30

4.3 Water and Environment orientation

Module of Water and Environment 30 ECTS

Courses of the module are compulsory for all students of the orientation. The module contains courses 'Introduction to the Environmental and Socio-economical Issues of the Barents Region', 'Introduction to the Environmental Legislative Systems of the Barents Region', and 'Sustainable Development' which are arranged jointly with BEE partner universities. The content of this module is 30 ECTS.

		Credits (ECTS)
488401A	Introduction to the Environmental and Socio-economical issues of the Barents Region	2
488402A	Sustainable Development	3
488403A	Introduction to the Environmental Legislative Systems of the Barents Region	5
477307S	Research Methodology	5
488203S	Industrial Ecology	5
488109S	Field Measurements in Environmental Engineering	2.5
488110S	Water and Wastewater Treatment	7.5

Advanced Module of Water and Environment 30 ECTS

The module contains compulsory and elective studies. Jointly arranged course 'Environmental Issues in the Barents Region', as well as 'Advanced Practical Training' and 'Hydrology and Hydraulics' are compulsory for students who studying at University of Oulu. Further, 'Introduction to Sustainable Energy' course provided by Narvik University College is recommended for all students of the orientation. Module content is approximately 30 ECTS.

		Credits (ECTS)
488405S	Environmental Issues in the Barents Region	5
488002S	Advanced Practical Training	3
488102A	Hydrology and Hydraulics	5
477041S	Experimental Design	5
477311S	Advanced Separation Processes	4
488104A	Industrial and Domestic Waste Management	5
NUC	Introduction to Sustainable Energy	10

Supplementary Module 3x10 ECTS

In the supplementary studies students select at least one course from each module 2-4. A field course in Russia is compulsory; otherwise the courses are elective. The sum of credits from the three elective modules is approximately 30 ECTS, so that the degree's total content of 120 ECTS must be filled.

		Credits (ECTS)
Module 2 'Environmental Impact'		
488103A	Environmental Impact Assessment	5
488404A	Global Change	5
ASTU	Field course in Russia	2
Module 3 'Economics and Management'		
555321S	Risk Management	3
721249A	Resource Economics	5
721675S	International Procurement and Logistics	5
Module 4 'Water and Environment'		
488112S	Chemical Processes in Water and Wastewater Engineering	5
488113S	Hydraulics for Environmental Engineering	5

Master's Thesis 30 ECTS

The diploma work project contains a compulsory maturity test.

	Credits (ECTS)
Diploma work	30

5 COURSE DESCRIPTIONS

5.1 Courses in University of Oulu, Finland

5.1.1 Department of Process and Environmental Engineering, Faculty of Technology

488401A Introduction to the Environmental and Socio-economical Issues of the Barents Region

Semester	Amount of contact teaching	Credits (ECTS)
autumn	20+10	2

Responsible person: International BEE lecturer team
Aims: To provide an introduction to the Barents region, including history and culture, and clarify the main environmental and socio-economic incentives to the need of the Barents environmental engineering programme.
Learning outcomes: Students will understand the main environmental and socio-economic issues of the Barents region.
Contents: History of the international cooperation between the areas along the coast of the Barents Sea, introduction to the environmental profile of the region, industry and infrastructure, people and cultures. Presentation of the Barents Cross-Border University Programme, the universities participating the Barents Environmental Engineering Programme and orientations in the programme. Showcasing the main foci of research and education in BEE universities.
Implementation: Contact teaching and learning portfolio.
Course literature: Material provided during the course.

488402A Sustainable Development

Semester	Amount of contact teaching	Credits (ECTS)
autumn	20+20	3

Responsible person: International BEE lecturer team
Aims: To provide an understanding of the multidisciplinary nature and concept of sustainability. Clarifying the patterns of resources use and limits of the carrying capacity of natural systems. Outlining the future perspectives on the prosperity of social and economic systems.
Contents: A multidisciplinary, intensive and interactive course with pre-course and post-course assignments. Presentations on: Principles of sustainable development, Environmental justice (human rights, minority rights), Economic development and sustainability (poverty and equity), Social development and culture, Corporate sustainability/corporate social responsibility.
Implementation: Contact teaching, case studies, negotiation simulations, group projects. Course evaluation to be based on activity during the seminar and post-course assignment
Course literature: Material provided during and prior to the course

488403A Introduction to the Environmental Legislative Systems of the Barents Region

Semester	Amount of contact teaching	Credits (ECTS)
autumn	30+30	5

Responsible person: International BEE lecturer team
Aims: To provide an understanding of the structure and differences between the legislative systems of EU / Finland, Norway and Russia.
Learning outcomes: Students have the skills to find relevant sources of information and apply current legislation.
Contents: Contact teaching providing a roadmap of the legislative systems, especially sources from where relevant information can be found. Exercise to solve problem-based case-studies related to implementing legislation, especially in a cross-border cooperative environment, as well as comparing the different systems across the Barents region.
Implementation: Problem-based learning, contact teaching, guided problem-solving, reporting and peer review through e-learning environment
Course literature: Sources of material provided during the course

488404A Global Change

Semester	Amount of contact teaching	Credits (ECTS)
autumn	0+60	5

Responsible person: International BEE lecturer team
Aims: To present the causes and course of global change.
Learning outcomes: Students provide the capacity to critically evaluate information available on the Internet and other electronic and popular media.
Contents: Review and essays based on background material freely available from Internet sources, peer review and e-discussion
Implementation: E-learning, literature survey and essay. Evaluation based on the essay and participation in e-discussion.
Course literature: Sources of material provided during the course

488405S Environmental Issues in the Barents Region

Semester	Amount of contact teaching	Credits (ECTS)
spring	30+20	5

Responsible person: International BEE lecturer team
Aims: To provide the student with a comprehensive understanding of the environmental landscape of the Barents region, the impacts of past activities, and projections of future economic and social development.
Contents: Northern land-use, Diversity of the northern environment, Land-use and socio-economical changes, Sustainable use of northern resources (Forest resources, Minerals, Barents sea resources), Global change in the north, Industry and pollution (Prevention and remediation), Socio-economic issues (Health, indigenous cultures, languages).
Teaching methods: Contact teaching, field-trip and course assignment.
Course literature: Material provided during and prior to the course

477041S Experimental Design

Semester	Amount of contact teaching	Credits (ECTS)
spring	30+30	5

Responsible person: Professor Kauko Leiviskä
Aims: To provide the student with understanding of the measurements uncertainty evaluation and calculation as well as ideas of implementing this information in experimental and computational research and measurements.
Learning outcomes: After the course, students understand measurements uncertainty evaluation and calculation. Further, they can utilize experimental design tool programs used in research, process industry experiment planning and process analysis.
Contents: Determining the uncertainty of measurements in chemical, physical and biochemical measurements, measurements reliability and traceability. Calculation examples supporting the learning of measurements uncertainty assessment preparation. Experimental design softwares (Modde, Minilab, Matlab tools). Experimental design preparation and execution in laboratory scale research. Test methods and variable significance, reliability of experimental data. Problems in laboratory, pilot and full scale experiments, problems in modeling and in simulation.
Implementation: Lectures and practical work. During the course continuous evaluation with lecture exam, and written report from the practical work.
Course literature: Material given in the lectures.

477203A Process Design

Semester	Amount of contact teaching	Credits (ECTS)
spring	30+10	5

Responsible person: Head Assistant Juha Ahola
Aim: Student gives generalistic view on process design, activities of design organizations, knowledge and skills needed in each design tasks and milestones.
Contents: Activities of design organization; safe, health and environmental issues as an intimate part of process design; design tasks from conceptual process design to detailed design.

Implementation: A chain of design exercises forms the tasks of design of a process, supported by contact learning and web-based learning environment, assessment by the reports of the group exercises and short theory, exams performed as individuals
Literature: Seider W.D., Seader J.D. & Lewin D.R.: Process Design Principles Synthesis, Analysis, and Evaluation. John Wiley & Sons, 1999. Smith R.: Chemical Process Design. McGraw-Hill, Inc., 1995

477206S Advanced Process Design

Semester	Amount of contact teaching	Credits (ECTS)
autumn	0+60	5

Responsible person: Professor Juha Tanskanen
Aims: To develop student's skills to work as a member in an industrial chemical process design project. The students will experience by team work the hierarchical character of the conceptual process design, the benefits of the systematic working methods and the need to understand the whole process performance when optimal design is sought. The importance of innovation and creative work is emphasized.
Contents: Conceptual process design and hierarchical decision making. Heuristics of process design. Design methodology: synthesis, analysis and evaluation. Design cycle. Performance evaluation of the chemical processes. Team work and meetings.
Implementation: Design projects in small groups.
Course literature: Seider W.D. Seader J.D. & Lewis D.R.: Process Design Principles Synthesis, Analysis and Design. John Wiley & Sons, 1999

477305S Flow Dynamics

Semester	Amount of contact teaching	Credits (ECTS)
autumn	60	5

Responsible person: Laboratory Manager Esa Muurinen
Aim: To familiarize the student with mathematical modeling of flow phenomena using computational fluid dynamics (CFD) and experimental validation of the results.
Contents: Equations in fluid dynamics. Partial differential equations. Difference method. Graphical representation. Modelling the turbulence. Finite element method. Finite volume method. Measurement techniques for flow properties. Fluid mechanical apparatus.
Implementation: Lectures and compulsory exercise done in small groups. Examination.
Literature: Anderson J.D.: Computational Fluid Dynamics, McGraw-Hill, 1995; Versteeg H.K. & Malalasekera W.: An Introduction to Computational Fluid Dynamics, Longman Scientific and Technical, 1995; Tavoularis S.: Measurement in fluid mechanics, Cambridge University Press, 2005.
Additional literature: Shaw C.T.: Using Computational Fluid Dynamics, Prentice Hall, 1992; Nakayama Y. & Boucher R.F.: Introduction to Fluid Mechanics. Arnold, 1999; Rathakrishnan E.: Instrumentation, measurements, and experiments in fluids. CRC Press, 2007.

477306S Non-ideal Reactors

Semester	Amount of contact teaching	Credits (ECTS)
autumn	60	5

Responsible teacher: Professor Riitta Keiski
Aims: By means of the residence time distribution theory, students adopt a way of thinking in modeling which is based on the concept of probability.
Learning outcomes: After completing the course the student can analyze the effect of non-ideal mixing conditions on the behavior of a reactor. He/she is capable of explaining the mechanisms of heterogeneous reactions, especially with methods that are used to analyze the effect of mass and heat transfer on kinetics of heterogeneous reactions. The student has rudimentary skills to do demanding reactor analysis and to design heterogeneous reactors.
Contents: Mixing models of a flowing material. Residence time distribution theory. Heterogeneous catalysis and biochemical reactions: mechanisms, mass and heat transfer, and reactor design. Gas-liquid reactions: mechanisms, mass transfer, and reactor design. Design heuristics. Microreactors.
Implementation: Lectures including exercises. Examination.

Literature: Nauman E.B.: Chemical Reactor Design. New York, John Wiley & Sons. 1987; Winterbottom J.M. & King M.B. (Editors) Reactor Design for Chemical Engineers. Padstow, T.J. International Ltd.,1999.
Additional literature: Gianetto A. & Silveston P.L.: Multiphase Chemical Reactors: Theory, Design, Scale-up. Hemisphere, Washington, D. 1986; Froment G. & Bischoff K.B.: Chemical Reactor Analysis and Design. New York, John Wiley & Sons. 1990; Hessel V., Hardt S. & Löwe H.: Chemical Micro Process Engineering. Weinheim 2004, Wiley-VHC Verlag GmbH & Co.

477307S Research Methodology

Semester	Amount of contact teaching	Credits (ECTS)
autumn, spring	36+24	5

Responsible teacher: Professor Riitta Keiski, researcher Mika Huuhtanen and other researchers
Aims: To familiarize the student with scientific research, scientific methods and data handling, especially in process and environmental engineering. The course will give the student the basis to do the research work and motivates him/her to post-graduate studies. The course gives the student skills for team work and increases the co-operation between the students and the research and teaching staff. The students are given experiences on co-operation between different fields of science, industry, and other universities and laboratories, as well as the skills for doctoral studies.
Learning outcomes: After the course the student is able to identify the role of research and different stages of research work. The student can classify the stages and the subtasks of research work as well as important elements related to research, i.e. literature search, experimental work, and data processing. In addition, the student can evaluate the amount of work needed in research stages. The student can write scientific text and use references appropriately. The student also has ability to recognize ethical issues related to the research and analyze the meanings of those. He/she can identify the principles of good scientific practices and is able to apply knowledge on research work.
Content: 1) Science and research politics. 2) Research education. 3) Fundamentals of philosophy of science. 4) Starting a research work: research types, funding, the process of research work, finding the research area, choosing the research topic, information sources. 5) Research plan and collecting data, experimental methods and significance of the variables, systematic experimental design, collecting experimental data, test equipments, reliability of the results, problems in laboratory experiments, modelling and simulation. 6) Mathematical analysis of results. 7) Reporting: writing a scientific text, referring, writing diploma, licentiate and doctoral theses, or reports. 8) Other issues connected to research work: ethical issues, integrity, and future. 9) Examples of scientific research in practice.
Implementation: Lectures, teaching in groups, project operation and demonstrations.
Literature: Melville S. & Goddard W.: Research Methodology; An Introduction for Science and Engineering Students. Kenwyn 1996, Juta & Co. Ltd.; Material introduced in the lectures.
Additional literature: Paradis J.G. & Zimmermann M.L.: The MIT Guide to Science and Engineering Communication, 2nd ed. Cambridge 2002, The MITPress.

477309S Process and Environmental Catalysis

Semester	Amount of contact teaching	Credits (ECTS)
spring	60	5

Responsible person*:* Professor Riitta Keiski
Aim*:* Introducing the history, principles of green engineering and the application of environmental catalysis, design, selection and testing of catalysts and catalytic reactors and processes, and the most important industrial catalytic processes.
Learning outcomes: After the course the student is able to present the fundamentals and history of catalysis and he/she can explain economical, environmental and technical meaning of catalysis. The student is capable of specifying the design, selection and testing of catalysts and catalytic reactors and processes. He/she is able to explain the most important industrial catalytic processes, the use of catalysts in environmental technology, catalyst research and the significance of interdisciplinary approach in the preparation, development and use of catalysts. He/she recognizes the connection between catalysis and green chemistry and the role of catalysis in sustainable processes and energy production.
Contents: Definition of catalysis and a catalyst, history of catalysis, economical, social and environmental meaning. Preparation of catalysts, principles, selection, design and testing of catalysts and catalytic reactors. Kinetics and mechanisms of catalytic reactions, catalyst deactivation. Industrially important catalysts, catalytic reactors and catalytic processes. Environmental catalysis. Catalysts in air pollution control and purification of waters and soil. Catalysis and green chemistry. Catalysis for sustainability. Principles in the design of catalytic processes.

Implementation: Lectures including design exercises. Examination.
Literature: Lecture handout; Richardson J.T.: Principles of Catalyst Development. New York. 1989; Janssen F.J.J.G. & van Santen R.A.: Environmental Catalysis. NIOK, Catalytic Science Series, Vol. 1. 1999.
Additional literature: Ertl G., Knözinger J. & Weitkamp J.: Handbook of Heterogeneous Catalysis. Vol. 1-5. Weinheim. 1997; Thomas J.M. & Thomas W.J.: Principles and Practice of Heterogenous Catalysis. Weinheim 1997; Somorjai G.A.: Surface Chemistry and Catalysis. New York 1994; van Santen R.A., van Leuwen P.W.N.M., Mouljin J.A. & Averill B.A.: Catalysis: An Integrated Approach, 2nd ed. Studies in Surface Science and Catalysis 123. Amsterdam 1999, Elsevier Sci. B.V.

477311S Advanced Separation Processes

Semester	Amount of contact teaching	Credits (ECTS)
spring	48	4

Responsible person: Professor Riitta Keiski
Aim: The course reviews the recent methods and techniques for separating and purifying components and products e.g. in chemical, food, biotechnology industry. The course introduces new research innovations in separation processes.
Learning outcomes: After completing the course the student can review the recent methods and techniques for separation and purification of components and products e.g. in chemical, food, biotechnology industry. He/she masters the principles of green separation processes and their research status and potentiality in industrial applications.
Contents: The course is divided into lectures given by visiting experts from different fields (industry, research institutes and universities) and seminars given by students and senior researchers. The lectures open up the newest innovations in separation and purification technologies. The lectures can include for example the following themes: Phenomena in Supercritical fluid extraction, Pressure-activated membrane processes, Reverse osmosis, Nanofiltration, Ultrafiltration, Microfiltration, Pervaporation, Polymer membranes, Dialysis, Electrolysis and Ion-exchange, Forces for adsorption and Equilibrium adsorption isotherms, Sorbent materials and heterogeneity of surfaces, Predicting mixture adsorption, Rate processes in adsorption/adsorbers and adsorber dynamics, Cyclic adsorption processes, Temperature and pressure swing adsorption. Innovative separation methods, Phenomena integration, New hybrid materials as separation agents. Fluids and their application in gas extraction processes, Solubility of compounds in supercritical fluids and phase equilibrium. Extraction from solid substrates: Fundamentals, hydrodynamics and mass transfer, applications and processes (including supercritical water and carbon dioxide). Counter-current multistage extraction: Fundamentals and methods, hydrodynamics and mass transfer, applications and processes. Solvent cycles, heat and mass transfer, methods for precipitation. Supercritical fluid chromatography. Membrane separation of gases at high pressures. The topics of the course seminars will change annually depending on the research relevance.
Implementation: Lectures during the 6th period. With the lectures the students will familiarize themselves to the latest research publications. Seminars. Examination. Notice! The course will be arranged for the first time in spring 2010. The course will be arranged every second year.
Course literature: The course literature will be chosen when the course is planned. Latest scientific research articles.
Additional literature: Separation Processes in the Food and Biotechnology Industries, Edited by: Grandison, A.S. & Lewis, M.J. 1996 Woodhead Publishing.

488102A Hydrology and Hydraulics

Semester	Amount of contact teaching	Credits (ECTS)
autumn, spring		5

Responsible person: Professor Björn Klöve, Assistant N.N.
Aim: To provide basics for understanding variations of water flow in natural and man made environments.
Contents: Hydrological cycle, physical properties of water, distribution of water resources, water balance, precipitation, evapotranspiration, soil and ground water, infiltration, runoff, snow hydrology, hydrometry, water quality, rivers and lakes.
Learning aims: The student will understand the main processes and measurement methods involved in quantification of the hydrological cycle and solve simple problems in water resources engineering
Implementation: Exercises and self study.
Course literature: Given later (upon request)
Prerequisites: Material and Energy Balances (recommended)

488103A Environmental Impact Assessment

Semester	Amount of contact teaching	Credits (ECTS)
autumn		5

Responsible person: Professor Björn Klöve, S. Pekkarinen, K. Reinikainen, visiting lecturers, Assistant N.N.
Aim: To provide a broad and multidisciplinary and sustainable approach to environmental impact assessment (EIA).
Learning aims: To understand the EIA process and the different methods used in environmental assessment.
Contents: EIA process and legislation, environmental change, principles and assessment methods in ecology, hydrology, economics and social sciences.
Implementation: Introduction module (autumn lectured in Finnish), and advanced modules in English in ecology, water resources, economics and social sciences in spring. The course is organized in a co-operation with Faculties of Technology, Economics, Social Sciences, Biology and the Thule Institute. Lectured every other year (even years)
Course literature: Lecture and exercise material.
Prerequisites: Basic course in economics (recommended), environmental sciences or engineering (recommended).

488104A Industrial and Domestic Waste Management

Semester	Amount of contact teaching	Credits (ECTS)
autumn	30	5

Responsible person: Professor Björn Klöve, assistant Tiina Leiviskä
Aim: Introduction to waste management legislation, management methods, technical principles and terminology.
Learning outcomes: Student can explain main things about waste management legislation. Student can describe how the waste amount can be diminished and how waste can be recycled and utilized. Furthermore, student can describe optimization methods of waste management processes.
Contents: EU and Finnish legislation, control of waste flows and amounts, recycling and utilisation, sorting and logistics, hazardous waste, environmental protection.
Implementation: Lectures, exercises, and field visits.
Course literature: Will be announced later.

488106A Basics in Geoenvironmental Engineering

Semester	Amount of contact teaching	Credits (ECTS)
autumn	20+50	5

Responsible person: Chief Engineer Kauko Kujala
Aim: To make the student familiar with the behaviour of detrimental elements in soil. Make the student acquainted with restoring the geologic environment and restraining the damages and also exploiting the industrial by-products in soil structures.
Contents: Soil as intermediate agent. Contaminant transfer in soil. Remediation of contaminated soil and purifying ground water. Final disposal sites for waste. Exploitation of industrial by-products and geo-environment in industry.
Implementation: Lectures. Exercises. Seminar.
Course literature: Lecture handout and material given in lectures.
Prerequisites: Course Introduction to Environmental Engineering recommended beforehand.

488108S Groundwater Engineering

Semester	Amount of contact teaching	Credits (ECTS)
autumn	24+20	5

Responsible person: Professor Björn Klöve
Aim: To acquire knowledge on water retention and flow in soils, hydraulics of ground water systems, ground water quality, ground water use and modelling.
Learning outcomes: The student will understand hydraulic properties of porous media and aquifers and the main methods used to describe and simulate flow processes in ground water.
Contents: Soil and ground water, aquifers, water balance, hydraulic properties of soils, formation of ground water, flow equations and solutions, pumping tests and methods, groundwater vulnerability, ground water directive, ground water dependent ecosystems, ground water quality and modelling.
Implementation: Lectures, soil laboratory work, modelling (GMS-MODFLOW). Lectured every other year (odd years).

Literature: Lecture material, Domenico & Schwartz: Physical and Chemical Hydrogeology.
Prerequisites: Hydrological Processes.

488109S Field Measurements in Environmental Engineering

Semester	Amount of contact teaching	Credits (ECTS)
autumn	6+20	2,5

Responsible person: Assistant Tiina Leiviskä, Dr. Jaakko Rämö, PhD students
Aim: To familiarize the student with field measurement techniques in environmental engineering.
Learning aims: Student can design field measurement project and sampling plan. Student can take water and environmental sample by taking into consideration quality and safety issues. In addition student can take soil and water sample using different samplers.
Content: Quality and safety of field measurements in environmental engineering. Planning of sampling and handling the results with statistical methods. Soil and water sampling with different sampling methods. Follow-up measurements.
Implementation: Lectures. Exercises. Field exercises with written reports.
Course literature: Announced during the course.

488110S Water and Wastewater Treatment

Semester	Amount of contact teaching	Credits (ECTS)
autumn	30+50	7,5

Responsible person: Laboratory manager Jarmo Sallanko, assistant N.N.
Aim: To familiarize the student with the unit operations of water and wastewater treatment used in communities and industry.
Contents: Biological, chemical and mechanical treatment methods, design practise and control of water and wastewater treatment. Handling, utilization and final displacement of waste water sludge. Wastewater treatment of communities and industry. On-site treatment systems.
Implementation: Lectures. Visits to treatment plants. Design exercises and laboratory modelling exercises.
Course literature: RIL 123-1.2003: Vesihuolto I and RIL 124-2.2004: Vesihuolto (some parts). Material represented in lectures.
Additional literature: AWWA, ASCE: Water Treatment Plant Design, McGraw-Hill, London 1998; Metcalf & Eddy: Wastewater Engineering, Treatment and Reuse. 4th ed. McGraw-Hill, London 2003; AWWA (Letterman, R.D. ed.): Water Quality and Treatment, McGraw-Hill, London 1999.
Prerequisites: Introduction to Environmental Engineering or equivalent information about water management.

488112S Chemical Processes in Water and Wastewater Engineering

Semester	Amount of contact teaching	Credits (ECTS)
spring	20+15	5

Responsible person: Professor Björn Klöve, assistant Tiina Leiviskä and Dr. Jaakko Rämö
Aim: To provide the student with understanding of chemical processes and chemicals in water treatment.
Learning aims: Student can describe different chemical processes and unit operations in water and wastewater treatment and which detrimental components these processes remove. Student can describe the factors that have an effect on optimization of chemical processes. Student can interpret analysis results of water and wastewater. Student can name chemicals that are used in processes and can tell their mechanism function. Student can explain different mechanism of coagulation/flocculation and how coagulation phenomenon is studied.
Content: Typical water treatment unit operations such as coagulation/flocculation mechanism. Effects on health.
Implementation: Lectures. Exercises.
Course literature: Material delivered during the course.
Additional literature: Sincero A. & Sincero A.: Physical-Chemical Treatment of Water and Wastewater, IWA Publishing, CRC Press; Snoeyink V.L. & Jenkins D.: Water Chemistry, Wiley; Gillberg L., Hansen B., Karlsson L., Nordström A. & Pålsson A.: About Water Treatment, Kemira.

488113S Hydraulics for Environmental Engineering

Semester	Amount of contact teaching	Credits (ECTS)
autumn	20+15	5

Responsible Person: Professor Björn Klöve
Aim: To assess the fate of detrimental elements in rivers and lakes and using mathematical modelling.
Content: Principles of open channel flow, lake hydraulics, dimensional analysis, hydraulic experiments, transport of conservative and reactive solutes in rivers. Analytical and numerical methods for surface water modeling.
Implementation: Lectures, exercises, laboratory, and modeling with Matlab. Lectured every other year.
Course literature: Chapra, S.: Surface water quality modelling; lecture notes.

488115S Advanced Geoenvironmental Engineering

Semester	Amount of contact teaching	Credits (ECTS)
autumn	26+30	5

Responsible person: Chief Engineer Kauko Kujala
Aim: To familiarize the student with properties of soil, geo-materials and by-products from industry, load, design and construction of geo- and environmental structures.
Contents: Soils, geo-materials and by-products. Strength and deformation properties. Calculation of stability, Bearing and soil pressure. Seepage water flow. Soil strengthening, congealing and melting. Soil investigation.
Implementation: Lectures. Calculation and design exercises.
Requirements: Laboratory and calculation exercises.
Course literature: Course handout and material given during course.

488117S Water Resources Management

Semester	Amount of contact teaching	Credits (ECTS)
autumn	40+20	7,5

Responsible person: Professor Björn Klöve
Aim: To familiarize the student with surface waters, their use, watershed modelling tools and integrated water resources management.
Contents: Different uses of water, planning and pressures, point and diffuse pollutant sources, water protection methods, water quality, land drainage and environmental impacts, river and lake restoration, habitat hydraulics, hydraulic structures (e.g. dams), reservoir regulation, flood routing, flood protection, IWRM, mathematical methods, interpolation, statistical hydrology, frequency analysis, time series analysis, GIS, hydrological and hydraulic modelling of rivers and watershed using the WMS environment.
Implementation: Lectures, design exercises: I) loading to water courses and plan for water course restoration II) time series analysis, III) river flow modelling with e.g. HEC-RAS, IV) hydrologic modelling with GSSHA. Lectured every other year.
Course literature: Material will be announced later.

488202S Production and Use of Energy

Semester	Amount of contact teaching	Credits (ECTS)
autumn	30	3

Responsible person: Lecturer Timo Nordman
Aim: To provide the student with the basics of energy supply, use and equipment in Finnish communities and industrial plants. The student will know energy production, transfer, consumption and market structure in Finland. He/she will also know the distribution, adequacy and environmental issues of energy resources
Learning outcomes: The student knows different methods and techniques to generate electricity and heat. He/she has knowledge about steam power technology, steam power plants and steam boilers. The student is able to explain the environmental impacts of energy production. He/she knows how the electricity markets work. The student also knows the adequacy of energy reserves.
Implementation: Lectures
Contents: Structure of energy production and consumption. Systems for electric transportation, storing and distribution. Distribution and adequacy of energy resources. Effects of environment contracts to the use of energy

resources Environmental comparison of different energy production methods and fuels. Energy markets. Development views of energy technology.
Course literature: Material will be announced later.

488203S Industrial Ecology

Semester	Amount of contact teaching	Credits (ECTS)
autumn	30+20	5

Responsible teacher: Docent Eva Pongrácz and Assistant Virpi Väisänen
Aim: To familiarize the student with the major concepts of industrial ecology and clarify the role of technology towards sustainable development.
Learning outcomes: The student will be able to use the tools of industrial ecology and apply them to industrial activity. The student can also analyze the interaction of industrial, natural and socio-economic systems and able to judiciously suggest changes to industrial practice in order to prevent negative impacts. The student can also analyze the examples of industrial symbioses and eco-industrial parks and able to specify the criteria of success for building eco-industrial parks.
Contents: Material and energy flows in economic systems and their environmental impacts. Physical, biological and societal framework of industrial ecology. Industrial metabolism, corporate industrial ecology, eco-efficiency, dematerialization, decarbonization. Tools of industrial ecology, such as life-cycle assessment, design for the environment, green chemistry and engineering. Systems-level industrial ecology, industrial symbioses, eco-industrial parks.
Implementation: Lectures. Exercise work. Examination.
Course literature: Lecture notes; Graedel T.E & Allenby B.R.: Industrial Ecology. New Jersey: Prentice Hall, 2003.

488204S Air Pollution Control Engineering

Semester	Amount of contact teaching	Credits (ECTS)
autumn	30+20	5

Responsible teacher: Lecturer Timo Nordman
Aim: To familiarize the student with the effects of air pollution, industrial emissions to air and the control. Legislation of air pollution.
Learning outcomes: The student is able to explain what kind of air emissions there are in industry and power plants, and knows their environmental impacts. The student knows the common air pollution control systems for different emissions (SO_2, NO_X, VOC, CO_2, dust) and is able to dimension air pollution cleaning devices. He/she knows how the air emissions are measured. The student knows the main laws related to air emission control.
Contents: Effects of pollution to the atmosphere. Acid rain. Climate change. Ozone. Effects of pollution to health and buildings. Legislation. Measurement of pollution. Long range transport and diffusion models. Control of emissions, VOC emissions, SO_x emissions, NO_x emissions, heavy metals, dioxins, freons.
Implementation: Lectures and exercises
Course literature: Lecture handout; de Nevers N.: Air Pollution Control Engineering. 2nd ed. McCraw-Hill 2000.
Additional literature: Singh H.B.: Composition, Chemistry, and Climate of the Atmosphere. New York 1995; Bretschneider B. & Kurfurst J.: Air Pollution Control Technology. Elsevier, Amsterdam 1987; Hester R.E. & Harrison R.M.: Volatile Organic Compound in the Atmosphere. Issues in Environmental Science and Technology. Vol. 4. Bath 1995; Hester R.E. & Harrison R.M.: Waste Incineration and the Environment. Issues in Environmental Science and Technology. Vol 4. Bath 1995.

488205S Environmental Load of Process Industry

Semester	Amount of contact teaching	Credits (ECTS)
spring	30	4

Responsible person: Lecturer Timo Nordman
Aim: To familiarize the student in more detail with the environmental impacts in process industry such as air pollution, waste water and solid waste. The student will also know about environmental leadership in an industrial plant.
Learning outcomes: The student knows the essential features of the environmental load in wood processing, chemical and metallurgical industry. He/she is aware of the type, quality, quantity and source of emissions. The student

knows the main emission control systems and techniques in different industrial sectors. He/she has skill to apply BAT-techniques in emission control. The student knows the environmental management system of an industrial plant.
Implementation: Lectures
Contents: Effluents: types, quality, quantity, sources. Unit operations in managing effluents, comprehensive effluent treatment. Environmental management systems, environmental licences, environmental reporting and BAT.
Literature: Material represented in lectures.

488406A Introduction to Environmental Science

Semester	Amount of contact teaching	Credits (ECTS)
autumn	-	5

Responsible teacher: Assistant Virpi Väisänen
Aims: The aim of the course is to familiarize the student with the principles of environmental science.
Learning outcomes: The student is able to define the basic concepts of environmental ecology. He/she has knowledge about the state of environment and is able to explain the essential environmental problems and the main effects of pollution. In addition, the student knows some solutions to the environmental problems and is aware about ethical thinking in environmental engineering.
Contents: Principles of environmental ecology. Roots of environmental problems. Global air pollution: ozone depletion, acid deposition, global warming and climate change. Water pollution, eutrophication, overexploitation of ground and surface water. Main effects of pollution and other stresses. Nonrenewable and renewable energy. Energy conservation and efficiency. Hazardous and solid waste problem. Principles of toxicology and risk assessment. Environmental ethics.
Teaching methods: E-learning in the Optima virtual learning environment.
Course literature: Chiras D.: Environmental Science: Creating a Sustainable Future. New York, Jones and Bartlett Publishers, 2001.

5.1.2 Courses from other Departments and/or Faculties at University of Oulu

555321S Risk Management

Semester	Amount of contact teaching	Credits (ECTS)
autumn		3

Responsible teacher: Professor Pekka Kess (Department of Industrial Engineering and Management)
Aims: To familiarize the student to the comprehensive risk management in the enterprises.
Contents: Theoretical definition of risk. Risks of business activities and their classification. Methods of risk management. Tools of risk management in the enterprises.
Implementation: Lectures. Case studies in small groups, which will be reported in the closing seminar.
Course literature: Bernstein P.L.: Against the Gods - The Remarkable Story of Risk. JohnWiley & Sons Inc., 1996.; Lecture material.

721249A Resource Economics

Semester	Amount of contact teaching	Credits (ECTS)
autumn	-	5

Responsible teacher: Dr. Artti Juutinen (Faculty of Economics and Business Administration)
Aims: The course aims to familiarize students to crucial questions of economics of natural resources and environment.
Contents: The course focuses especially on economical issues of the use and recovery of renewable (e.g. forest and fishing industries) and non-renewable (e.g. mining activities) resources.
Implementation: Literature examination and written essay
Course literature: Hartwick & Olewiler: The Economics of Natural Resources Use (2ed); chapters1-10. 1998.

721721A International Procurement and Logistics

Semester	Amount of contact teaching	Credits (ECTS)
autumn	-	5

Responsible teacher: Head assistant Ulla Lehtinen (Faculty of Economics and Business Administration)
Aims: This course presents the concepts, principles, and techniques of procurement and logistical management in international business environment.
Contents: Emphasis will be placed on students developing a basic knowledge set while centering them in the real themes while discussing electronic procurement, suppliers' analysis, coordination and integration, strategic procurement outsourcing etc. A special emphasis will be given to the analysis of international logistics environment along with the question of coordination and responsiveness requirements in international production.
Implementation: Lectures (24 h) and assignments. The final exam will be based on lectures, article collection and books (60%). The assignment and class participation account for 40% of the grade. Accurately completed exercise will give a good base for passing the final exam. Class participation includes in-class discussion, students' contributions and preparation for the exercises.
Course literature: Schary P. & Skjött-Larsen T.: Managing the Global Supply Chain, Copenhagen Business School Press, 2001 or 2007; Supplementary material provided by lecturer.

5.2 Courses in Narvik University College, Norway

NUC 1 Introduction to Sustainable Energy

Semester	Amount of contact teaching	Credits (ECTS)
spring		10

Responsible teacher: Professor Bjørn R. Sørensen
Aims: To give a survey on the most common sustainable energy productions and discuss the consequences of using such energy.
Contents: The importance of energy for the development of society. Global energy policy. The threat of the green house effect. The Kyoto Convention. Master plans and planning systems for sustainable energy. Environmental Impact Assessment, national-and EU legislation. Resources and development of sustainable energy like: Hydropower, Wind power, Solar energy, Waves - and tidewater energy, Geo energy, Thermal energy, Bio energy, Waste incineration, Hydrogen, Nuclear energy. Energy usage or energy consumption, Energy management in housing, industry and transport. The energy market. Competition and financing sustainable energy. CO_2 – quotas.
Teaching methods: Lectures, seminars. Examination.
Course literature: G. Boyle, B. Everett, J. Ramage: Energy Systems and Sustainability. Oxford University Press.. G. Boyle: Renewable Energy, Power for sustainable future, Oxford University Press.

NUC 2 Renewable Energy

Semester	Amount of contact teaching	Credits (ECTS)
autumn		5

Responsible teacher: Professor Bjørn R. Sørensen
Aims: Knowledge about the coherence of energy and environment, the interaction between energy systems, environment, building envelope, user activities, external as well as internal influences and indoor climate. Insight to the most important initiatives, instruments and measures towards more sustainable and efficient energy supplies and end use. Obtain high competence on utilization of sustainable energy sources and attain overview of available energy resources. Achieve good skills and expertise on consumer energy systems to assess and solve real world problems in buildings and industry.
Contents: Hydrogen - the energy carrier of the future. Bioenergy. Energy from waste. Wind and solar energy.
Teaching methods: Lectures, exercises, use of simulation software.
Course literature: Material will be announced later.
Prerequisites: Basic knowledge of physics and thermodynamics, Introduction to Sustainable Energy course

NUC 3 Energy and Environment

Semester	Amount of contact teaching	Credits (ECTS)
autumn		5

Responsible teacher: Professor Bjørn R. Sørensen
Aims: Knowledge about the coherence of energy and environment, the interaction between energy systems, environment, building envelope, user activities, external as well as internal influences and indoor climate. Insight to the most important initiatives, instruments and measures towards more sustainable and efficient energy supplies and end use. Obtain high competence on utilization of sustainable energy sources and attain overview of available energy resources. Achieve good skills and expertise on consumer energy systems to assess and solve real world problems in buildings and industry.
Contents: Global environmental situation. Different scenarios of future energy and environmental development. Green energy. Consequences of increased energy demands. Cleaning methods. Trading with emission shares. CO_2 neutral heating through use of biomass. CO_2 neutral transport through use of bio fuels. Local and regional energy and environmental planning. Cold climate challenges.
Teaching methods: Lectures, exercises, use of simulation software.
Course literature: Material will be announced later.
Prerequisites: Basic knowledge of physics and thermodynamics, Introduction to Sustainable Energy course

NUC 4 Energy Systems in Buildings and industry

Semester	Amount of contact teaching	Credits (ECTS)
autumn		10

Responsible teacher: Professor Bjørn R. Sørensen
Aims: Knowledge about the coherence of energy and environment, the interaction between energy systems, environment, building envelope, user activities, external as well as internal influences and indoor climate. Insight to the most important initiatives, instruments and measures towards more sustainable and efficient energy supplies and end use. Obtain high competence on utilization of sustainable energy sources and attain overview of available energy resources. Achieve good skills and expertise on consumer energy systems to assess and solve real world problems in buildings and industry.
Contents: Energy systems in buildings and industry (ECTS 10): Laws, directives and regulations. Thermal insulation of the building envelope. Windows and glazed areas. Heating systems. Heat transmission. Ventilation and infiltration. Heat recovery systems. Heat pumps. External climate (wind, sun). Determination of design power. Energy consumption calculation methods. Energy efficiency. Energy flexibility. Investment and profitability analysis. Indoor climate.
Teaching methods: Lectures, exercises, use of simulation software.
Course literature: Material will be announced later.
Prerequisites: Basic knowledge of physics and thermodynamics, Introduction to Sustainable Energy course

NUC 5 Pre-aster work

Semester	Amount of contact teaching	Credits (ECTS)
autumn		10

Responsible teacher: Professor Bjørn R. Sørensen
Contents: Chosen subject within sustainable energy engineering
Implementation: Project based pre-master work. Literature studies and network building. Project report.
Course literature: Material will be announced later.
Prerequisites: Introduction to Sustainable Energy, Renewable Energy, Energy and Environment, Energy Systems in Buildings and Industry courses

6 GENERAL INFORMATION

6.1 Degree awarded

Graduating students will be awarded a degree of Master of Science in Engineering from the University of Oulu, a diploma supplement from the university where exchange period has been taken, and a BCBU certificate.

6.2 Personal Study Plan

All students in BEE the programme will follow their personal study plan. Personal Study Plan will be done in the beginning of the studies together with the BEE student advisor. Any changes to the personal study plan must be accepted by the BEE student advisor.

6.3 Student exchange

Barents Master's Programme in Environmental Engineering contains an exchange period in Partner University. In Clean Production and Water and Environment orientations courses completed during the exchange period can be included in curriculum's modules, but these courses must be agreed in advance with BEE student advisor.

6.4 Useful Information

- University of Oulu's main webpage www.oulu.fi/english/
- In University of Oulu's webpage www.oulu.fi/students/ is collected much information relevant for students about registration to university, current events, studies, guides and student life.
- Faculty of technology in University of Oulu www.ttk.oulu.fi/English/
- Department of Process and Environmental Engineering in University of Oulu http://pyo.oulu.fi/
- City of Oulu webpage www.oulu.ouka.fi/english/
- Higher education in Oulu website www.studyinoulu.fi