

## MODULE HANDBOOK

### CHEMICAL ENGINEERING

#### Bachelor's Degree Programme in Chemical Engineering

The Bachelor's degree programme takes three years, corresponds to 180 ECTS credits and leads to degree of Bachelor of Science in Technology.

Bachelor's degree programme 180 ECTS cr	
A. General studies, 107 ECTS cr	
B. Major subject, 40 ECTS cr (min.) B.Sc. thesis included	C. Minor subject, 20 ECTS cr (min.)
D. Elective studies, 6-11 ECTS	

#### Major subjects

1. Applied Chemistry
2. Fiber and Paper Technology
3. Process Engineering

#### Minor subjects

1. Applied Chemistry
2. Fiber and Paper Technology
3. Process Engineering

#### Bachelor's degree in Chemical Engineering comprises the following studies

A. General studies	107	ECTS cr
B. Major subject, B.Sc. Thesis included	40 (min.)	ECTS cr
C. Minor subject	20 (min.)	ECTS cr
D. Elective studies	6-11	ECTS cr
<i>Studies in total</i>	<i>180 (min.)</i>	<i>ECTS cr</i>

#### A. General studies

<i>Obligatory general studies (107 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BH20A0300	Fundamentals of Heat Transfer	B.Sc. 3	1-2	3
BH20A0700 <sup>t</sup>	Fundamentals of Engineering Thermodynamics	B.Sc. 2	2	2
BH40A0250	Pumps, Blowers, Fans and Compressors (KETE)	B.Sc. 3	1	2
BH40A1400	Fluid Dynamics I	B.Sc. 2	3	3
BJ20A1400	Particle Characterization and Treatment of Particulate Solids	B.Sc. 2	2	2
BJ20A1500	Introduction to Mass Transfer	B.Sc. 2	3-4	2
BJ20A1600	Chemical Engineering Unit Operations I	B.Sc. 3	1-2	4
BJ20A1700	Introduction to Studies of Chemical Technology	B.Sc. 1	1	1
BJ30A0302	Process and Plant Design	B.Sc. 3	1-2	7
BJ70A0001	Inorganic Chemistry	B.Sc. 1	1-3	6
BJ70A0201	Analytical Chemistry	B.Sc. 1	1-4	6
BJ70A0900	Organic Chemistry	B.Sc. 2	1-4	6

BJ80A1000	Chemical Thermodynamics	B.Sc. 2	3-4	6
BJ90A1000	Natural Recourses in Chemical and Energy Industries	B.Sc. 2	3-4	3
BK20A1901	Basics of Technical Drawing	B.Sc. 1	1	2
BM20A0000	Mathematics SäEnKeA1	B.Sc. 1	1	3
BM20A0200	Mathematics SäEnKeA2	B.Sc. 1	1-2	5
BM20A0400	Mathematics SäEnKeB1	B.Sc. 1	3	3
BM20A0600	Mathematics SäEnKeB2	B.Sc. 1	3-4	2
BM20A0800	Mathematics SäEnKeB3	B.Sc. 1	4	3
BM20A1401	Statistics I	B.Sc. 2	1	3
BM20A1501	Numerical methods I	B.Sc. 2	3	3
BM20A4301	Introduction to Technical Computation	B.Sc. 1	4	4
BM20A4310	Practical Assignment in Technical Computation	B.Sc. 1	4	1
BM30A0210	Physics L, part 1	B.Sc. 1	1-2	5
BM30A0220	Physics L, part 2	B.Sc. 1	2	2
BM30A0230	Physics L, osa 3	B.Sc. 1	3-4	5
BM30A0320	Physics, Laboratory course (KETE, KOTE)	B.Sc. 2	2	3
FV13A1200	Technical Swedish	B.Sc. 1-3	1, 2, 3, 4	2
FV18A1000	Oral communication in Finnish	B.Sc. 2	1, 1-2, 2, 3, 3-4, 4	2
FV10A 4cr <sup>***</sup>	Language studies			4
HARK2	Practical training, 2 cr			2

<sup>1)</sup> In Chemical Technology Programme the module is studied in first (B.Sc. 1) year

<sup>\*\*)</sup> FV11A8900 Academic Writing in English 4 ECTS cr is recommended

## B. Major subjects

### Applied Chemistry

<i>Obligatory studies (41 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ50A0101	Technical Polymer Chemistry	B.Sc. 2	3-4	3
BJ70A0102 <sup>(1)</sup>	Advanced Special Studies in Inorganic Chemistry	B.Sc. 3	3-4	5
BJ70A0701	Analytical Methods in Industry and Environment I	B.Sc. 3	2-4	6
BJ70A1001 <sup>(1)(**)</sup>	Advanced Special Studies in Organic Chemistry	B.Sc. 3	3-4	5
BJ80A0400	Reaction Kinetics	B.Sc. 2	2	3
BJ80A0600	Physical Chemistry Laboratory Course	B.Sc. 3	1-2	4
BJ90A0100	Chemical Reaction Engineering	B.Sc. 3	1-2	6
BJ90A0900	Industrial Chemistry and Technical Polymer Chemistry Laboratory Course	B.Sc. 3	1-2	4
BJ10A0101	Bachelor's Thesis and Seminar	B.Sc. 3	1-4	10

<sup>1)</sup> Modules are alternative

<sup>2)</sup> The module will be lectured every other year, next during the academic year 2011-2012.

<sup>\*\*)</sup> The module will be lectured every other year, next during the academic year 2010-2011.

### Fiber and Paper Technology

<i>Obligatory studies (40 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BH61A0500 <sup>1)</sup>	Energy Economics in Wood Processing Industry	M.Sc.1	3-4	6
BJ50A0200	Natural Polymers	B.Sc. 3	2-4	4
BJ60A0001	Introduction Course in Paper Technology	B.Sc. 3	1-2	5
BJ60A0800	Fiber and Paper Technology, Laboratory Course	B.Sc. 3	1-2	5
BJ60A0900	Fiber and Paper Manufacture	B.Sc. 3	3-4	5
BJ60A1700	Biorefineries	B.Sc. 3	4	2
BL40A0110	Measurement and Automation Technology, an Introduction	B.Sc. 2	1-2	3
BJ10A0101	Bachelor's Thesis and Seminar	B.Sc. 3	1-4	10

<sup>1)</sup> In Chemical Technology Programme the module is studied in second (B.Sc. 2) or in third (B.Sc. 3) year

### Process Engineering

<i>Obligatory studies (43 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ20A0100	Mechanical Separation Processes	B,Sc. 2	3-4	4
BJ20A0200	Laboratory Course of Mechanical Process Engineering	B.Sc. 3	1-3	3
BJ20A0301	Introduction to Process Simulation	B.Sc. 3	1-2	5
BJ20A0700	Unit Operations Laboratory Course	B.Sc. 3	3-4	4
BJ20A0800	Treatment Processes of Industrial Discharges	B.Sc. 3	3-4	5

BJ30A0400	Seminar on Process Design	B.Sc. 3	3-4	4
BL40A0110	Measurement and Automation Technology, an Introduction	B.Sc. 2	1-2	3
CS31A0600	Capital Investment Appraisal	B.Sc. 3	1	5
BJ10A0101	Bachelor's Thesis and Seminar	B.Sc. 3	1-4	10

### C. Minor Subjects for students in the Degree Programme in Chemical Engineering

#### Applied Chemistry

<i>Obligatory studies (24 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ70A0102 <sup>(1)</sup>	Advanced Special Studies in Inorganic Chemistry	B.Sc. 3	3-4	5
BJ70A0701	Analytical Methods in Industry and Environment I	B.Sc. 3	2-4	6
BJ70A1001 <sup>(1)**</sup>	Advanced Special Studies in Organic Chemistry	B.Sc. 3	3-4	5
BJ80A0400	Reaction Kinetics	B.Sc. 2	2	3
BJ80A0600	Physical Chemistry Laboratory Course	B.Sc. 3	1-2	4
BJ90A0100	Chemical Reaction Engineering	B.Sc. 3	1-2	6

<sup>1)</sup> Modules are alternative

<sup>\*</sup> The module will be lectured every other year, next during the academic year 2011-2012.

<sup>\*\*</sup> The module will be lectured every other year, next during the academic year 2010-2011.

#### Fiber and Paper Technology

<i>Obligatory studies (21 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ50A0200	Natural Polymers	B.Sc. 3	2-4	4
BJ60A0001	Introduction Course in Paper Technology	B.Sc. 3	1-2	5
BJ60A0800	Fiber and Paper Technology, Laboratory Course	B.Sc. 3	1-2	5
BJ60A0900	Fiber and Paper Manufacture	B.Sc. 3	3-4	5
BJ60A1700	Biorefineries	B.Sc. 3	4	2

#### Process Engineering

<i>Obligatory studies (22 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ20A0100	Mechanical Separation Processes	B.Sc. 2	3-4	4
BJ20A0700	Unit Operations Laboratory Course	B.Sc. 3	3-4	4
BJ20A0800	Treatment Processes of Industrial Discharges	B.Sc. 3	3-4	5
BJ30A0400	Seminar on Process Design	B.Sc. 3	3-4	4
CS31A0600	Capital Investment Appraisal	B.Sc. 3	1	5

### D. Elective studies

The student has to take a suitable amount of elective studies to reach the total 180 ECTS credits required for the Bachelor's degree. The student may include any courses taught at LUT, also another minor subject, in his/her Bachelor's degree. Studies in other domestic or foreign higher education institutions can be included in the degree by application; the studies are approved by the Head of Degree Programme. The leadership training provided by the National Defence Forces can be included in the elective studies (6 ECTS cr) provided that these studies are not included in any previous degree.

### Master's Degree Programme in Chemical Engineering

The Master's degree programme takes two years, corresponds to 120 ECTS credits and leads to degree of Master of Science in Technology.

Master's degree programme 120 ECTS cr	
A. General studies, 21 ECTS cr	
B. Major subject, 60 ECTS cr (min.) M.Sc. thesis included	C. Minor subject, 20 ECTS cr (min.)
D. Elective studies, 16-18 ECTS	

## Major subjects

4. Applied Chemistry
5. Fiber and Paper Technology
6. Process and Product Development
7. Unit Operations of Chemical Engineering

## Minor subjects

4. Applied Chemistry
5. Environmental and Safety Technology
6. Fiber and Paper Technology
7. Hydrometallurgy
8. Process and Equipment Design

The major and minor subjects studied in Bachelor's programme of Chemical Technology in LUT set the following limits for choosing of Major subject in Master's programme:

- The student can take **Process and Product Development** or **Unit Operations of Chemical Engineering** as major subject in Master programme if he/she has studied Process Engineering as major or minor subject in Bachelor's programme
- The student can take **Fiber and Paper Technology** as major subject in Master programme if he/she has studied Fiber and Paper Technology as major or minor subject in Bachelor's programme
- The student can take **Applied Chemistry** as major subject in Master programme if he/she has studied Applied Chemistry as major or minor subject in Bachelor's programme

Acceptable combinations of Major and Minor subjects in Master programme are given in the table below

Major subject:	Possibilities for Minor subjects:
Applied Chemistry	<ul style="list-style-type: none"> <li>- Environmental and Safety Technology</li> <li>- Fiber and Paper Technology</li> <li>- Hydrometallurgy</li> <li>- Process and Equipment Design</li> </ul>
Fiber and Paper Technology	<ul style="list-style-type: none"> <li>- Applied Chemistry</li> <li>- Environmental and Safety Technology</li> <li>- Process and Equipment Design</li> </ul>
Process and Product Development	<ul style="list-style-type: none"> <li>- Applied Chemistry</li> <li>- Fiber and Paper Technology</li> <li>- Environmental and Safety Technology</li> <li>- Hydrometallurgy</li> <li>- Process and Equipment Design</li> </ul>
Unit Operations of Chemical Engineering	<ul style="list-style-type: none"> <li>- Applied Chemistry</li> <li>- Fiber and Paper Technology</li> <li>- Hydrometallurgy</li> <li>- Process and Equipment Design</li> </ul>

Minor subject can also be taken by application from another Master Degree Programme at LUT, if the content of subject is suitable for the degree. The studies are approved by the Head of Degree Programme.

## Master's degree in Chemical Engineering comprises the following studies

A. General studies	21	ECTS cr
B. Major subject, M.Sc. Thesis included	60 (min.)	ECTS cr
C. Minor subject	20 (min.)	ECTS cr
D. Elective studies	16-18	ECTS cr
<i>Studies in total</i>	<i>120 (min.)</i>	<i>ECTS cr</i>

## A. General studies

<i>Obligatory general studies (21 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BM20A1900	Statistics II	M.Sc. 1-2	2	3
BM20A2701	Numerical Methods II	M.Sc. 1	4	3
BM20A3900	Modelling Methodology in Process Engineering	M.Sc. 1	1-2	6
FV18A4000	Scientific Writing in Finnish	M.Sc. 1-2	1, 2, 3, 4	1
FV10A 4cr	Language studies			4
HAR4	Practical training 4 cr			4

## B. Major subjects

### Applied Chemistry

<i>Obligatory studies (63 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ50A0001	Membrane Technology	M.Sc. 1	1-2	4
BJ50A0400 <sup>(1)</sup>	Advanced Course in Membrane Technology and Technical Polymer Chemistry	M.Sc. 2	1-2	10
BJ70A0801	Analytical Methods in Industry and Environment II	M.Sc.1-2	4, 1-2	8
BJ80A0500	Surface and Colloid Chemistry	M.Sc. 1	3	3
BJ80A0900	Chemical Properties of Real Solutions	M.Sc. 2	2	4
BJ90A0200 <sup>(1)</sup>	Industrial Chemistry	M.Sc. 1	3-4	10
BJ90A0400 <sup>(1)</sup>	Catalysis	M.Sc.1-2	1-2	4
BJ10A0201	Master's Thesis and Seminar	M.Sc. 2	1-4	30

### Fiber and Paper Technology

<i>Obligatory studies (62 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ60A0501	Paper Chemistry, Laboratory Course	M.Sc. 1	3-4	4
BJ60A1100	Fiber and Paper Technology; Personal Assignment	M.Sc. 1-2	3-4/1-2	10
BJ60A1200	Sheet Formation and Wet End Chemistry	M.Sc. 1	1-2	5
BJ60A1300	Usage and Properties of Paper	M.Sc. 1	3-4	5
BJ60A1400	Chemical Pulping Technology	M.Sc. 1	1-2	5
BJ60A1600	Coating and Plating Chemistry	M.Sc. 1	3-4	3
BJ10A0201	Master's Thesis and Seminar	M.Sc. 2	1-4	30

### Process and Product Development

<i>Obligatory studies (61 - 63 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ30A0500	Project on Process and Plant Design	M.Sc. 2	1-2	11
BJ30A0900 <sup>(1)</sup>	Hazard Identification and Risk Management in Process Industry	M.Sc. 1	1-2	6
BJ30A1100	Process Integration	M.Sc. 1	1-2	6
BJ30A1600 <sup>(1)</sup>	Advanced Process Simulation	M.Sc. 1	3-4	8
BJ40A0000	Creative Design	M.Sc. 1	1	3
BJ40A0100	Product Design	M.Sc. 1	4	5
BJ10A0201	Master's Thesis and Seminar	M.Sc. 2	1-4	30

<sup>(1)</sup> Modules are alternative

### Unit Operations of Chemical Engineering

<i>Obligatory studies (62 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ10A0400	Process Control Systems in Pulp and Paper Industry	M.Sc. 2	1-2	3
BJ20A1100	Filtration and Mixing	M.Sc. 1	3-4	6
BJ20A1801	Chemical Engineering Unit Operations II	M.Sc. 1	1-2	5
BJ20A1901	Advanced Course in Environmental Technology and Unit Operations	M.Sc. 1	3-4,1	6
BJ30A0600	Modelling of Unit Processes	M.Sc. 1	3-4	6
BJ30A0900	Hazard Identification and Risk Management in Process Industry	M.Sc. 1	1-2	6
BJ10A0201	Master's Thesis and Seminar	M.Sc. 2	1-4	30

## C. Minor Subjects for students in the Degree Programme in Chemical Technology

### Applied Chemistry

<i>Obligatory studies (12 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ50A0200	Natural Polymers	B.Sc. 3	2-4	4
BJ90A0400 <sup>f</sup>	Catalysis	M.Sc. 1-2	1-2	4
BJ90A0900	Industrial Chemistry and Technical Polymer Chemistry Laboratory Course	B.Sc. 3	1-2	4

<sup>f</sup> The module will be lectured every other year, next during the academic year 2010-2011.

The student has to take a suitable amount of elective studies from the module list below to reach the total of 20 ECTS credits required for Minor subject.

<i>Elective studies (at least 8 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ40A0100	Product Design	M.Sc. 1	4	5
BJ70A0102 <sup>f</sup>	Advanced Special Studies in Inorganic Chemistry	B.Sc. 3	3-4	5
BJ70A0801	Analytical Methods in Industry and Environment II	M.Sc. 1-2	4, 1-2	8
BJ80A0500	Surface and Colloid Chemistry	M.Sc. 1	3	3
BJ80A0900	Chemical Properties of Real Solutions	M.Sc. 2	2	4

<sup>f</sup> The module will be lectured every other year, next during the academic year 2011-2012.

### Environmental and Safety Technology

<i>Obligatory studies (12 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ20A1901	Advanced Course in Environmental Technology and Unit Operations	M.Sc. 1	3-4,1	6
BJ30A0900	Hazard Identification and Risk Management in Process Industry	M.Sc. 1	1-2	6

The student has to take a suitable amount of elective studies from the module list below to reach the total of 20 ECTS credits required for Minor subject.

<i>Elective studies (at least 8 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ20A1100	Filtration and Mixing	M.Sc. 1	3-4	6
BJ20A1801	Chemical Engineering Unit Operations II	M.Sc. 1	1-2	5
BJ70A0701	Analytical Methods in Industry and Environment I	B.Sc. 3	2-4	6
BJ70A0801	Analytical Methods in Industry and Environment II	M.Sc. 1-2	4, 1-2	8

### Fiber and Paper Technology

<i>Elective studies (at least 20 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ60A0501	Paper Chemistry, Laboratory Course	M.Sc. 1	3-4	4
BJ60A1000 <sup>f1</sup>	Fiber and Paper Technology; Personal Assignment	M.Sc. 1-2	3-4/1-2	6
BJ60A1100 <sup>f1</sup>	Fiber and Paper Technology; Personal Assignment	M.Sc. 1-2	3-4/1-2	10
BJ60A1200	Sheet Formation and Wet End Chemistry	M.Sc. 1	1-2	5
BJ60A1300	Usage and Properties of Paper	M.Sc. 1	3-4	5
BJ60A1400	Chemical Pulping Technology	M.Sc. 1	1-2	5
BJ60A1600	Coating and Plating Chemistry	M.Sc. 1	3-4	3

<sup>f1</sup> Modules are alternative

### Hydrometallurgy

<i>Obligatory studies (18 - 20 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ20A1100	Filtration and Mixing	M.Sc. 1	3-4	6
BJ90A0200 <sup>f1</sup>	Industrial Chemistry	M.Sc. 1	3-4	10
BJ90A0720 <sup>f1</sup>	Chemical Separation Methods	M.Sc. 1	3-4	8
BJ90A1100 <sup>f</sup>	Hydrometallurgy	M.Sc. 1-2	1-2	4

<sup>f1</sup> Modules are alternative

<sup>f</sup> The module will be lectured every other year, next during the academic year 2011-2012.

The student has to take a suitable amount of elective studies from the module list below to reach the total of 20 ECTS credits required for Minor subject.

<i>Elective studies (at least 0-2 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ30A0500	Project on Process and Plant Design	M.Sc. 2	1-2	11
BJ30A0600	Modelling of Unit Processes	M.Sc. 1	3-4	6
BJ30A0700	Computational Fluid Dynamics in Chemical Engineering	M.Sc. 2	2	6
BJ30A1100	Process Integration	M.Sc. 1	1-2	6

BJ30A1600	Advanced Process Simulation	M.Sc. 1	3-4	8
BJ80A0500	Surface and Colloid Chemistry	M.Sc. 1	3	3
BJ80A0900	Chemical Properties of Real Solutions	M.Sc. 2	2	4
BJ90A0400 <sup>†</sup>	Catalysis	M.Sc. 1-2	1-2	4
BJ90A0900	Industrial Chemistry and Technical Polymer Chemistry Laboratory Course	B.Sc. 3	1-2	4

<sup>†</sup> The module will be lectured every other year, next during the academic year 2010-2011.

### Process and Equipment Design

<i>Obligatory studies (11 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ30A0500	Project on Process and Plant Design	M.Sc. 2	1-2	11

The student has to take a suitable amount of elective studies from the module list below to reach the total of 20 ECTS credits required for Minor subject.

<i>Elective studies (at least 9 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BJ20A1100	Filtration and Mixing	M.Sc. 1	3-4	6
BJ20A1901	Advanced Course in Environmental Technology and Unit Operations	M.Sc. 1	3-4,1	6
BJ30A0600	Modelling of Unit Processes	M.Sc. 1	3-4	6
BJ30A0700	Computational Fluid Dynamics in Chemical Engineering	M.Sc. 2	2	6
BJ30A0900	Hazard Identification and Risk Management in Process Industry	M.Sc. 1	1-2	6
BJ30A1100	Process Integration	M.Sc. 1	1-2	6
BJ30A1600	Advanced Process Simulation	M.Sc. 1	3-4	8
BJ40A0000	Creative Design	M.Sc. 1	1	3
BJ40A0100	Product Design	M.Sc. 1	4	5

### D. Elective studies

The student has to take a suitable amount of elective studies to reach the total 120 ECTS credits required for the Master's degree. The student may include any courses taught at LUT, also another minor subject, in his/her Master's degree. Studies in other domestic or foreign higher education institutions can be included in the degree by application; the studies are approved by the Head of Degree Programme. The leadership training provided by the National Defence Forces can be included in the elective studies (6 ECTS cr) provided that these studies are not included in any previous degree.

## MODULES

### Chemical Engineering

<b>BJ10A0001</b>	<b>LABORATORY WORK COURSE IN CHEMICAL TECHNOLOGY</b>	<b>10 - 30 ECTS cr</b>
	<b>Laboratory Work Course in Chemical Technology</b>	
	<b>The course is mainly intended for foreign visiting students. The students register for the course by contacting the supervisor.</b>	
<b>Teacher(s)</b>	N. N.	
<b>Aims</b>	Person in Charge: Head of the Laboratory Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>Carry out independently a small research project (the contents of the module varies substantially)</li> </ul>	
<b>Content</b>	A specific project which is done in one of the laboratories of the department. The project is planned together with the supervisor(s) and consists mainly of laboratory work, literature work and report writing. The course may contain lectures and seminars. The project may also be planned together with industry and then carried out at some industrial location.	
<b>Modes of Study</b>	The amount of work hours in the project will determine the amount of credits, e.g. three months of work would give 15 ECTS cr. Credits will be granted when the final report is delivered. Extra credits can be received if specific examinations are made.	

<b>Evaluation</b>	0-5 or pass/fail, depending on the project carried out.
<b>Study materials</b>	Literature related to the project.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ10A0101</b>	<b>BACHELOR'S THESIS AND SEMINAR</b>	<b>10 ECTS cr</b>
	<b>Kandidaatintyö ja seminaari</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-4	
<b>Teacher(s)</b>	Lecturers of the major subjects.	
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>• define a small-scale research problem or design task</li> <li>• select appropriate methods for a small-scale research problem or design task in the field</li> <li>• can find and use critically data, information and knowledge in the field</li> <li>• apply his/her chemical engineering knowledge to solve a small research problem or carry out a design task</li> <li>• report the results orally</li> <li>• write a report from the task</li> </ul>	
<b>Content</b>	The Bachelor's thesis is a concise research or planning project. It is related to a course in the student's major subject. Students must demonstrate the ability to handle the topic of the thesis independently and following instructions. The project is supervised and evaluated by the teacher of the course in question. The thesis is connected to a seminar.	
<b>Modes of Study</b>	Students complete the research project and prepare a concise report. The report is briefly presented in the seminar to other students and the lecturer, who then poses questions on the presentation to the entire group. The seminar is organised once a month.	
<b>Evaluation</b>	0-5, Bachelor's thesis. The seminar may raise or lower the grade by one point.	

<b>BJ10A0201</b>	<b>MASTER'S THESIS AND SEMINAR</b>	<b>30 ECTS cr</b>
	<b>Diplomityö ja seminaari</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 2, Period 1-4	
<b>Teacher(s)</b>	Professor of the major subject.	
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>• define a restricted research problem or design task</li> <li>• select appropriate methods for a restricted research problem or design task in the field</li> <li>• can find and use critically data, information and knowledge in the field, and estimate their reliability</li> <li>• apply his/her chemical engineering knowledge to solve a restricted research problem or carry out a design task</li> <li>• apply his creativity to find new solutions or in best case to generate new technology</li> <li>• report the results orally and participate in a scientific discussion</li> <li>• write a report from the task according to scientific principles</li> </ul>	
<b>Content</b>	The thesis is a research or planning project. Students must demonstrate the ability to complete the project independently and following a plan. A report is prepared following the instructions for the Master's thesis.	
<b>Modes of Study</b>	The thesis is connected to a seminar with other thesis students and their instructors. Each student gives a brief presentation on the results of his/her project. The presentations are then discussed, and teachers pose questions on them to the entire group.	
<b>Evaluation</b>	0-5, Master's thesis 100%.	

<b>BJ10A0400</b>	<b>PROCESS CONTROL SYSTEMS IN PULP AND PAPER INDUSTRY</b>	<b>3 ECTS cr</b>
	<b>Process Control Systems in Pulp and Paper Industry</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 2, Period 1-2	

<b>Teacher(s)</b>	Lic.Sc. (Tech.) Merja Mäkelä Professor, Ph.D. Andrzej Kraslawski (contact person)
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>• interpret the documents describing process control, measurement and automation</li> <li>• describe the basic principles and methods in process control, measurement and automation</li> <li>• define the control and measurement needs of a process</li> </ul>
<b>Content</b>	Processes and instrumentation. Need of measurements, open loop and closed loop control. Distributed control systems, programmable logic controllers and open control networks. Communication from process sensors, transmitters and actuators to control rooms. Process plant visualization and control room operation. System configuration, engineering and documentation. Single-input, single-output and multiple-input, multiple-output control strategies. Use of PID, fuzzy logic, model predictive and optimization control principles. Paper and board quality online measurement and control. Automation in original and renewal plant investment projects. Maintenance and innovative development in automation.
<b>Modes of Study</b>	Lectures 16 h, 1st period. Lectures 12 h, 2nd period. Individual or team project work with supervision 12 h, 2nd period.
<b>Evaluation</b>	0-5, written examination 60%, project work 40%.
<b>Study materials</b>	Learning Environment for Papermaking and Automation, KnowPap, Licentia 2004, Espoo Finland. Learning Environment for Chemical Pulping and Automation, KnowPulp, Licentia 2004, Espoo Finland. Matlab-Simulink simulation environment, Process Control, System Identification and Fuzzy Control toolboxes, Mathworks 1984 - 2004. Leiviskä, K., Process control, Book 14, in Papermaking Science and Technology, Fapet, 1999, 297 p., ISBN 952-5216-00-4. Sell, Nancy J., Process Control Fundamentals for the Pulp and Paper Industry, Tappi, 1995, Atlanta, USA, 612 p., ISBN 0-89852-294-3.
<b>Further Information</b>	Blackboard. This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ10A0500</b>	<b>CROSS-CULTURAL COMMUNICATION FOR WORKING LIFE</b> 2 ECTS cr
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3
<b>Teacher(s)</b>	M.Sc. (Tech.) Mark Middleton Professor, Ph.D. Andrzej Kraslawski (contact person)
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>• communicate and work in an international project or team</li> </ul>
<b>Content</b>	Information exchange and understanding the viewpoints of parties involved. Effective communication, how to understand attitudes, values and danger areas. Cultural aspects and linguistic tools for goal-oriented communication. Project management, negotiations, presentations and resolution of dispute situations.
<b>Modes of Study</b>	Intensive course. Lectures 16 h, exercises 16 h, 3rd period. No examination. The number of participants is limited. Priority is given to the students of the Master's Degree Programme in Chemical and Process Engineering (IPPE).
<b>Evaluation</b>	Pass/Fail. Active participation in lectures and exercises.
<b>Study materials</b>	Blackboard.

<b>BJ20A0100</b>	<b>MECHANICAL SEPARATION PROCESSES</b> 4 ECTS cr
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 3-4
<b>Teacher(s)</b>	Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila
<b>Aims</b>	After a module a student can

	<ul style="list-style-type: none"> <li>• list most important methods and equipment used for solid-liquid separation</li> <li>• select a suitable separation method for different kind of suspensions</li> <li>• size preliminary the separation equipment based on the data from laboratory tests</li> <li>• search and use literature valid for the field on separation technology</li> <li>• perform a literature assignment with a seminar presentation</li> </ul>
<b>Content</b>	Settling velocity of a particle in a fluid. Separation by filtration and by sedimentation. Upstream and downstream processes and equipment.
<b>Modes of Study</b>	Lectures and seminars 14 h, exercises 14 h, 3rd period. Lectures and seminars 14 h, exercises 14 h, 4th period. Seminar work 15 h.
<b>Evaluation</b>	Lectures, exercises, seminars, seminar report and individual home assignments.
<b>Study materials</b>	0-5, exam 50%, seminar report 50%. Coulson, J.M., Chemical Engineering, Vol. 1 – 2, 4th ed., Pergamon Press (where applicable). Svarovsky, L., Solid-liquid Separation (where applicable). Blackboard.
<b>Prerequisites</b>	Recommended BJ20A1400 Partikkeliteknikka ja kiintoaineiden käsittely attended.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ20A0200</b>	<b>LABORATORY COURSE OF MECHANICAL PROCESS ENGINEERING</b>	<b>3 ECTS cr</b>
<b>Year and Period</b>	<b>Mekaanisen prosessitekniiikan laboratoriotyöt</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 1-3 Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• describe and explain operation of some equipment from the area of particle treatment and solid-liquid separation based on laboratory experiments</li> <li>• perform a short experimental measurement in a laboratory</li> <li>• write a technical report from the measured results</li> <li>• analyse results</li> </ul>	
<b>Content</b>	Four laboratory assignments in pairs. Reports on the assignments.	
<b>Modes of Study</b>	Lectures 2 h, 1st period. Laboratory work 24 h, 1st–2nd period, reports by the end of the 3rd period. Lectures, laboratory work, reports. The course must be completed within one year. Registration both by WebOodi and on the notice board of the laboratory.	
<b>Evaluation</b>	0-5, graded reports (average) 100%.	
<b>Study materials</b>	Laboratory instructions and lecture material Blackboard.	
<b>Prerequisites</b>	BJ20A1400 Partikkeliteknikka ja kiintoaineiden käsittely and BJ20A0100 Mekaaniset erotusmenetelmät audited.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ20A0301</b>	<b>INTRODUCTION TO PROCESS SIMULATION</b>	<b>5 ECTS cr</b>
<b>Year and Period</b>	<b>Introduction to Process Simulation</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 1-2 Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• explain basics of process simulation</li> <li>• can draw an information (simulation) flowsheet</li> <li>• can choose decision parameters and define iterative streams of the process</li> <li>• explain a basic structure of a process simulator</li> <li>• simulate simple chemical and paper processes with suitable commercial simulators.</li> </ul>	
<b>Content</b>	Theoretical basics of steady state process simulation, calculation of mass and energy balances by using commercial simulators (ASPEN, BALAS).	

<b>Modes of Study</b>	Lectures and exercises 28 h, 1st period. Simulation exercises 21 h, 2nd period. Individual assignments 45 h, 2nd period.
<b>Evaluation</b>	0-5, exam 80%, assignments 20%.
<b>Study materials</b>	Biegler, L.T., Grossmann, I.E., Westerberg, A.W., Systematic Methods of Chemical Process Design, Prentice Hall PTR, 1997 (where applicable). Course notes and other lecture materials. Blackboard.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ20A0700</b>	<b>UNIT OPERATIONS LABORATORY COURSE</b>	<b>4 ECTS cr</b>
<b>Year and Period</b>	Kemian laitetekniikan laboratoriotyöt	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 3-4 Researcher/Teacher, D.Sc. (Tech.) Harri Niemi	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• prepare a measurement plan to fulfill an experimental research plan in the field of mass and heat transfer</li> <li>• operate with laboratory scale mass and heat transfer equipment and estimate the reliability of the measurement data</li> <li>• analyze experimental data, to produce quantitative results and to estimate the reliability of the results</li> <li>• produce a clear technical and scientific written report.</li> </ul>	
<b>Content</b>	To teach students about equipment and experimental research methods in heat and mass transfer operations in the chemical and process industry.	
<b>Modes of Study</b>	Laboratory work 24 h, 3rd–4th period. Written reports on the assignments, reports are graded 0-5. Blackboard support.	
<b>Evaluation</b>	Registration both by WebOodi and on the notice board of the laboratory. 0-5, the final grade of the course is the mean value of the grades of the reports.	
<b>Study materials</b>	Assignment instructions.	
<b>Prerequisites</b>	BJ20A1600 Kemiantekniikan yksikköoperaatiot I and BH20A0300 Lämmönsiirron perusteet attended.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BJ20A0800</b>	<b>TREATMENT PROCESSES OF INDUSTRIAL DISCHARGES</b>	<b>5 ECTS cr</b>
<b>Year and Period</b>	Treatment Processes of Industrial Discharges	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 3-4 Docent, Researcher/Teacher, Ph.D. (Tech.) Sergei Preis	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• list, define and explain the most important methods and equipment used for water, wastewater and air emissions treatment, and solid waste processing and disposal</li> <li>• suggest and evaluate suitable treatment methods and their combinations for solving different kinds of environmental problems</li> <li>• search, summarize and report data extracted from the literature concerning the environmental techniques and technology</li> <li>• size the equipment for settling processes in water treatment</li> <li>• compute and analyze numerical values of water quality parameters</li> </ul>	
<b>Content</b>	The course includes three main parts: basics in water and wastewater treatment, treatment of air polluted with particulate and gaseous matter, and solid waste handling and disposal. Water and wastewater treatment part considers basic methods in water treatment: sedimentation, coagulation/flocculation, filtration, biological treatment, sludge disposal and disinfection. Air treatment part concentrates on dust removal and gaseous pollutant abatement. Solid waste treatment concentrates on the processing techniques: volume reduction, materials recovery, incineration and energy recovery.	

<b>Modes of Study</b>	Lectures and exercises 21 h, 3rd period. Lectures and exercises 21 h, 4th period.
<b>Evaluation</b>	0-5, written examination 100%.
<b>Study materials</b>	Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engineering, McGraw-Hill, 1st ed., 1985.
<b>Prerequisites</b>	Recommended: BJ20A1400 Partikkeliteknikka ja kiintoaineiden käsittely BH40A1400 Virtaustekniikka I BJ20A0100 Mekaaniset erotusmenetelmät BH40A0250 Pumput, puhaltimet ja kompressorit (Kete) BJ20A1600 Kemiantekniikan yksikköoperaatiot I

<b>BJ20A1100</b>	<b>FILTRATION AND MIXING</b>	<b>6 ECTS cr</b>
	<b>Filtration and Mixing</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Antti Häkkinen Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila Docent, D.Sc. (Tech.) Tuomas Koiranen Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen Person in Charge: Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen	
<b>Aims</b>	Filtration part: A student can <ul style="list-style-type: none"> <li>list different methods and equipment used for solid-liquid separation</li> <li>choose and size suitable equipment for separation process based on knowledge of the suspension and data from laboratory tests.</li> <li>explain the effects of characteristics of solid material and liquid to the separation and post treatment process</li> <li>define different filter media used in filters and select preliminary a type of medium for different cases</li> <li>perform an experimental test in a laboratory</li> <li>write a scientific report</li> </ul> Mixing part: A student can <ul style="list-style-type: none"> <li>apply obtained understanding of fluid dynamics and rheology</li> <li>select different mixing device (stirred tanks, static mixers, inline mixers) for a specific application such as blending of liquids and mixing of solids and mixing of multi-phase systems (gas-liquid, liquid-liquid, solid-liquid and gas-solid-liquid systems)</li> <li>size and scale up the basic blending device.</li> <li>model heat transfer of mixing device</li> </ul>	
<b>Content</b>	The topics are as follows: Filtration: fundamentals of filtration, filtration methods, operation of filters, cake formation and washing, deliquoring, design and modeling of filters. Filter medium. Mixing: fundamentals of mixing, rheology, mixing equipment, design of mixers and scale-up.	
<b>Modes of Study</b>	Lectures 18 h, exercises 18 h, filtration laboratory work 20 h, 3rd period. Lectures 9 h, exercises 9 h, mixing case study 21 h, 4th period.	
<b>Evaluation</b>	0-5, written examination 80%, laboratory work and case study work 20%.	
<b>Study materials</b>	Additional material will be informed at lectures. Blackboard.	
<b>Prerequisites</b>	BJ20A0100 Mekaaniset erotusmenetelmät passed.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BJ20A1200</b>	<b>FRESHMAN/STUDENT TUTORING</b>	<b>3 ECTS cr</b>
	<b>Vertaistutorointi</b>	
	<b>The course is intended for student tutors.</b>	
<b>Year and Period</b>	Period 4, 1-2	
<b>Teacher(s)</b>	Part-time Untenured Teacher, M.A. (Educ.) Annikka Nurkka Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila	

<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• describe the operational environment of the university</li> <li>• explain meaning of the methodological planning of one's studies</li> <li>• improve student's group tutoring and communication skills in problematic or unexpected situations</li> </ul>
<b>Content</b>	Understanding the importance of tutoring, small group tutoring and communication skills. Acquainting new students to the university, studying and student community as well as the tools needed for studying.
<b>Modes of Study</b>	Applicants send a free application form to student advisers/counsellors. Tutors are selected in February. Approximately 100 students in LUT are selected to be peer tutors. The instruction of tutors begins in spring and continues until the new students arrive in autumn. Training includes lectures on issues relating to studying, activities on small group tutoring and group dynamics, practicing independent information gathering, online work as well as departmental training on issues related to a particular department.
<b>Evaluation</b>	Small groups led by peer tutors meet ten times in the autumn during the first period. Tutors answer the study module feedback form and write a written report on their experiences of peer tutoring during the second period.
<b>Study materials</b>	Pass/Fail. Course material handed out during the training, guidebook on group tutoring and online material.

<b>BJ20A1300</b>	<b>ENHANCEMENT OF LEARNING IN THE DEGREE PROGRAMME OF CHEMICAL TECHNOLOGY</b>	<b>2 - 3 ECTS cr</b>
	<b>Oppimisen kehittäminen kemiantekniikan koulutusohjelmassa</b>	
	<b>Recommended for the students of study years B.Sc. (Tech.) 1 and 2.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1-2, Period 3	
<b>Teacher(s)</b>	Different lecturers.	
<b>Aims</b>	Person in Charge: Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila After a module a student can <ul style="list-style-type: none"> <li>• describe the university as learning environment</li> <li>• define quality assurance of teaching and learning</li> <li>• use different learning styles and strategies</li> <li>• improve his/her learning skills</li> </ul>	
<b>Content</b>	Quality assurance in the degree programme. The university as a study environment. An adult as a learner. Different learning styles and strategies. Communication in a learning situation.	
<b>Modes of Study</b>	Lectures and exercises 14 h, 3rd period. Participants are encouraged to attend different seminars and sessions connected to quality assurance work at the department. Learning diary. Producing a poster as group work. The extent of the course is 3 ECTS cr if the student actively participates in the quality assurance work at the department. No examination.	
<b>Evaluation</b>	Pass/Fail (a learning diary and a poster).	
<b>Study materials</b>	Will be delivered during lectures.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BJ20A1400</b>	<b>PARTICLE TECHNOLOGY AND TREATMENT OF PARTICULATE SOLIDS</b>	<b>2 ECTS cr</b>
	<b>Partikkeliteknikka ja kiintoaineiden käsittely</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 2	
<b>Teacher(s)</b>	Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• define size of single particle and describe size distribution of solid material</li> <li>• define and calculate mostly used average sizes from the known size distribution</li> <li>• list mostly used sample handling and analyzing methods</li> </ul>	

	<ul style="list-style-type: none"> <li>• select suitable analyzers for known sample</li> <li>• describe common methods and equipment used for storing, transportation and comminution of solid material</li> <li>• select an equipment which could be used for treatment of different solid materials</li> </ul>
<b>Content</b>	Shape and size of single particle and determining the particle size distribution of solid powder. Determining different average or mean particle sizes from a given particle size distribution. Size reduction, storing, transporting and sampling of solid material.
<b>Modes of Study</b>	Lectures 14 h, exercises 14 h, 2nd period. Lectures, exercises, graded assignments.
<b>Evaluation</b>	0-5, exam or graded home assignments 100%.
<b>Study materials</b>	Coulson, J.M., Chemical Engineering, Vol. 2, 4th ed., Pergamon Press. Holdich, R.G. Fundamentals of Particle Technology, Midland Information Technology and Publishing, 2002. Blackboard.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.

<b>BJ20A1500</b>	<b>INTRODUCTION TO MASS TRANSFER</b>	<b>2 ECTS cr</b>
	<b>Aineensiirtotekniikan perusteet</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 3-4	
<b>Teacher(s)</b>	Researcher/Teacher, D.Sc. (Tech.) Harri Niemi	
<b>Aims</b>	After a module a student can	
	<ul style="list-style-type: none"> <li>• explain equilibrium in mass transfer, and the meaning of diffusivity and mass transfer resistances</li> <li>• estimate mass transfer parameters and mass flux in diffusive and convective mass transfer</li> <li>• list most important methods and equipment used for gas-liquid, gas-solid, liquid-liquid and solid-liquid mass transfer unit operations</li> <li>• explain the fundamentals and operation of equipment in absorption</li> <li>• size the separation equipment for an absorption process</li> <li>• explain the fundamentals of equilibrium stage processes</li> <li>• estimate the required number of ideal stages by using graphical methods</li> </ul>	
<b>Content</b>	To give the basic knowledge of the following topics: fundamentals of mass transfer, phase equilibria, diffusive and convective mass transfer, mass transfer coefficients, absorption. An introduction to equilibrium stage processes, unit operations in separation technology and mass transfer equipment used in these operations.	
<b>Modes of Study</b>	Lectures 8 h, exercises 14 h, 3. period. Lectures 4 h, exercises 10 h, 4. period. Blackboard-support. Lectures, exercises passed, examination. Participating the examination is allowed until the exercises is passed.	
<b>Evaluation</b>	0-5, exam 100%.	
<b>Study materials</b>	McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, 7th ed., McGraw-Hill, 2005 (specified sections). Luentomoniste.	
<b>Prerequisites</b>	BM20A0000 Matematiikka SäEnKeA1 and BM20A0200 Matematiikka SäEnKeA2. Recommended BJ80A1000 Kemiallinen termodynamiikka.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BJ20A1600</b>	<b>CHEMICAL ENGINEERING UNIT OPERATIONS I</b>	<b>4 ECTS cr</b>
	<b>Kemiantekniikan yksikköoperaatiot I</b>	
	<b>The course doesn't replace the course Ke3110400 Kemiantekniikan yksikköoperaatiot I.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-2	
<b>Teacher(s)</b>	Researcher/Teacher, D.Sc. (Tech.) Harri Niemi	

<b>Aims</b>	<p>After a module a student can</p> <ul style="list-style-type: none"> <li>explain the fundamentals and operation of equipment in distillation, extraction, humidification processes, gas and solid drying, adsorption and evaporation</li> <li>select a suitable separation method for different kind of gas-liquid, gas-solid, liquid-liquid and solid-liquid mass transfer problems</li> <li>design plate columns</li> <li>estimate number of ideal stages required for a given separation task</li> <li>utilise the i-x-diagram of humid air for designing humidification or drying equipment and cooling towers</li> <li>estimate drying rate and /or drying time in drying of solid material and select a suitable drying method for a given drying task</li> <li>estimate the required amount of adsorbent in batch adsorption or bed length/operating time of the fixed bed in continuous adsorption for a given separation task</li> <li>size a single-stage evaporator (required heat transfer area, steam consumption, capacity and economy of the evaporator) and select a suitable equipment for a given concentration task</li> <li>utilise numerical computing methods (Matlab) for solving simple design problems of unit operations.</li> </ul>
<b>Content</b>	To give the basic knowledge of the following topics: Equilibrium stage operations in separation technology, distillation, extraction (solid-liquid and liquid-liquid), properties of humid air, humidification, drying of solid material. Fundamentals of evaporation, industrial evaporators. Introduction to the mass transfer simultaneously with chemical reaction.
<b>Modes of Study</b>	Lectures 8 h, exercises 14 h, 1. period. Lectures 8 h, exercises 14 h, 2. period. Individual assignment. Blackboard-support. Lectures, exercises passed, individual assignment (written report graded by "passed/not passed"), examination. Participating the examination is allowed until the exercises are passed.
<b>Evaluation</b>	0-5, exam 100%.
<b>Study materials</b>	McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, 7th ed., McGraw-Hill, 2005 (specified sections). Lecture handouts.
<b>Prerequisites</b>	BM20A0000 Matematiikka SäEnKeA1, BM20A0200 Matematiikka SäEnKeA2, BM20A4301 Johdatus tekniseen laskentaan and BJ80A1000 Kemiallinen termodynamiikka. BJ20A1500 Aineensiirtotekniikan perusteet attended.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ20A1700</b>	<b>INTRODUCTION TO STUDIES OF CHEMICAL TECHNOLOGY</b>	<b>1 ECTS cr</b>
<b>Year and Period</b>	Johdatus kemiantekniikan opiskeluun	
<b>Teacher(s)</b>	B.Sc. (Tech.) 1, Period 1 Various lecturers Person in Charge: Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila Study Coordinator, M.A., B.A. (Educ.) Tarja Nevalainen	
<b>Aims</b>	<p>After a module a student</p> <ul style="list-style-type: none"> <li>has an insight of the chemical technology degree programme and the professional tasks of a M.Sc. (Tech.) in the field of chemistry.</li> <li>is able to plan his/her studies and access an affect of selection of major/minor subject to his/her later studies.</li> <li>can search information needed on the field of chemical technology from the library data basis</li> </ul>	
<b>Content</b>	Brief look at the fields of process engineering. The different professional tasks of a M.Sc. (Tech.). Getting information from different data banks and the Internet (library visit 1 h and Blackboard instruction). The contents of the chemical technology degree programme. Instructions for studies.	
<b>Modes of Study</b>	Obligatory lectures 8 h, 1st period (also in the 3rd period if needed). Visits to the department's laboratories. Planning the personal study plan for the first year. No	

<b>Evaluation</b>	examination. Pass/Fail.	
<b>BJ20A1801</b>	<b>CHEMICAL ENGINEERING UNIT OPERATIONS II</b>	<b>5 ECTS cr</b>
<b>Year and Period</b>	<b>Chemical Engineering Unit Operations II</b>	
<b>Teacher(s)</b>	<b>Replaces the course BJ20A1800 Chemical Engineering Unit Operations IIB.</b>	
<b>Aims</b>	<p>M.Sc. (Tech.) 1, Period 1-2          Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen          Researcher/Teacher, D.Sc. (Tech.) Harri Niemi          Person in Charge: Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen</p> <p>After a module a student can</p> <ul style="list-style-type: none"> <li>explain the fundamentals of multicomponent mass transfer and the differences between binary and multicomponent mass transfer</li> <li>explain the mass transfer phenomena in membrane separation processes</li> <li>list and describe the operation of the most important equipment and membrane types used for industrial membrane processes</li> <li>estimate the number of required membrane modules for a given separation task by utilizing mass transfer modeling and process simulation</li> <li>explain the fundamentals of industrial crystallization (kinetics, solid-liquid equilibrium, population density, crystal size distributions, polymorphism, solvate and hydrate formation, mass transfer in crystallization and dissolution)</li> <li>list and describe the operation of the most important industrial crystallizers</li> <li>estimate preliminary size of a simple MSMPR crystallizer</li> </ul>	
<b>Content</b>	<p>The topics are as follows:</p> <ol style="list-style-type: none"> <li>Multicomponent mass transfer: differences between mass transfer in binary and multicomponent systems, basic theory and examples in evaporation, distillation, desorption, membrane separation, heterogeneous reaction, etc.</li> <li>Membrane separation: Mass transfer, modelling, process design, simulation of industrial membrane processes.</li> <li>Industrial crystallization: theory, operation and design of crystallizers. Mass transfer of dissolution.</li> </ol>	
<b>Modes of Study</b>	Lectures 18 h, exercises 42 h, laboratory work, Matlab case study, 1st-2nd period.	
<b>Evaluation</b>	0-5, exam 80%, assignments 20%.	
<b>Study materials</b>	Davey, R. J., Garside, J., From Molecules to Crystallizers, Oxford, Oxford University Press, 2000.	
<b>Prerequisites</b>	Lecture notes. BJ20A1600 Kemianteekniikan yksikköoperaatiot I and BJ80A1000 Kemiallinen termodynamiikka passed.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	
<b>BJ20A1901</b>	<b>ADVANCED COURSE IN ENVIRONMENTAL TECHNOLOGY AND UNIT OPERATIONS</b>	<b>6 ECTS cr</b>
<b>Year and Period</b>	<b>Advanced Course in Environmental Technology and Unit Operations</b>	
<b>Teacher(s)</b>	<b>Replaces the course BJ20A1900 Advanced Course in Environmental Technology and Unit Operations.</b>	
<b>Aims</b>	<p>M.Sc. (Tech.) 1, Period 3-4,1          Docent, Researcher/Teacher, Ph.D.(Tech.) Sergei Preis          Professor, D.Sc. (Tech.) Antti Häkkinen          Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen          Researcher/Teacher, D.Sc. (Tech.) Harri Niemi          Researcher/Teacher, D.Sc. (Tech.) Ritva Tuunila          Person in Charge: Professor, D.Sc. (Tech.) Marjatta Louhi-Kultanen</p> <p>After a module a student can</p> <ul style="list-style-type: none"> <li>select sustainable unit operations</li> </ul>	

	<ul style="list-style-type: none"> <li>select appropriate water treatment methods for challenging pollutants among Advanced Oxidation Processes</li> <li>select sustainable chemicals (reactants, solvents) and processes to avoid chemical and energy losses, and to minimize emissions</li> <li>explain the concept and the application of the product and process life cycle analysis</li> <li>search and use the literature valid for the field on selected topics on separation and environmental technology</li> <li>produce a clear technical and scientific written report</li> <li>present research results in front of audience clearly and compactly</li> <li>make constructive peer assessment (acting as an opponent in seminar, reviewing the reports of other students)</li> </ul>
<b>Content</b>	Green Chemistry in technology and in treatment of industrial and municipal wastes. Case studies of various unit operations and green chemistry applications.
<b>Modes of Study</b>	Lectures 12 h, 3rd period. Seminars 16 h, 4th period.
<b>Evaluation</b>	Literature review or experimental/simulation work, report and seminar presentation. The student has to attend 80% of seminar presentations.
<b>Study materials</b>	0-5, exam 30%, assignments 70%.
<b>Further Information</b>	Lecture notes. This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ30A0302</b>	<b>PROCESS AND PLANT DESIGN</b>	<b>7 ECTS cr</b>
	<b>Prosessi- ja tehdassuunnittelu</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-2	
<b>Teacher(s)</b>	Assistant, D.Sc. (Tech.) Terhi Virkki-Hatakka Person in Charge: Professor, D.Sc. (Tech.) Ilkka Turunen	
<b>Aims</b>	Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>list the conventional stages of a process or plant design project</li> <li>explain the nature and most conventional methods of process and plant design</li> <li>interpret the usual documents of process design (process diagrams, equipment specifications, drawings and Isits)</li> <li>carry out simple design calculations, especially material and energy balances</li> <li>evaluate preliminary investment and operation costs of the process as well as carry out profitability estimation.</li> </ul>	
<b>Content</b>	Initial data for design. The nature and methodology of process design. Process synthesis and process analysis. Process integration. Equipment design. Plant lay-out. Cost estimation. Profitability estimation. Projects and scheduling. Procurement, installation and start-up. Plant operation, maintenance and further development.	
<b>Modes of Study</b>	Lectures 6 h, exercises 6 h, 1st period. Lectures 14 h, exercises 14 h, 2nd period. Homework.	
<b>Evaluation</b>	0-5, examination 100%.	
<b>Study materials</b>	Coulson, J.M. et. al., Chemical Engineering, Vol. 6 (specified sections). Blackboard.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ30A0400</b>	<b>SEMINAR ON PROCESS DESIGN</b>	<b>4 ECTS cr</b>
	<b>Prosessisuunnittelun seminaari</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 3-4	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Ilkka Turunen Associate Professor, D.Sc. (Tech.) Eero Kolehmainen	
<b>Aims</b>		
<b>Content</b>		
<b>Modes of Study</b>	Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>participate in a preliminary process design project</li> <li>carry out preliminary process synthesis leading to process flow diagram</li> </ul>	

	<ul style="list-style-type: none"> <li>• carry out preliminary process analysis leading to material and energy balances</li> <li>• apply his chemical engineering knowledge to equipment design</li> <li>• perform a cost and profitability evaluation of a process</li> </ul>
<b>Evaluation</b>	The course consists of lectures and seminars. In the latter, students present the results of their design, and the related problems are discussed together. Both the lectures and seminars are related to the chosen project.
<b>Study materials</b>	Blackboard.
<b>Prerequisites</b>	BJ30A0302 Prosessi- ja tehdassuunnittelu attended.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ30A0500</b>	<b>PROJECT ON PROCESS AND PLANT DESIGN</b>	<b>11 ECTS cr</b>
	<b>Project on Process and Plant Design</b>	
	<b>HUOM! Suomenkielisille työryhmille opintojakso opetetaan suomeksi.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 2, Period 1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Ilkka Turunen	
<b>Aims</b>	Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>• apply his chemical engineering knowledge to real industrial process design project</li> <li>• perform technical and economical design calculations</li> <li>• solve real design problems sometimes starting from limited and incomplete initial information</li> <li>• seek and create novel solutions to design problems</li> </ul>	
<b>Content</b>	The projects are carried out in groups of five students. The topics are from industry. A typical topic is a feasibility study of a process covering a brief market survey, comparison of process alternatives, preliminary process design (process flowsheet, mass and energy balances, sizing of main equipment), lay-out, cost and profitability estimation. Different aspects are emphasized in different projects, depending on the topic. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures 5 h, project meetings, 1st period. Lectures 5 h, project meetings, 2nd period. Design and project work about 280 h, 1st-2nd period. No examination.	
<b>Evaluation</b>	0-5, design reports 100%.	
<b>Prerequisites</b>	BJ30A0302 Prosessi- ja tehdassuunnittelu passed.	
<b>Further Information</b>	Recommended BJ30A0400 Prosessisuunnittelun seminaari. This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BJ30A0600</b>	<b>MODELLING OF UNIT PROCESSES</b>	<b>6 ECTS cr</b>
	<b>Yksikköprosessien mallinnus</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4	
<b>Teacher(s)</b>	Professor, Ph.D. Heikki Haario	
<b>Aims</b>	Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>• describe process phenomena with mathematical models</li> <li>• validate the models and estimate models parameters from experimental results</li> <li>• apply mechanistic models in different tasks of process development and design such as design, simulation, optimization and scale-up)</li> <li>• use adequate software for these tasks</li> </ul>	
<b>Content</b>	Mechanical models as research and design tools. Models in the various stages of a process lifespan. Test design. The estimation of parameters. Simulation. Optimisation. Scale-up. An introduction to the software in the field. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures and seminars 21 h, 3rd period. Lectures and seminars 21 h, personal assignment, 4th period. No examination.	
<b>Evaluation</b>	Pass/Fail.	

<b>Study materials</b>	Lecture notes.
<b>Prerequisites</b>	Recommended: BM20A0000 Matematiikka SäEnKeA1 BM20A0200 Matematiikka SäEnKeA2 BM20A0400 Matematiikka SäEnKeB1 BM20A0600 Matematiikka SäEnKeB2 BM20A0800 Matematiikka SäEnKeB3
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ30A0700</b>	<b>COMPUTATIONAL FLUID DYNAMICS IN CHEMICAL ENGINEERING</b>	<b>6 ECTS cr</b>
<b>Year and Period</b>	<b>Computational Fluid Dynamics in Chemical Engineering</b>	
<b>Teacher(s)</b>	M.Sc. (Tech.) 2, Period 1	
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Ilkka Turunen Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>• understand theoretical basis of computational fluid dynamics</li> <li>• use CFX-software in computational fluid dynamics</li> <li>• identify the most potential application areas of computational fluid dynamics in chemical engineering</li> <li>• apply computational fluid dynamics to some chemical engineering problems e.g. in equipment design or trouble shooting</li> </ul>	
<b>Content</b>	Theoretical basis of CFD. Introduction of CFX software. Applications of CFD in process industry. Solving chemical engineering problems with CFD.	
<b>Modes of Study</b>	Lectures 28 h, 1st period.	
<b>Evaluation</b>	Exercises with CFD software 120 h, 2nd period. Seminar presentation. No examination. 0-5, seminar presentation 70%, exercise report 30%. At least 90% presence at lectures required.	
<b>Study materials</b>	To be announced later. Blackboard.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BJ30A0900</b>	<b>HAZARD IDENTIFICATION AND RISK MANAGEMENT IN PROCESS INDUSTRY</b>	<b>6 ECTS cr</b>
	<b>Prosessien vaarojen tunnistaminen ja riskien hallinta</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Professor (VTT), D.Sc. (Tech.) Raija Koivisto M.Sc. (Tech.) Seppo Koskinen	
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Ilkka Turunen Upon completion of the module, the student will be able to	
	<ul style="list-style-type: none"> <li>• recognize the safety risks in industrial processes</li> <li>• describe the basic principles of safety risk management</li> <li>• apply some methods of risk management</li> </ul>	
<b>Content</b>	The risk management process. Hazard identification of processes. Risk management methods and means. Safety-conscious design. A case study on the detailed solution of a broad, real safety problem.	
<b>Modes of Study</b>	32 h of lectures as an intensive course. Seminar presentations. Solution of a broad safety problem in a team of three students, about 100 h, periods 1 and 2.	
<b>Evaluation</b>	0-5, written examination 80%, seminar presentations and case study 20%.	
<b>Study materials</b>	Will be given during the lectures.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ30A1100</b>	<b>PROCESS INTEGRATION</b>	<b>6 ECTS cr</b>
	<b>Prosessi-integraatio</b>	

<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2
<b>Teacher(s)</b>	D.Sc. (Tech.) Jarmo Söderman
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Ilkka Turunen Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>• synthesise processes from subprocesses</li> <li>• describe the methodology of process synthesis</li> <li>• apply methods of process analysis and optimization, especially taking into account energy questions</li> <li>• analyze processes on the basis of technical thermodynamics</li> <li>• take into account the recovery and efficient use of energy in process design</li> </ul>
<b>Content</b>	The course deals with the formation of an entire process from subprocesses and presents the analysis and optimisation possibilities that can be used for this purpose. Special emphasis is on thermodynamics and the recovery and exploitation of energy in the design of an entire process.
<b>Modes of Study</b>	Lectures 28 h as an intensive course, exercises 14 h, 1st period. Exercises 14 h, 2nd period. Assignment 80 h, 1st-2nd period.
<b>Evaluation</b>	Lectures, exercises and assignments.
<b>Prerequisites</b>	0-5, examination 100%, assignments passed. Four of the following courses passed: BH40A1400 Virtaustekniikka I BH40A0250 Pumput, puhaltimet ja kompressorit (Kete) BJ20A0100 Mekaaniset erotusmenetelmät BJ20A1400 Partikkeliteknikka ja kiintoaineiden käsittely BJ80A1000 Kemiällinen termodynamiikka
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ30A1401</b>	<b>PROCESS AND PRODUCT INNOVATIONS</b>	<b>10 ECTS cr</b>
	<b>Process and Product Innovations</b>	
	<b>Mainly for Finnish and international students from the departments of Chemical Technology, Mechanical Engineering, Electrical Engineering and Industrial Engineering and Management. The number of participants is limited and the applicants will be interviewed.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 1-4	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Tuomo Kässi Associate Professor, D.Sc. (Tech.) Ville Ojanen Associate Professor, D.Sc. (Tech.) Kimmo Kerkkänen	
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Ilkka Turunen Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>• explain typical methods, problems and their solution in the generation of innovations an novel technology</li> <li>• carry out interdisciplinary teamwork in international environment</li> <li>• apply typical methods of process and product development</li> </ul>	
<b>Content</b>	Methods of product and process development. Interdisciplinary R & D activities as project and teamwork. Development of new technology, patenting. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Informational lectures, 6 h/period. Project meetings, 6 h/period. Independent project and teamwork in groups of 4-8 students.	
<b>Evaluation</b>	0-5, project work 100%.	
<b>Study materials</b>	Blackboard.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ30A1600</b>	<b>ADVANCED PROCESS SIMULATION</b>	<b>8 ECTS cr</b>
	<b>Advanced Process Simulation</b>	

<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4
<b>Teacher(s)</b>	Senior Assistant, D.Sc. (Tech.) Yury Avramenko Person in Charge: Professor, Ph.D. Andrzej Kraslawski
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>represent the process flowsheet in digital form based on textual process description or printed flow diagram.</li> <li>draw the process diagrams using available widely used software like MS Visio.</li> <li>work with simulation software: mainly BALAS and ASPEN Plus – however, the skills can be applied for other simulation software.</li> <li>translate the real process unit operations to model blocks of simulation software with adjustment of important parameters..</li> <li>carry out teamwork during fulfillment of complex computational projects.</li> </ul>
<b>Content</b>	Introduction to process modeling and process simulation. Levels of process representation and reading process diagrams. Overview of existing simulation software. Practice in use of ASPEN and BALAS-software. Examples of simulation cases for process development, design, retrofit and optimisation of flowsheets. Suitable also for postgraduate studies.
<b>Modes of Study</b>	Lectures and exercises 42 h, 3rd-4th period. Project work 120 h.
<b>Evaluation</b>	0-5, project 60%, class work 40%.
<b>Study materials</b>	Lecture notes, BALAS and ASPEN Plus manuals.
<b>Prerequisites</b>	BJ20A0301 Introduction to Process Simulation
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ40A0000</b>	<b>CREATIVE DESIGN</b>	<b>3 ECTS cr</b>
	<b>Creative Design</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1	
<b>Teacher(s)</b>	Professor, Ph.D. Andrzej Kraslawski	
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>describe the types of innovation</li> <li>explain the concept and models of creativity</li> <li>apply several creativity techniques to real problems</li> </ul>	
<b>Content</b>	Types of innovation. Product, process, service innovation. Innovations in process engineering. Models of creativity. Enhancement of creativity (brainstorming, synectics, morphological analysis, case-based reasoning, quality function deployment, TRIZ).	
<b>Modes of Study</b>	Lectures and exercises 56 h, 1st period.	
<b>Evaluation</b>	0-5, written examination 50%, exercises and presence at the lectures 50%.	
<b>Study materials</b>	Lecture notes.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ40A0100</b>	<b>PRODUCT DESIGN</b>	<b>5 ECTS cr</b>
	<b>Product Design</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 4	
<b>Teacher(s)</b>	Professor, Ph.D. Andrzej Kraslawski	
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>describe different product types</li> <li>explain stages and methods of product development</li> <li>carry out computer-aided product design</li> </ul>	
<b>Content</b>	Types of products. Identification of consumer needs. Product functional and physical-chemical properties. High-throughput experiments. Knowledge-based systems for product design. Computer-aided product design.	
<b>Modes of Study</b>	Lectures 15 h, exercises 20 h, 4th period.	
<b>Evaluation</b>	0-5, written examination 50%, exercises and presence at the lectures 50%.	
<b>Study materials</b>	Lecture notes.	

<b>BJ40A0300</b>	<b>MANAGEMENT OF TECHNICAL INFORMATION IN EXPORT OF PROCESSING EQUIPMENT TO RUSSIAN FEDERATION</b>	<b>5 ECTS cr</b>
<b>Year and Period</b>	Management of Technical Information in Export of Processing Equipment to Russian Federation	
<b>Teacher(s)</b>	M.Sc. (Tech.) 1, Period 4 Professor, Ph.D. Andrzej Kraslawski N.N. (St. Petersburg State Mining Institute) N.N. (St. Petersburg Plant Polymers University) Person in Charge: Professor, Ph.D. Andrzej Kraslawski	
<b>Aims</b>	Upon completion of the module, the student will be able to <ul style="list-style-type: none"> <li>explain technical and organizational aspects of exporting processes and equipment to Russian Federation</li> </ul>	
<b>Content</b>	Technical documentation needed for export of basic processing equipment to Russian Federation (safety, environment, technical norms, role of climatic regions). Differences between the European and Russian norms and standards for the processing equipment. Flow of documents between the EU companies and Russian institutions (e.g. Rostekhnadzor) and certification organizations. Examples of exporting the processing equipment for chemical, mineral and pulp & paper industry.	
<b>Modes of Study</b>	Intensive course. Lectures 28 h, exercises 28 h, 4th period. Several projects. No examination.	
<b>Evaluation</b>	0-5, active participation in lectures and exercises. Successful project works.	
<b>Study materials</b>	Lecture notes.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BJ50A0001</b>	<b>MEMBRANE TECHNOLOGY</b>	<b>4 ECTS cr</b>
	<b>Membranitekniiikka</b>	
	<b>Replaces the course BK50A0000 Kalvotekniikka.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Mika Mänttari Researcher/Teacher, D.Sc. (Tech.) Arto Pihlajamäki Postdoctoral Researcher, D.Sc. (Tech.) Mari Kallioinen	
<b>Aims</b>	At the end of the course a student is expected to know how to: <ul style="list-style-type: none"> <li>explain the basic terms and membrane processes</li> <li>interpret observed phenomena in the separation process and their influence to the separation process</li> <li>compare the feasibility of membrane materials, modules and manufacturing processes</li> <li>choose the most appropriate membrane and membrane process for a separation process</li> <li>identify the benefits and limits of membrane processes</li> </ul>	
<b>Content</b>	Membrane processes (micro-, ultra- and nanofiltration, reverse osmosis, pervaporation, etc.). Manufacturing membranes, membrane materials and structures Phenomena in membrane processes (fouling, concentration polarisation, etc.). Modules. Separation mechanisms. Characterisation of membranes. Applications.	
<b>Modes of Study</b>	Lectures and seminars 14 h, 1st period. Lectures and seminars 14 h, 2nd period. Laboratory work 14 h, 2nd period. Blackboard-support.	
<b>Evaluation</b>	Lectures, obligatory seminars and laboratory work, exam.	
<b>Study materials</b>	0-5, examination 70%, seminar and laboratory work 30%. Mulder, M., Basic Principles of Membrane Technology, 2nd ed., Kluwer, 1996/2003 (where applicable). Handouts.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for	

	open university instruction.	
<b>BJ50A0101</b>	<b>TECHNICAL POLYMER CHEMISTRY</b>	<b>3 ECTS cr</b>
<b>Year and Period</b>	<b>Teknillinen polymeerikemia</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 2, Period 3-4 Researcher/Teacher, D.Sc. (Tech.) Arto Pihlajamäki Professor, D.Sc. (Tech.) Mika Mänttari Postdoctoral Researcher, D.Sc. (Tech.) Mari Kallioinen Visiting lecturers	
<b>Aims</b>	At the end of the course a student is expected to know how to: <ul style="list-style-type: none"> <li>• name the preparation reactions of the most important thermosets and thermoplastic polymers</li> <li>• explain the properties of different polymers and their differences</li> <li>• explain the ways to modify polymer properties</li> <li>• explain and compare the manufacturing processes of different plastic products</li> </ul>	
<b>Content</b>	Producing plastic polymers, modification (polymer solutions and mixtures, copolymerization, reactions, fractionation), manufacturing of polymer products (plastic technology, rubber technology, rheology). Special subjects (e.g., polymers as separation media, coatings (wood, cardboard, paper) and composite materials (wood-polymer-composites). Special polymers (e.g. electronics, medical science, etc.).	
<b>Modes of Study</b>	Lectures will be organised partly as webcourse (Blackboard). Guest lectures as normal lectures.	
<b>Evaluation</b>	0-5, examination 100 %. Possible extrapoints from Blackboard-assessments.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BJ50A0200</b>	<b>NATURAL POLYMERS</b>	<b>4 ECTS cr</b>
<b>Year and Period</b>	<b>Luonnon polymeerit</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 2-4 Professor, D.Sc. (Tech.) Mika Mänttari	
<b>Aims</b>	At the end of the course a student is expected to know how to: <ul style="list-style-type: none"> <li>• explain the wood structure and its functions</li> <li>• explain properties of wood compounds and their meanings in wood refining</li> <li>• explain physical and chemical behavior of natural polymers</li> <li>• explain how natural polymers can be exploited.</li> </ul>	
<b>Content</b>	WooWood chemistry. Natural polymers, their properties and exploitation via downstream operation. The chemical and physical behaviour of different polymer groups. New trends in polymer chemistry. Natural polymers in biorefinery.	
<b>Modes of Study</b>	Introductory lectures (obligatory) 3 h, 2nd period. Lectures and seminars 18 h, 3rd period. Lectures and seminars 21 h, 4th period. Lectures and seminars (50% obligatory). Industrial visits when possible.	
<b>Evaluation</b>	0-5, written examination 70%, seminars 30%.	
<b>Study materials</b>	Blackboard.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	
<b>BJ50A0400</b>	<b>ADVANCED COURSE IN MEMBRANE TECHNOLOGY AND TECHNICAL POLYMER CHEMISTRY</b>	<b>10 ECTS cr</b>
	<b>Membranitekniikan ja teknillisen polymeerikemian syventävä opintojakso</b>	
	<b>The course will be given in English if required.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 2, Period 1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Mika Mänttari	

<b>Aims</b>	<p>Researcher/Teacher, D.Sc. (Tech.) Arto Pihlajamäki          Postdoctoral Researcher, D.Sc. (Tech.) Mari Kallioinen          At the end of the course a student is expected to know in the project-like research work how to:</p> <ul style="list-style-type: none"> <li>• draw up a research plan for the assigned topic</li> <li>• perform high quality measurements</li> <li>• interpret results and draw conclusions based on them</li> <li>• report in writing and orally.</li> </ul>
<b>Content</b>	Membrane processes and their special characters, optimization and characterization of materials. Exploitation of polymeric materials. Yearly changing project subjects.
<b>Modes of Study</b>	Lectures, seminars and personal guidance 8 h, 1st period. Lectures, seminars and personal guidance 8 h, 2nd period. Personal research project 165 h laboratory work and reporting, 1st–2nd period. Lectures, laboratory work, seminar lectures and possibly a test. Obligatory seminars.
<b>Evaluation</b>	Enrolling to the course using the WebOodi but also in the laboratory's noticeboard preferably on preceding spring. 0-5, personal laboratory research work 25%, seminars 75%.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b><i>BJ60A001</i></b>	<b><i>INTRODUCTION COURSE IN PAPER TECHNOLOGY</i></b>	<b><i>5 ECTS cr</i></b>
<b>Year and Period</b>	<b>Paperitekniiikan perusteet</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 1-2 Professor, D.Sc. (Tech.) Isko Kajanto Assistant, M.Sc. (Tech.) Mika Pulkkinen D. Sc. (Tech.) Päivi Rousu	
<b>Aims</b>	After a module a student can	
	<ul style="list-style-type: none"> <li>• describe papermaking processes and the basics of paper technology.</li> <li>• explain the connection between papermaking theory and practice</li> <li>• define paper and paperboard properties</li> <li>• define paper and paperboard grades</li> </ul>	
<b>Content</b>	Basics of paper technology: papermaking fibres, their composition, structure and interaction with water. Filtration of fibre suspension and flow properties. Properties of paper web. Introduction to fibre physics and paper physics. Characterisation of printing papers and packaging papers and paperboards. Properties of paper and paperboard Papermaking technology: Overview of papermaking. An example of modern paper machine line. Control, quality and economical management of processes. Environmental aspects of papermaking.	
<b>Modes of Study</b>	Lectures 28 h, 1st period. Lectures and seminars 28 h, 2nd period. Support on a web-based learning environment platform (Noppa). Seminar assignment, possible excursions. Two intermediate exams or final exam.	
<b>Evaluation</b>	0-5, grade consists of examination, seminar work and making of home work.	
<b>Study materials</b>	Lectures and material in the web. Blackboard. KnowPap-database. Hägglom-Ahnger, U. & Komulainen, P.: Kemiallinen metsäteollisuus 2: Paperin ja kartongin valmistus. 5. painos. Opetushallitus, Jyväskylä 2006. Gullichsen, J., Paulapuro, H. (eds): Book 18: Paper and Board Grades, Papermaking Science and Technology, Fapet Oy.	
<b>Further Information</b>	Other literature announced at lectures. This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b><i>BJ60A0501</i></b>	<b><i>PAPER CHEMISTRY, LABORATORY COURSE</i></b>	<b><i>4 ECTS cr</i></b>
	<b>Paperikemian laboratoriotyöt</b>	

<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4
<b>Teacher(s)</b>	University Lecturer, Lic.Sc. (Tech.) Kati Turku
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Isko Kajanto After a module a student can <ul style="list-style-type: none"> <li>• use basic research methods used in paper chemistry</li> <li>• plan and carry out a small-scale research project</li> <li>• prepare a scientific report.</li> </ul>
<b>Content</b>	Retention, the chemistry of circulation water, internal sizing, use of fillers. An independent, experimental research assignment in pairs.
<b>Modes of Study</b>	Ca. 70 hours planning and laboratory work, 3rd–4th period. Oral presentation about the plan design and results of the experimental study. Final report of the laboratory work. Support on a web-based learning environment platform (Blackboard). Registration required on both WebOodi and the bulletin board of the Laboratory of Paper Technology.
<b>Evaluation</b>	0-5, consists of the performing of the laboratory work and the final report.
<b>Study materials</b>	Course material on Blackboard. Handouts.
<b>Prerequisites</b>	BJ60A0800 Kuitu- ja paperitekniiikan laboratoriotyöt passed and BJ60A1200 Rainanmuodostus ja määränpään kemia attended.

<b>BJ60A0800</b>	<b>FIBRE AND PAPER TECHNOLOGY, LABORATORY COURSE</b>	<b>5 ECTS cr</b>
	<b>Kuitu- ja paperitekniiikan laboratoriotyöt</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-2	
<b>Teacher(s)</b>	University Lecturer, Lic.Sc. (Tech.) Kati Turku Assistant, M.Sc. (Tech.) Mika Pulkkinen	
<b>Aims</b>	Person in Charge: University Lecturer, Lic.Sc. (Tech.) Kati Turku After a module a student can <ul style="list-style-type: none"> <li>• list typical pulp and paper laboratory equipment and methods</li> <li>• explain connection between theories and practice</li> <li>• plan a small scale laboratory study</li> <li>• write a report based on the laboratory study</li> </ul>	
<b>Content</b>	Pulp processing and analyzing. Sheet making and laboratory analysis. Laboratory work in pairs.	
<b>Modes of Study</b>	Laboratory work 50 h, 1st period. Laboratory work 50 h, 2nd period. Reports and learning diary.	
<b>Evaluation</b>	Pass-Fail	
<b>Study materials</b>	Web material. Material in Noppa/Blackboard. Aaltonen, P., Kuituraaka-aineen ja paperin testausmenetelmiä, 492 Otakustantamo. Kurssimoniste: Turku, K. LUT:n paperitekniiikan laboratorion massa- ja arkkitestausohjeita, 2008.	
<b>Prerequisites</b>	BJ60A0001 Paperitekniiikan perusteet attended.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ60A0900</b>	<b>FIBRE AND PAPER MANUFACTURE</b>	<b>5 ECTS cr</b>
	<b>Kuidun ja paperin valmistus</b>	
	<b>Replaces the course BJ60A0201 Paperin valmistus.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 3-4	
<b>Teacher(s)</b>	Professor, N. N. Assistant, M.Sc. (Tech.) Mika Pulkkinen	
	Person in Charge: Professor, N. N.	

<b>Aims</b>	After a modudule a student can <ul style="list-style-type: none"> <li>• define mechanical, chemical and recycled pulp manufacturing,</li> <li>• define paper and board manufacturing techniques and equipment</li> </ul>
<b>Content</b>	Wood and fibre structure and properties. Wood species. Manufacturing of mechanical and chemical pulp. Pulp washing, bleaching and screening. Chemical recovery. Recycled pulp. Unit operations of papermaking. Papermaking equipment. Controls.
<b>Modes of Study</b>	Lectures, exercises and seminars, 28 h, 3rd period. Lectures, exercises and seminars, 28 h, 4th period. Noppa-portal material.
<b>Evaluation</b>	Intermediate tests or final exam.
<b>Study materials</b>	0-5, grade consists of quick exam. Lectures and course's web material. Blackboard. KnowPap-database. Häggbloom - Ahnger, U. & Komulainen P.: Kemiallinen metsäteollisuus 2: Paperin ja kartongin valmistus, Opetushallitus, Jyväskylä 2006. Seppälä, M. (toim): Kemiallinen metsäteollisuus 1: Paperimassan valmistus, 2.-3. painos, Opetushallitus, Saarijärvi 2005. Luennoilla ilmoitettava muu kirjallisuus. Additional reading: Gullichsen, J., Paulapuro, H. (eds): Papermaking Science and Technology, Fapet Oy, vol. 5 (1999), vol. 6 part 1 (2008), vol. 6 part 2 (2008) vol. 7 (2000), vol. 8 (2007), vol. 9 (2000), vol. 16 (2007) soveltuvin osin.
<b>Prerequisites</b>	BJ60A0001 Paperitekniiikan perusteet attended.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.

<b>BJ60A1000</b>	<b>FIBER AND PAPER TECHNOLOGY; PERSONAL ASSIGNMENT</b>	<b>6 ECTS cr</b>
	<b>Fiber and Paper Technology; Personal Assignment</b>	
	<b>Opintojakson voi suorittaa joko englannin tai suomen kielellä.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 3-4/1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Isko Kajanto Professor, M.Sc. (Tech.) Kaj Henricson Research Director, D.Sc. (Tech.) Jari Käyhkö University Lecturer, Lic.Sc. (Tech.) Kati Turku Assistant, M.Sc. (Tech.) Mika Pulkkinen	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• apply obtained understanding of a specialized area of fiber, paper or coating technology or paper chemistry</li> <li>• perform individual literature assignment and seminar presentation on a specified subject</li> <li>• search information on given topic</li> <li>• write a scientific literature report</li> </ul>	
<b>Content</b>	An individual and independent literature work and seminar on fiber, paper or coating technology or paper chemistry. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	The course is held both during the autumn and the spring semester. Literature work 3rd-4th period/1st-2nd period. Seminar 4th/2nd period. Registration with WebOodi but also required to register at the bulletin board of the Laboratory of Paper Technology.	
<b>Evaluation</b>	0-5, literature work and seminar 100%.	
<b>Study materials</b>	Literature related to the project. Course material.	
<b>Prerequisites</b>	BJ60A0001 Paperitekniiikan perusteet or BJ60A1500 Fiber and Paper Basics and BJ60A0900 Kuidun ja paperin valmistus (attended) or corresponding knowledge. BJ80A0500 Pinta- ja kolloidikemia is recommended.	

<b>BJ60A1100</b>	<b>FIBER AND PAPER TECHNOLOGY; PERSONAL</b>	<b>10 ECTS cr</b>
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<b>ASSIGNMENT</b>	
	<b>Fiber and Paper Technology; Personal Assignment</b>
	<b>Opintojakson voi suorittaa joko englannin tai suomen kielellä.</b>
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 3-4/1-2
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Isko Kajanto University Lecturer, Lic.Sc. (Tech.) Kati Turku
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Isko Kajanto After a module a student can <ul style="list-style-type: none"> <li>• apply obtained understanding of a specialized area of fiber, paper or coating technology or paper chemistry</li> <li>• perform individual assignment including experimental and literature parts and seminar presentation on a specified subject</li> <li>• search information on given topic</li> <li>• analyse results of the laboratory experiments</li> <li>• write a scientific report</li> </ul>
<b>Content</b>	An individual and independent assignment on fiber, paper or coating technology or paper chemistry including literature and experimental part. A seminar presentation is to be given on the assignment. Suitable also for postgraduate studies.
<b>Modes of Study</b>	The course is held both during the autumn and the spring semester. Assignment including ca. 200 h practical work and a final report, 3rd-4th period/1st-2nd period. Seminar 4th/2nd period. Registration with WebOodi but also required to register at the bulletin board of the Laboratory of Paper Technology.
<b>Evaluation</b>	0-5, consists of the performing of the research work, final report and seminar.
<b>Study materials</b>	Literature related to the project. Course material.
<b>Prerequisites</b>	BJ60A0001 Paperitekniiikan perusteet and BJ60A0800 Kuitu- ja paperitekniiikan laboratoriotyöt or BJ60A1500 Fiber and Paper Basics and BJ60A0900 Kuidun ja paperin valmistus (attended) or corresponding knowledge. BJ80A0500 Pinta- ja kolloidikemia is recommended.

<b>BJ60A1200</b>	<b>SHEET FORMATION AND WET END CHEMISTRY</b>	<b>5 ECTS cr</b>
	<b>Rainanmuodostus ja määränpään kemia</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Isko Kajanto University Lecturer, Lic.Sc. (Tech.) Kati Turku Docent, D.Sc. (Tech.) Kaj Backfolk	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• define wet end operations of paper making process</li> <li>• apply obtained deeper understanding of the chemical phenomena encountered at the wet end of a paper machine</li> <li>• explain reasons for the use of chemical additives in paper making.</li> </ul>	
<b>Content</b>	Sheet forming. Short circulation. Water systems of the paper machine. Relevant concepts of surface and colloid chemistry. Retention. Fillers. Dry and wet strength aids and hydrophobic sizing. Paper machine water chemistry. Wet end control.	
<b>Modes of Study</b>	Lectures 21 h, 1st period. Lectures and seminars 21 h, 2nd period. Support on a web-based learning environment platform (Blackboard).	
<b>Evaluation</b>	Lectures, seminar and online and/or home assignments. Written examination.	
<b>Study materials</b>	0-5, consists of written exam, seminar and home and/or online assignments. Course material on Blackboard. Other literature to be announced during lectures. Gullichsen, J., Paulapuro, H. (eds.), Papermaking Science and Technology, Fapet Oy, vol. 3 Forest Products Chemistry (2000), vol. 4 Papermaking Chemistry (1999), vol. 8 Papermaking, Part 1, Stock preparation and Wet End (2000)(specified sections).	
<b>Prerequisites</b>	BJ60A0001 Paperitekniiikan perusteet. Recommended: BJ80A0500 Pinta- ja kolloidikemia attended.	

<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.
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<b>BJ60A1300</b>	<b>USAGE AND PROPERTIES OF PAPER</b>	<b>5 ECTS cr</b>
	<b>Usage and Properties of Paper</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Isko Kajanto Assistant, M.Sc. (Tech.) Mika Pulkkinen Visiting lecturer(s)	
<b>Aims</b>	Person in Charge: Professor, D.Sc. (Tech.) Isko Kajanto After a module a student can <ul style="list-style-type: none"> <li>• explain how the properties of paper are linked to its structure and its manufacturing process</li> <li>• explain the most typical uses of paper and how various properties of paper are taken advantage of in various end uses.</li> <li>• categorize printing methods.</li> </ul>	
<b>Content</b>	Paper physics: fibrous networks, paper strength, interaction of water with paper, dimensional stability. Improvement of surface properties of paper - coating and calendering. Printing methods: offset, gravure, inkjet, electrophotography. Interactions with printing ink and the paper surface. Paperboard packaging and converted paper products. Future trends. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures 28 h, 3rd period. Lectures 28 h, 4th period. Blackboard support.	
<b>Evaluation</b>	Seminar presentation and a written report. Examination.	
<b>Study materials</b>	0-5, the grade consists of the examination and the seminar work. Lectures and lecture material. Named parts of the books: Gullichsen, J., Paulapuro, H. (eds), Papermaking Science and Technology, Fapet Oy, vol. 11, vol. 12, vol. 13, vol. 16.	
<b>Prerequisites</b>	BJ60A0001 Paperiteknikan perusteet and BJ60A0900 Kuidun ja paperin valmistus or BJ60A1500 Fiber and Paper Basics or corresponding knowledge of forest industry. BJ80A0500 Pinta- ja kolloidikemia is recommended.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BJ60A1400</b>	<b>CHEMICAL PULPING TECHNOLOGY</b>	<b>5 ECTS cr</b>
	<b>Chemical Pulping Technology</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Professor, M.Sc. (Tech.) Kaj Henricson Doctoral Student, M.Sc. (Tech.) Katriina Kolhonen	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• list the process and equipment technology used in the manufacture of chemical pulp and the recovery of cooking chemicals and in bio-refineries combined with chemical pulp mills.</li> <li>• define energy and mass balances and mill emissions</li> </ul>	
<b>Content</b>	Machinery and processes used in the fiberline with special focus on the sulfate process. Recovery of cooking chemicals and mill energy systems. Alternative cooking methods. Bio-refineries in combination with pulp mills. Mill emissions related to the manufacture of chemical pulp. Available wood resources. Properties of chemical fibers. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures, exercises and seminars 14 h, 1st period. Lectures, exercises and seminars 14 h, 2nd period. Blackboard-support.	
<b>Evaluation</b>	Lectures, personal assignment and seminar. 0-5, written examination 75%, personal assignment 25%.	

<b>Study materials</b>	Gullichsen, J., Paulapuro, H. (eds), vol. 1 (1998), vol. 3 (2000), vol. 6A (1999), vol. 6B (1999), Papermaking Science and Technology, Fapet Oy. Sixta, H., Handbook of Pulp, Volume 1 and 2, Wileys - VCH (2006). Dence, C., Reeve, D. (eds), Pulp Bleaching - Principles and Practice, Tappi Press (1996). Adams, Terry N. et. al., Kraft Recovery Boilers, Tappi Press (1997). Vakkilainen, Esa K., Kraft Recovery Boilers: Principles and Practice, Suomen Soodakattilayhdistys (2005). Blackboard course material, handouts and other specified reading.
<b>Prerequisites</b>	BJ60A0900 Kuidun ja paperin valmistus or BJ60A1500 Fiber and Paper Basics attended or corresponding knowledge of forest industry.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ60A1500</b>	<b>FIBER AND PAPER BASICS</b>	<b>4 ECTS cr</b>
	<b>Fiber and Paper Basics</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Isko Kajanto D.Sc. (Tech.) Päivi Rousu University Lecturer, Lic.Sc. (Tech.) Kati Turku Assistant, M.Sc. (Tech.) Mika Pulkkinen Visiting lecturers Person in Charge: Professor, D.Sc. (Tech.) Isko Kajanto	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• categorize pulping and papermaking processes</li> <li>• define properties of paper and board</li> <li>• explain principles of paper technical laboratory work and methods of analysis used in the paper industry</li> </ul>	
<b>Content</b>	Chemical and mechanical pulp, recycled fiber. Basic properties of papermaking fibres: structure, interactions with water and bonding. Filtration of fibre suspension and flow properties. Papermaking processes: Defibration and refining of pulp, web forming, web pressing, drying and coating. Structure and properties of paper web. Paper and board grades. Sheet making and analytics of paper laboratory. Pulp and paper testing exercises in pairs.	
<b>Modes of Study</b>	Lectures 21 h, 1st period. Guided laboratory work 30 h and report, 1st-2nd period. Support on web-based learning environment platform (Blackboard).	
<b>Evaluation</b>	0-5, exam 100% and passed laboratory work.	
<b>Study materials</b>	Lectures. Course material on Blackboard. Other literature given on lectures.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ60A1600</b>	<b>COATING AND PLATING CHEMISTRY</b>	<b>3 ECTS cr</b>
	<b>Päällystyksen ja pintakäsittelyn kemia</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4	
<b>Teacher(s)</b>	University Lecturer, Lic.Sc. (Tech.) Kati Turku Part-time Untenured Teacher, M.Sc. (Tech.) Tuula Sokka Person in Charge: University Lecturer, Lic.Sc. (Tech.) Kati Turku	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• describe the composition and qualities of coating colour</li> <li>• perform laboratory assignments</li> <li>• write a report based on laboratory results</li> </ul>	
<b>Content</b>	Components of coating mix	
<b>Modes of Study</b>	Lectures 12 h, 3rd period. Laboratory assignments 15 h, 3rd-4th period. Blackboard course material. Lectures, laboratory assignments with their reports, and peer review of laboratory and report.	

<b>Evaluation</b>	Registration via WebOodi, but students must register also on the laboratory notice board.
<b>Study materials</b>	0-5, examination 100 %. Laboratory assignment Pass/Fail. Gullichsen, J., Paulapuro, H. (eds.), Papermaking Science and Technology, Fapet Oy, vol. 11 (2000) (relevant parts). Online course material.
<b>Prerequisites</b>	Course handout: Instructions for laboratory work. Literature notified during the lectures.
<b>Further Information</b>	BJ60A0001 Introduction Course in Paper Technology and BJ60A0101 Paper Technology, Laboratory Course completed. This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ60A1700</b>	<b>BIOREFINERIES</b>	<b>2 ECTS cr</b>
<b>Year and Period</b>	<b>Biojalostamot</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 4 Person in Charge: Professor, D.Sc. (Tech.) Isko Kajanto	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• list most important products from biorefiners</li> <li>• explain different biorefinery constructions that are under investigation</li> </ul>	
<b>Content</b>	What does a biorefinery mean. Development of forest industries in Finland and development scenarios. Biorefinery products from the point of view of market. Different biorefinery construction, economy of biorefineries.	
<b>Modes of Study</b>	Lectures 22 h, 4th period. Possible group work during lectures, participation on those lectures is mandatory.	
<b>Evaluation</b>	0-5, examination 100%. Extra point to the examination can be obtained from quizz during lectures.	
<b>Study materials</b>	Lectures, lecture material. Alén Raimo ed.), Biorefining, Paperi ja Puu Oy, to be published in 2010.	
<b>Prerequisites</b>	BJ50A0200 Luonnon polymeerit	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BJ70A0001</b>	<b>INORGANIC CHEMISTRY</b>	<b>6 ECTS cr</b>
	<b>Epäorgaaninen kemia, Oorganisk kemi</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 1-3	
<b>Teacher(s)</b>	Part-time Untenured Teacher, D.Sc. (Tech.) Riitta Heikka Post-Doctoral Researcher, D.Sc. (Tech.) Maaret Paakkunainen Part-time Untenured Teacher, N. N.	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Describe the most important fundamentals of general chemistry</li> <li>• List the most important chemistry elements</li> <li>• Solve/calculate/analyze simple exercises in the field of inorganic chemistry, such as liquid concentrations and material/concentration balance.</li> </ul>	
<b>Content</b>	The structure of an atom, chemical bonds, the periodic table of the elements, the reactions of inorganic elements and their most important compounds, stoichiometry, oxidation-reduction reactions, thermo chemistry, the ideal gas law, the properties of solutions, chemical equilibrium, acids and bases and pH, solubility constant, the mass balances of simple processes, the basic phenomena and equations of electrochemistry, complex ions. The processes of the most common inorganic industrial chemicals.	
<b>Modes of Study</b>	Lectures 21 h, exercises 14 h, 1st period. Lectures 14 h, exercises 21 h, 2nd period. Lectures 14 h, exercises 21 h, 3rd period. 3 intermediate exams or a written examination.	
<b>Evaluation</b>	0-5, written examination (or intermediate exams) 100%.	
<b>Study materials</b>	Zumdahl, S. S., Zumdahl, S. A.: Chemistry 6th ed., Houghton Mifflin Company, ISBN 0-618-22156-5.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for	

	open university instruction.	
<b>BJ70A0102</b>	<b>ADVANCED SPECIAL STUDIES IN INORGANIC CHEMISTRY</b>	<b>5 ECTS cr</b>
	<b>Epäorgaanisen kemian syventävät tiedot</b>	
	<b>Replaces the course BJ70A0101 Epäorgaanisen kemian syventävät tiedot.</b>	
	<b>The course will be lectured every other year, next during the academic year 2011 - 2012.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 3-4	
<b>Teacher(s)</b>	Professor, Ph.D. Heli Sirén Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Post-Doctoral Researcher, D.Sc. (Tech.) Maaret Paakkunainen	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Explain widely about the inorganic chemistry and the usage of inorganic products</li> <li>• Explain the chemistry behind solid materials</li> <li>• List the general mineral groups and crystal structures</li> <li>• Describe the most common analytical methods developed for inorganic samples (solid, crystal and liquid samples)</li> <li>• Explain some novel inorganic industrial processes</li> <li>• List basic advantages / disadvantages of some inorganic compounds / products</li> <li>• Give an oral presentation, write a report and act as an opponent from a given topic</li> </ul>	
<b>Content</b>	The lectures will handle the principal properties of the most important elements in solid state (properties, structure, identification, appearance, extraction and use) and quantitative analysis methods (inductively coupled plasma-mass spectrometry, atom emission spectrometry, UV/VIS-spectrophotometry, atom absorption spectrometry, electrodriven techniques, ion chromatography, microscopic techniques, infra red spectroscopy, thermogravimetric techniques). In addition, the lectures will explain some extraction methods of industrial minerals, their importance and utilisation. Especially, iron, silicon, platinum, aluminium, mercury, zinc, nickel, lead, noble metals, lanthanides, alkali and alkali earth metals (caesium), wolfram and composition of metals. Furthermore, the principal properties and industrial applications of solid state chemistry are stated in seminars.	
<b>Modes of Study</b>	The student makes a small-scale literature review on a specific selected topic of the course area, writes a report and introduces it in a seminar. Lectures 14 h, seminar tutorials 3 h, 3rd period. Lectures 14 h, seminar tutorials 3 h, 4th period. A laboratory assignment carried out independently together with another student. Lectures, approved seminar presentation and participation in the seminars. Registration both through WebOodi and on the notice board of the laboratory (see the laboratory web site).	
<b>Evaluation</b>	0-5, examination 100%.	
<b>Study materials</b>	E-learning material (Blackboard) and study book. Cotton, F. A., Wilkinson, G., Murillo, C. A.: Advanced Inorganic Chemistry, New York (N.Y.), Wiley, uusin painos, ISBN 0471199575.	
<b>Prerequisites</b>	Other literature announced during lectures. BJ70A0001 Epäorgaaninen kemia.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BJ70A0201</b>	<b>ANALYTICAL CHEMISTRY</b>	<b>6 ECTS cr</b>
	<b>Analyttinen kemia</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 1-4	
<b>Teacher(s)</b>	Professor, Ph.D. Heli Sirén Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Researcher, M.Sc. (Tech.) Jarno Kohonen Post-Doctoral Researcher, D.Sc. (Tech.) Maaret Paakkunainen Part-time Untenured Teacher, N. N.	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• List the most common analytical methods utilized in analyzing liquids</li> <li>• List the analytical methods utilized in electrochemistry of liquids</li> <li>• Explain the bases of the chromatographic methods</li> </ul>	

<p><b>Content</b></p> <p><b>Modes of Study</b></p> <p><b>Evaluation</b></p> <p><b>Study materials</b></p> <p><b>Further Information</b></p>	<ul style="list-style-type: none"> <li>Realize in what applications the most common chemical elements and separation methods can be utilized</li> <li>Select the correct analytical method for detecting different kind of compounds</li> </ul> <p>After the laboratory hours, student is able to</p> <ul style="list-style-type: none"> <li>Recognize the risks during the laboratory exercises</li> <li>Work safely in the laboratory</li> <li>Prepare simple solutions</li> <li>Calculate concentrations of the prepared solutions</li> <li>Determine results achieved with real samples (from analytical measurements)</li> </ul> <p>The lectures will introduce traditional laboratory methods, like gravimetry, solvent methods (titration), from instrumental analytics separation techniques (IC, HPLC, GC, MS, CE) and spectrophotometry. In addition, in the lectures spectroscopic methods AAS and ICP-OES as well as electrodriven analysis methods will be introduced. For examples about the use of the instrumentation are from industry and research institutes. In addition, international method standards are introduced. The practical examples are from chemical, pharmaceutical, pulp- and paper industry and from monitoring of environment. During the laboratory experiment period the student will learn the techniques and methods in practice by attending group works and demonstrations. Furthermore, there will be laboratory works that are made independently.</p> <p>Lectures 4 h, laboratory exercises 24 h, 1st period. Laboratory exercises 24 h, 2nd period. Lectures 14 h, laboratory exercises 35 h, 3rd period. Laboratory exercises 25 h, 4th period. Blackboard support. Registration both through WebOodi and on the notice board of the laboratory (see the laboratory web site).</p> <p>0-5, examination 50%, laboratory exercises 50%. Lecture notes, laboratory work instructions.</p> <p>This course has 11-15 places for open university students. More information on the web site for open university instruction.</p>
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<b>BJ70A0600</b>	<b>ANALYTICAL CHEMISTRY LABORATORY COURSE</b>		<b>3 ECTS cr</b>
<p><b>Year and Period</b></p> <p><b>Teacher(s)</b></p> <p><b>Aims</b></p> <p><b>Content</b></p> <p><b>Modes of Study</b></p> <p><b>Evaluation</b></p> <p><b>Study materials</b></p> <p><b>Further Information</b></p>	<p><b>Analyttisen kemian laboratoriotyökurssi</b></p> <p>B.Sc. (Tech.) 1, Period 3-4 Professor, Ph.D. Heli Sirén Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Post-Doctoral Researcher, D.Sc. (Tech.) Maaret Paakkunainen Doctoral Student, Lic.Sc. (Tech.) Kari Vahteristo</p> <p>After a module student can:</p> <ul style="list-style-type: none"> <li>Recognize the risks during the laboratory exercises</li> <li>Work safely in the laboratory</li> <li>Prepare simple solutions</li> <li>List common ion reactions</li> <li>Separate different kind of ions</li> <li>List the typical methods of classical analytical chemistry and modern instrumental methods.</li> </ul> <p>The most common ion reactions and qualitative and quantitative analytical methodologies are analyzed and practiced in a laboratory. The exercises also include practical work with basic instrumental chemistry equipment. Specific analysis works with personal studies.</p> <p>Lectures 4h, 3rd period. Laboratory exercises 42 h, 3rd period. Laboratory exercises 30 h, 4th period. Laboratory assignments and exams. Blackboard eLearning environment. Registration via WebOodi. The student should also sign up for laboratory work on the bulletin board of the laboratory.</p> <p>0-5; the grade will be based on the personal assignments and examinations. Laboratory work instructions, Blackboard eLearning material.</p> <p>This course has 6-10 places for open university students. More information on the web site for open university instruction.</p>		

<b>BJ70A0701</b>	<b>ANALYTICAL METHODS IN INDUSTRY AND ENVIRONMENT I</b>	<b>6 ECTS cr</b>
	<b>Teollisuus- ja ympäristöanalytiikka I</b>	
	<b>Replaces the course BJ70A0700 Teollisuus- ja ympäristöanalytiikka I.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 2-4	
<b>Teacher(s)</b>	Professor, Ph.D. Heli Sirén Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Professor, Ph.D. Heikki Haario	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Describe the analytical methods utilized in environmental monitoring</li> <li>• Describe the methods utilized in evaluating the reliability of sampling</li> <li>• Explain the bases of the sampling and experimental design</li> <li>• Apply basic concepts of experimental design</li> <li>• Realizes how the sample preparation is carried out for handling inorganic and organic samples</li> </ul>	
<b>Content</b>	The course will introduce techniques applied in various fields of industry, as well as in monitoring of environmental emissions. This will include chemical instrumentation, sampling from chemical analysis and design of experiments. Different pre-treatment methods and sampling methods (in inorganic and organic chemistry) will cover on-, off- and at-line measurements and instrumentation (sensors, chromatographic methods, etc.). Standard procedures in quantification of inorganic and organic components in environmental studies will be introduced. Practical laboratory work will increase the practical experience of the topics. BM20A3401 Design of Experiments (DoE) will also be included into the course content. This course will introduce the mathematical basic methods and importance of experimental design. There will be a project work with be done with chemistry-oriented data.	
<b>Modes of Study</b>	Lectures 14 h, 2. period Lectures 14 h, 3. period Lectures 14 h, intensive course, 4 period. Exercises 14 h and project work 14 h, 4. period.	
<b>Evaluation</b>	Approved three midterm examinations and a project work.	
<b>Study materials</b>	0-5, midterm examinations or final examination 70%, project work 30%. Lecture material on Blackboard. S. Mitra (Ed.), Sample Preparation Techniques in Analytical Chemistry, ISBN-10 0471328456. Sirén, H., Perämäki, P., Laiho, J.: Esikäsittelyn käsikirja, ohjeita vesi-, ympäristö-, ja prosessitekniiikan sekä lääkeaineteollisuuden laboratorioille, ISBN 978-951-8983-29-9 The material of the course BM20A3401 Design of Experiments.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	
<b>BJ70A0801</b>	<b>ANALYTICAL METHODS IN INDUSTRY AND ENVIRONMENT II</b>	<b>8 ECTS cr</b>
	<b>Teollisuus- ja ympäristöanalytiikka II</b>	
	<b>Replaces the course BJ70A0800 Teollisuus- ja ympäristöanalytiikka II.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 4, 1-2	
<b>Teacher(s)</b>	Professor, Ph.D. Heli Sirén Researcher/Teacher, Docent, D.Sc. (Tech.) Satu-Pia Reinikainen Post-Doctoral Researcher, D.Sc. (Tech.) Maaret Paakkunainen Doctoral Student, Lic.Sc. (Tech.) Kari Vahteristo Professor, Ph.D. Heikki Haario	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Describe and explain more widely about instrumental analysis and chemometrics methods, which are utilized for the interpretation and analysis of chemical measurements</li> <li>• Work under supervision with analytical instruments</li> <li>• Write a technical report from the measured results</li> <li>• Utilize multivariate methods in handling modern data</li> </ul>	

<b>Content</b>	Course introduces theory of instrumental analytics, and their utilization in various fields or industry (i.e., food, pharmaceutical, pulp and paper, etc). Also industrial chemometrics and multivariate methods are an independent part of the course content. Lecture content includes basic concept of chromatographic methods (IC, LC, GC), mass spectrometry (MS) and capillary electrophoresis (CE). Instrumentation and difference between these methods will be discussed. Quantification of Industrial and environmental samples with separation techniques will be included. Chemometrics as a mathematical tool in calibration and in multivariate analysis is introduced. This multivariate part is equal to a course BJ70AJ105 Multivariate Methods in Industry, which is included into the course content as an intensive course. Examples cover large range of cases, e.g., from bio and food quality assessments, from air water and soil analytics and from analytics pulp and paper industry as well as from metallurgy or pharmaceutical industry.
<b>Modes of Study</b>	4th year (M.Sc. 1): Lectures 14 h, 4th period. 5th year (M.Sc. 2): Lectures 14 h, laboratory work 42 h, 1st period. Lectures 9 h, exercises 8 h, 2nd period. Lectures and exercises, 32 h (see course BJ70AJ105 Multivariate Methods in Industry), 2nd period. Lectures and exercises. Approved assignment on laboratory work including reports. Three midterm examinations or final examination. Registration both through WebOodi and on the notice board of the laboratory.
<b>Evaluation</b>	0-5, midterm examinations or final examination 70%, laboratory work 30%.
<b>Study materials</b>	Lecture material on Blackboard. Luentomateriaali Blackboardilla. D.A. Skoog, F.J. Holler, S.R. Crouch, Principles of Instrumental Analysis, ISBN-10 0030020780. S.P.J. Higson, Analytical Chemistry, Oxford University Press, ISBN 0-19-850289-3. Also the material of the course: BJ70AJ105 Multivariate Methods in Industry.
<b>Prerequisites</b>	BJ70A0701 Teollisuus- ja ympäristöanalytiikka I attended.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BJ70A0900</b>	<b>ORGANIC CHEMISTRY</b>	<b>6 ECTS cr</b>
	<b>Orgaaninen kemia, Organisk kemi</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 1-4	
<b>Teacher(s)</b>	Professor, Ph.D. Heli Sirén Doctoral Student, Lic.Sc. (Tech.) Kari Vahteristo Researcher/Teacher, D.Sc. (Tech.) Arto Pihlajamäki	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• List characters, structures, basic reactions and preparation of organic compounds</li> <li>• Give names for organic compounds and to look for their functional groups</li> <li>• Explain basic terms in organic chemistry</li> <li>• Choose chemicals and to synthesize desired products</li> <li>• Identify different polymerization reactions and prepared polymers</li> <li>• Choose the identification methods for end products of syntheses</li> <li>• Write a report about the synthesis carried out, product of the synthesis and identification</li> </ul>	
<b>Content</b>	Part 1. Basics of organic chemistry. The lectures are focused to naming of the organic compounds and grouping them based on their structures, to identify functional groups, activity, and polarity of the bonds, physicochemical properties, reaction mechanisms, reaction kinetics, steric effects and acidity, but also the working methods of organic chemistry. During the course the students will be acquainted with traditional identification methods for organic compounds and their use. As examples there are e.g. existence of organic compounds in environment and in various biomaterials, like blood and cells. In addition, in the subjects of the lectures there will be examples for the use of synthesis in research. There are weekly performed syntheses trainings that follow the lectures preceding them. During the lectures there are also laboratory demonstrations where the students are in groups and make some simple organic separation and identification analyses. After lecture period there are practical laboratory works to those the accession requires passing the compulsory laboratory examination. Part 2. The basics of polymer chemistry.	

<b>Modes of Study</b>	During the period of the polymer learning nomenclatures and the most important polymerization reactions are discussed. In addition, the main types of polymer reactions and molar masses of polymers are touched. Part 1: Lectures 14 h, exercises and demonstrations 10 h, 1st period. Lectures 14 h, exercises and demonstrations 10 h, 2nd period. Laboratory tutorials 24 h, 3rd period. Part 2: Lectures 6 h, 3rd period. E-learning material (Blackboard) and study book.
<b>Evaluation</b>	The final grade is based on the results of either 4 intermediate tests or a written examination on the content of the lectures and laboratory tutorials.
<b>Study materials</b>	0-5, written examination (or intermediate tests) 62,5%, laboratory works 37,5%. Hart, H., Organic Chemistry: A Short Course, Houghton Mifflin. Pennanen, S., Orgaanisen kemian työtavoista, Otatieto. Vogel's Textbook of Practical Organic Chemistry, Longman/Wiley.
<b>Prerequisites</b>	BJ70A0201 Analyttinen kemia required for laboratory work.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ70A1001</b>	<b>ADVANCED SPECIAL STUDIES IN ORGANIC CHEMISTRY</b>	<b>5 ECTS cr</b>
	<b>Orgaanisen kemian syventävät tiedot</b>	
	<b>Replaces the course BJ70A1000 Orgaanisen kemian syventävät tiedot.</b>	
	<b>The course will be lectured every other year, next during the academic year 2010 - 2011.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 3-4	
<b>Teacher(s)</b>	Professor, Ph.D. Heli Sirén Doctoral Student, Lic.Sc. (Tech.) Kari Vahteristo Researcher/Teacher, D.Sc. (Tech.) Arto Pihlajamäki	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Explain reaction mechanisms, reaction kinetics and the affecting factors.</li> <li>• List instruments needed for identification of molecules.</li> <li>• Use and solve structure information by measuring functionalities of the main products of synthesis.</li> <li>• Practice them self for a problem solving study and reporting.</li> <li>• Realize how biochemistry and polymer chemistry are utilized in analytics and how the components are identified</li> <li>• Search information from the field of organic chemistry</li> </ul>	
<b>Content</b>	The aim of the course is to deepen knowledge on synthesis of organic compounds and polymers, on identification of molecule structures and on controlling reaction mechanisms. There will be information about the use of spectrometric methods in identification of structures of organic molecules, analysis of reaction mechanisms and identification of the syntheses routes of reaction products. The lectures will give inform on the meaning of organic reactions in analytics and sample preparation, and on chemical and biochemical conversion of organic compounds in various matrices. The students will solve projects based on literature and laboratory experiments, and write reports for presentations in a seminar.	
<b>Modes of Study</b>	Lectures 14 h, exercises 7 h, 3rd period. Lectures 14 h, laboratory experiments, demonstrations, seminar 10 h, 4th period. Two students as a pair prepare the seminar presentations of interpretation of molecule spectra. The seminar exercises will be collected from the educational teacher and they will be done unprompted according to instructions. The final reports are introduced in a seminar. Attendance in seminars is obligatory.	
<b>Evaluation</b>	0-5, examination 70%, demonstrations and laboratory works 30%. Passing the seminar project gives additional points to examination.	
<b>Study materials</b>	Lecture material on Blackboard. Housecraft, C. E., Constable, E. C.: Chemistry (3rd ed.), Pearson Education Limited, Ashford Colour Press Ltd, Gosport, UK, 2006, ISBN 0131275674. Additional material will be informed during lectures.	
<b>Prerequisites</b>	For lectures: BJ70A0900 Orgaaninen kemia lectures passed. For laboratory work: BJ70A0900 Orgaaninen kemia laboratory work passed.	

<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.
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<b>BJ80A0001</b>	<b>GENERAL CHEMISTRY</b>	<b>3 ECTS cr</b>
	<b>Yleinen kemia</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 1	
<b>Teacher(s)</b>	Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen Part-time Untenured Teacher, N. N.	
<b>Aims</b>	Person in Charge: Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen After a module student can: <ul style="list-style-type: none"> <li>Use the most important principles of fundamentals of university chemistry and chemical technology</li> </ul>	
<b>Content</b>	Elements of physical, inorganic and organic chemistry. These elements form the theoretical background for important chemical phenomena: e.g. corrosion, burning of fuels, storage of electrochemical energy, and treatment of wastewaters.	
<b>Modes of Study</b>	Lectures 28 h, exercises 14 h, 1st period. Written examination.	
<b>Evaluation</b>	0-5, written examination 100%.	
<b>Study materials</b>	Lecture notes and problems manual or the corresponding literature suggested by the teacher.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BJ80A0400</b>	<b>REACTION KINETICS</b>	<b>3 ECTS cr</b>
	<b>Reaktiokinetiikka</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Matti Lindström	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>Explain the basic principles of reaction kinetics</li> <li>Describe mathematically the most important types of reactions</li> <li>Derive the rate law from the most important mechanisms of reactions</li> <li>Describe mathematically basic types of catalysis.</li> </ul>	
<b>Content</b>	Basic principles and variables of chemical kinetics. Determination of the rate laws for simple reactions from experimental data. Molecular interpretation of reaction kinetics and reaction mechanisms. Reaction systems containing several steps. Adsorption isotherms, surface reactions, and heterogeneous catalysis. Reactions in the liquid phase and homogeneous catalysis.	
<b>Modes of Study</b>	Lectures 21 h, exercises 14 h, 2nd period.	
<b>Evaluation</b>	0-5, written examination 100%.	
<b>Study materials</b>	Atkins, P. & Paula, J. de, Atkins' Physical Chemistry (8th ed.), Oxford University Press, 2006, chapters 22-25. Hill, C.G. Jr., An Introduction to Chemical Engineering Kinetics & Reactor Design, chapters 1-7. Lecture notes and problems manual. Blackboard.	
<b>Prerequisites</b>	BM30A0210 Fysiikka L, osa 1, BM30A0230 Fysiikka L, osa 3 and BJ70A0001 Epäorgaaninen kemia or BM30A0111 Fysiikka, osa 1: Lämpöoppi and BJ80A0001 Yleinen kemia passed.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BJ80A0500</b>	<b>SURFACE AND COLLOID CHEMISTRY</b>	<b>3 ECTS cr</b>
	<b>Pinta- ja kolloidikemia</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3	
<b>Teacher(s)</b>	Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>Describe the principles and formulation of surface chemistry</li> <li>Describe the adsorption phenomena</li> <li>Explain and treat mathematically electrical double layer</li> <li>Explain the principles of colloid chemistry and evaluate the basic parameters of colloid systems.</li> </ul>	

<b>Content</b>	Concepts needed in the thermodynamic formulation of the surface. Surface tension, surface energy, and films on the surface. Adsorption. Surfaces in electrolyte solutions and electrical double layer. Suspension and emulsion. Macromolecules in solutions. Electrokinetic phenomena.
<b>Modes of Study</b>	Lectures 28 h, exercises 14 h, 3rd period. Written examination.
<b>Evaluation</b>	0-5, written examination 100%.
<b>Study materials</b>	Lecture notes: Partanen, J. I., Luentomoniste opintojaksoon Fysikaalinen kemia 5 (Pinta- ja kolloidikemia), Lappeenrannan teknillinen yliopisto, Kemianteeniikan osasto, opetusmoniste 6, 2002 ja Partanen, J. I., Laskuesimerkkejä opintojaksoon Fysikaalinen kemia 5 (Pinta- ja kolloidikemia), Lappeenrannan teknillinen yliopisto, Kemianteeniikan osasto, opetusmoniste 7, 2002.
<b>Prerequisites</b>	BM30A0210 Fysiikka L, osa 1, BM30A0230 Fysiikka L, osa 3, BM30A0320 Fysiikan laboratoriotyöt (KETE, KOTE), BJ70A0001 Epäorgaaninen kemia and BJ80A1000 Kemiallinen termodynamiikka attended.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ80A0600</b>	<b>PHYSICAL CHEMISTRY LABORATORY COURSE</b>	<b>4 ECTS cr</b>
	<b>Fysikaalisen kemian laboratoriotyöt</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-2	
<b>Teacher(s)</b>	Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen Doctoral Student, Lic.Sc. (Tech.) Kari Vahteristo Person in Charge: Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Realize the experimental background of all theories of physical chemistry</li> <li>• Measure exactly physico-chemical properties of substances</li> <li>• Use reliable calculation methods needed in the treatment of experimental data</li> <li>• Make exact calorimetric measurements and the high-quality measurements of pressure, pH, conductivity and density of solutions.</li> </ul>	
<b>Content</b>	Seven laboratory experiments on chemical thermodynamics, reaction kinetics, and surface chemistry. The course begins with an introductory lecture where, for example, the working groups are formed.	
<b>Modes of Study</b>	Lectures 4 h, laboratory exercises 56 h, 1st-2nd period. The course is passed after the reports of the laboratory experiments and a brief examination of the calculations of the reports have been accepted. No other examination.	
<b>Evaluation</b>	Pass/Fail.	
<b>Study materials</b>	Manuals of the experiments.	
<b>Prerequisites</b>	BM30A0210 Fysiikka L, osa 1, BM30A0230 Fysiikka L, osa 3, BM30A0320 Fysiikan laboratoriotyöt (KETE, KOTE) and BJ80A1000 Kemiallinen termodynamiikka attended.	
<b>Further Information</b>	BJ70A0900 Orgaaninen kemia laboratory work passed. This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ80A0900</b>	<b>CHEMICAL PROPERTIES OF REAL SOLUTIONS</b>	<b>4 ECTS cr</b>
	<b>Todellisten liuosten kemialliset ominaisuudet</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 2, Period 2	
<b>Teacher(s)</b>	Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>• Explain and use the concepts used in the description of thermodynamic properties of electrolyte and nonelectrolyte solutions</li> <li>• Use mathematically modern approaches in treatment of electrolyte solutions.</li> </ul>	
<b>Content</b>	Ideal, ideally dilute, and real solutions. Experimental methods for measuring the activity and osmotic coefficients in solutions. Wilson equation, NRTL equation, and UNIQUAC equations for nonelectrolyte solutions. The Debye Hückel theory for electrolyte solutions. Pitzer equations for real electrolyte solutions. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures 28 h, exercises 14 h, 2nd period. Written examination.	
<b>Evaluation</b>	0-5, written examination 100%.	

<b>Study materials</b>	Partanen, J. I., Luentomoniste opintojaksoon Todellisten liuosten kemialliset ominaisuudet, Lappeenrannan teknillinen yliopisto, Kemianteeniikan osasto, opetusmoniste 8, 2007.
<b>Further Information</b>	Partanen, J. I., Laskuesimerkkejä opintojaksoon Todellisten liuosten kemialliset ominaisuudet, Lappeenrannan teknillinen yliopisto, Kemianteeniikan osasto, opetusmoniste 9, 2007. This course has 6-10 places for open university students. More information on the web site for open university instruction.

<b>BJ80A1000</b>	<b>CHEMICAL THERMODYNAMICS</b>	<b>6 ECTS cr</b>
<b>Year and Period</b>	<b>Kemiallinen termodynamiikka</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 2, Period 3-4 Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen Doctoral Student, Lic.Sc. (Tech.) Kari Vahteristo Person in Charge: Researcher/Teacher, Docent, D.Sc. (Tech.) Jaakko Partanen	
<b>Aims</b>	After a module student can: <ul style="list-style-type: none"> <li>Describe and use the four laws of thermodynamics</li> <li>Explain and use the fundamental applications of these laws in chemistry and chemical technology including the properties of gases, liquids, and solids, the heat of reaction, reaction equilibrium and phase equilibrium, properties of solutions, phase diagrams, and galvanic cells.</li> </ul>	
<b>Content</b>	The properties and equations of state for gases, liquids, and solids. Heat of reaction. Chemical potential. Reaction equilibrium. Thermodynamic tables and their use. Partial molar quantities. One- and multicomponent phase equilibria. Colligative properties of solutions. Ideality and non-ideality in solutions. Phase diagrams. Galvanic cells.	
<b>Modes of Study</b>	Lectures 56 h, exercises 28 h, 3rd and 4th period. Lectures and exercises.	
<b>Evaluation</b>	One written examination or two intermediate examinations.	
<b>Study materials</b>	0-5, examination or intermediate examinations 100 %. Atkins, P. & Paula, J. de, Atkins' Physical Chemistry (8th ed.), Oxford University Press, 2006, chapters 1-7.	
<b>Further Information</b>	Lecture notes and problems manual. This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BJ90A0100</b>	<b>CHEMICAL REACTION ENGINEERING</b>	<b>6 ECTS cr</b>
<b>Year and Period</b>	<b>Kemiallinen reaktioteeniikka</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 3, Period 1-2 Senior Assistant, D.Sc. (Tech.) Kimmo Klemola Post-Doctoral Researcher, D.Sc. (Tech.) Tuomo Sainio Person in Charge: Senior Assistant, D.Sc. (Tech.) Kimmo Klemola	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>apply basic thermodynamic concepts to chemical reaction equilibrium calculations</li> <li>derive material and energy balances for ideal reactors</li> <li>compute the performance of gas and liquid phase ideal reactors</li> <li>explain the derivation of reaction mechanisms</li> <li>fit the reaction equations to dynamic reactor data</li> <li>explain the factors that affect the performance of the reactors</li> <li>design a reactor and choose a proper ideal reactor</li> </ul>	
<b>Content</b>	The application of chemical thermodynamics and kinetics in the choice and measurement of reactors. Emphasis is placed on homogenic reactions, which take place in ideal reactors.	
<b>Modes of Study</b>	Lectures 21 h, tutorials 18 h, 1st period. Lectures 21 h, tutorials 18 h, 2nd period. Lectures, tutorials and homework.	
<b>Evaluation</b>	0-5, examination 100%.	
<b>Study materials</b>	Fogler, H. Scott, Elements of Chemical Reaction Engineering, 4th ed., Prentice-Hall, 2005. Levenspiel, O., Chemical Reaction Engineering, 3rd ed., John Wiley & Sons, Inc., 1999.	
<b>Prerequisites</b>	BJ80A1000 Kemiallinen termodynamiikka passed. BJ90A1000 Luonnonvarat ja niiden prosessointi kemian- ja energiateollisuudessa attended.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for	

	open university instruction.	
<b>BJ90A0200</b>	<b>INDUSTRIAL CHEMISTRY</b>	<b>10 ECTS cr</b>
<b>Year and Period</b>	<b>Teknillinen kemia</b>	
<b>Teacher(s)</b>	<b>The lectures will be given in English and they are the same as in the course BJ90A0700 Chemical Separation Methods.</b>	
<b>Aims</b>	<p>M.Sc. (Tech.) 1, Period 3-4          Professor, D.Sc. (Tech.) Erkki Paatero          Post-Doctoral Researcher, D.Sc. (Tech.) Tuomo Sainio          Senior Assistant, D.Sc. (Tech.) Kimmo Klemola          Post-Doctoral Researcher, D.Sc. (Tech.) Tuomo Sainio          After a module a student can</p> <ul style="list-style-type: none"> <li>list the main chemical separation methods</li> <li>name industrial uses of the chemical separation methods</li> <li>perform laboratory-scale experiments (e.g. chromatography) and use some analyzing instruments</li> <li>give oral presentation of a scientific topic</li> <li>prepare a scientific report</li> </ul>	
<b>Content</b>	Individual assignment on reaction engineering or separation technology. Part of the exercises are from the field of food technology. Lectures support the research subjects.	
<b>Modes of Study</b>	Lectures and seminars 40 h, 3rd period. Lectures and seminars 40 h, 4th period. Literature work and seminars, excursions and laboratory exercises approximately 120 h.	
<b>Evaluation</b>	Lectures, seminars, approved assignments and an oral examination.	
<b>Prerequisites</b>	0-5, examination 25%, literature report 25%, laboratory work 50%. BJ90A1000 Luonnonvarat ja niiden prosessointi kemian- ja energiateollisuudessa, BJ90A0100 Kemiallinen reaktioteknikka and BJ90A0900 Teknillisen kemian ja teknillisen polymeerikemian laboratoriotyöt passed.	
<b>BJ90A0400</b>	<b>CATALYSIS</b>	<b>4 ECTS cr</b>
<b>Year and Period</b>	<b>Catalysis</b>	
<b>Teacher(s)</b>	<b>The course will be lectured every other year, next during the academic year 2010 - 2011.</b>	
<b>Aims</b>	<p>M.Sc. (Tech.) 1-2, Period 1-2          Professor, D.Sc. (Tech.) Erkki Paatero          After a module a student can</p> <ul style="list-style-type: none"> <li>explain the basics of homogeneous catalysis</li> <li>explain the basics of heterogeneous catalysis</li> <li>explain how the catalysts work in chemical reactors</li> <li>explain the basic mechanisms of catalytic reactions</li> <li>make a preliminary catalyst selection</li> <li>carry out some catalyst characterization experiment</li> </ul>	
<b>Content</b>	The focus during the course is on the structures, properties and applications of heterogeneous catalysts. Homogeneous and enzyme catalysts are briefly described. The mechanisms of catalytic reactions and the derivation of rate expressions. How to choose the catalyst and the reactor. Applications in environmental engineering. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Intensive course. Lectures and exercises 28 h, 1st-2nd period. Laboratory demonstration and homework.	
<b>Evaluation</b>	0-5, written examination 100%, homework passed.	
<b>Study materials</b>	Thomas, J.M. & Thomas, W.J., Principles and Practice of Heterogeneous Catalysis, John Wiley & Sons, Inc., 1997.	
<b>Prerequisites</b>	BJ90A1000 Luonnonvarat ja niiden prosessointi kemian- ja energiateollisuudessa passed.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ90A0710</b>	<b>CHEMICAL SEPARATION METHODS</b>	<b>4 ECTS cr</b>
	<b>Chemical Separation Methods</b>	
	<b>The lectures are included as a part in BJ90A0200 Teknillinen kemia.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Erkki Paatero Post-Doctoral Researcher, D.Sc. (Tech.) Tuomo Sainio Senior Assistant, D.Sc. (Tech.) Kimmo Klemola	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>list the main chemical separation methods</li> <li>name industrial uses of the chemical separation methods</li> <li>give oral presentation of a scientific topic</li> <li>use scientific search engines</li> </ul>	
<b>Content</b>	The focus during the course is on the chemistry involved in the application of solvent extraction, ion-exchange, adsorption, chromatographic separation and flotation. Applications of these technologies are found widely especially in hydrometallurgy, food industry, pharmaceutical industry and chemical industry. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures and seminars 28 h, 3rd period. Lectures and seminars 7 h, 4th period. Oral presentation of a literature study.	
<b>Evaluation</b>	Written examination. 0-5, examination 80%, seminar presentation 20%.	
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.	

<b>BJ90A0720</b>	<b>CHEMICAL SEPARATION METHODS</b>	<b>8 ECTS cr</b>
	<b>Chemical Separation Methods</b>	
	<b>The lectures are included as a part in BJ90A0200 Teknillinen kemia.</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 3-4	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Erkki Paatero Senior Assistant, D.Sc. (Tech.) Kimmo Klemola Post-Doctoral Researcher, D.Sc. (Tech.) Tuomo Sainio	
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>list the main chemical separation methods</li> <li>name industrial uses of the chemical separation methods</li> <li>give oral presentation of a scientific topic</li> <li>make a scientific report</li> <li>use scientific search engines</li> <li>perform a laboratory experiment and use some analyzing instruments</li> </ul>	
<b>Content</b>	The focus during the course is on the chemistry involved in the application of solvent extraction, ion-exchange, adsorption, chromatographic separation and flotation. Applications of these technologies are found widely especially in hydrometallurgy, food industry, pharmaceutical industry and chemical industry.	
<b>Modes of Study</b>	The students have a possibility to get training in scientific reporting and oral presentation. Lectures and seminars 28 h, 3rd period. Lectures and seminars 14 h, 4th period. Oral and written presentation of a literature study. Laboratory work of approximately 40 h.	
<b>Evaluation</b>	Written examination. 0-5, examination 70%, report 20% and seminar presentation 10%.	

<b>BJ90A0900</b>	<b>INDUSTRIAL CHEMISTRY AND TECHNICAL POLYMER CHEMISTRY LABORATORY COURSE</b>	<b>4 ECTS cr</b>
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	<b>Teknillisen kemian ja teknillisen polymeerikemian laboratoriotyöt</b>
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-2
<b>Teacher(s)</b>	Senior Assistant, D.Sc. (Tech.) Kimmo Klemola Researcher/Teacher, D.Sc. (Tech.) Arto Pihlajamäki Postdoctoral Researcher, D.Sc. (Tech.) Mari Kallioinen Post-Doctoral Researcher, D.Sc. (Tech.) Katri Sirola
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• analyse polymer properties</li> <li>• study reactions and/or chemical separations in laboratory scale</li> <li>• prepare scientific report.</li> <li>• perform a laboratory experiment and use some analyzing instruments</li> </ul>
<b>Content</b>	Conducting laboratory-scale tests related to technical chemistry, e.g. chemical reactions or separations. Reporting. Group assignments related to polymer chemistry and applied polymer chemistry.
<b>Modes of Study</b>	Laboratory assignments 30 h, 1st period. Laboratory assignments 30 h, 2nd period. Hyväksytyt laboratoriotyöt selostuksineen.
<b>Prerequisites</b>	Registration via WebOodi, but students must register also through the laboratory notice board. BJ50A0101 Teknillinen polymeerikemia and BJ90A1000 Luonnonvarat ja niiden prosessointi kemian- ja energiateollisuudessa attended.

<b>BJ90A1000</b>	<b>NATURAL RESOURCES IN CHEMICAL AND ENERGY INDUSTRIES</b> <b>3 ECTS cr</b>
	<b>Luonnonvarat ja niiden prosessointi kemian- ja energiateollisuudessa</b>
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 3-4
<b>Teacher(s)</b>	Senior Assistant, D.Sc. (Tech.) Kimmo Klemola
<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• list the primary fossil energy sources and their environmental impacts</li> <li>• list the biomass processing technologies and the limits of biomass use</li> <li>• name the interconnections between energy resources, food and raw materials for process industries</li> <li>• explain the theory and consequences of peak oil</li> <li>• give an oral presentation of a scientific topic</li> <li>• use scientific search engines</li> </ul>
<b>Content</b>	The conversion processes from fossil and biomass resources to end products, mainly fuels and biofuels, are introduced. Such processes are e.g. oil refining, gas-to-liquids, coal-to-liquids and biomass-to-liquids. The natural resources have geological and/or ecological limits, and the conversion processes have physical, technological and economical limits. Global and Finnish chemical, forest and metallurgical process industries and some main chemical processes are also introduced.
<b>Modes of Study</b>	Lectures and seminars 21 h, 3rd. period. Lectures 14 h, 4th period. Lectures, seminars and homework. Examination is based on lectures and other course material.
<b>Evaluation</b>	0-5, examination 80 %, seminars 20 %, approved homework.
<b>Study materials</b>	Lecture material, articles and other literature.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.

<b>BJ90A1100</b>	<b>HYDROMETALLURGY</b> <b>4 ECTS cr</b>
	<b>Hydrometallurgy</b>
	<b>The course will be lectured every other year, next during the academic year 2011 - 2012.</b>
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 1-2
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Erkki Paatero

<b>Aims</b>	After a module a student can <ul style="list-style-type: none"> <li>• explain the fundamentals of hydrometallurgy</li> <li>• list the most important methods and equipment used for hydrometallurgical processes</li> <li>• name real industrial hydrometallurgical cases worldwide</li> </ul>
<b>Content</b>	Solution chemistry in metallurgical solutions and use of the Eh-pH diagram. Leaching and treatment of leach solutions by adsorption, ion exchange, solvent extraction and precipitation. Electrochemical methods.
<b>Modes of Study</b>	Intensive course. Lectures and exercises 28 h, 1st-2nd period.
<b>Evaluation</b>	0-5, written examination 100%, exercises passed.
<b>Study materials</b>	Fathi Habashi, Textbook of Hydrometallurgy, Metallurgie Extractive Quebec, 2nd edition, 1999.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

### Obligatory modules from Energy Technology

<b>BH20A0300</b>	<b>FUNDAMENTALS OF HEAT TRANSFER</b>	<b>3 ECTS cr</b>
	<b>Lämmönsiirron perusteet</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 3, Period 1-2	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Timo Hyppänen Person in Charge: Professor, D.Sc. (Tech.) Timo Hyppänen	
<b>Aims</b>	After a course a student <ul style="list-style-type: none"> <li>• knows the basic phenomena and the laws of heat conduction, convection and radiation and can apply these in analyzing practical heat transfer cases.</li> <li>• can apply fin theories in heat conduction and convection, how to use lumped methods in unsteady conduction cases.</li> <li>• knows the meaning of boundary layers and can apply experimental correlations in analyzing free convection, boiling and condensation.</li> <li>• can apply theories of heat exchangers in analysing and designing heat exchangers.</li> </ul>	
<b>Content</b>	Stationary heat conduction, fin theory, unsteady heat conduction – lumped model, basics of boundary layers, forced and free convection, coiling and condensation, heat exchangers, basics of radiative heat transfer.	
<b>Modes of Study</b>	1st period: 10 h of lectures, 12 h of tutorials. 2nd period: 10 h of lectures, 12 h of tutorials. Students must complete the compulsory tutorials and home work before taking the examination.	
<b>Evaluation</b>	0-5, examination and homework	
<b>Study materials</b>	Incropera, De Witt: Fundamentals of Heat and Mass Transfer. Holman J.P.: Heat Transfer. Noppa: Luentomateriaali Blackboard.	
<b>Prerequisites</b>	Students are required to have attended the lectures of BH20A0800 Teknillinen termodynamiikka.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BH20A0700</b>	<b>FUNDAMENTALS OF ENGINEERING THERMODYNAMICS</b>	<b>2 ECTS cr</b>
	<b>Teknillisen termodynamiikan perusteet</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 2	
<b>Teacher(s)</b>	Researcher/Teacher, D.Sc. (Tech.) Tero Tynjälä Person in Charge: Professor, D.Sc. (Tech.) Timo Hyppänen	
<b>Aims</b>	After passing the course the student	

<b>Content</b>	<ul style="list-style-type: none"> <li>• knows fundamental concepts and definitions, such as, temperature, property of substance, types of systems, processes, forms of energy and laws of thermodynamics.</li> <li>• can use thermodynamic tables and charts for retrieving physical properties.</li> <li>• can formulate energy balance for a general open system based on first law of thermodynamics.</li> <li>• can solve work and heat as well as change of entropy in compression or expansion processes of ideal gas.</li> <li>• knows working principles of different power cycles and concepts such as Carnot efficiency and maximum thermal efficiency of a power cycle.</li> </ul>
<b>Modes of Study</b>	<p>1. Introductory concepts  2. Properties, ideal and real gases  3. Energy and work, heat and the first Law.  4. Calculation of work, isothermal, isentropic and polytropic compression and expansion  5. Second law, Carnot-process, isentropic efficiency, cycles.  6. Thermoeconomics, exergy.</p> <p>2nd period: 12 h of lectures, 12 h of tutorials.  Multiple choice (Quiz) assignments. Students must complete the compulsory tutorials before taking the examination.</p>
<b>Evaluation</b>	0-5 exam 80%, quiz assignments 20 %
<b>Study materials</b>	Moran, M.J. & Shapiro, H.N.: Fundamentals of Engineering Thermodynamics, 5 th ed. 2004.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.

<b>BH40A0250</b>	<b>PUMPS, BLOWERS, FANS AND COMPRESSORS</b>	<b>2 ECTS cr</b>
<b>Year and Period</b>	Pumput, puhaltimet ja kompressorit (Kete)	
<b>Aims</b>	B.Sc. (Tech.) 3, Period 1 After the course the student	
<b>Content</b>	<ul style="list-style-type: none"> <li>• knows the structure and operational principle of pumps, blowers, fans and compressors, and is able to choose the appropriate type for different applications.</li> <li>• will obtain sufficient knowledge for economical optimization and for sale or purchase meetings.</li> <li>• will obtain basic knowledge to design these machines. Difference if compared to the extensive course BH40A0200: kinetic compressors and centrifugal pumps are not considered in details.</li> </ul>	
<b>Modes of Study</b>	Different types of pumps and their operating principles. Different types of compressors and how they work. Different types of blowers and how they work. Process applications, selection and control.	
<b>Evaluation</b>	Lectures 10 h, tutorials 10h, 1st period.	
<b>Study materials</b>	Written examination. Lectures together with course BH40A0200.	
<b>Prerequisites</b>	0-5, exam 100%	
<b>Further Information</b>	Luentomateriaali Blackboardissa. Airila, Mauri et al.: Kompressorikirja. Wirzenius, A.: Keskipakopumput. Seppänen, O.: Ilmastointiteknikka ja sisäilmasto (puhaltimet). Larjola, Jaakko: Radiaalikompressorit. Recommended: BH40A1400 Fluid Dynamics attended. This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BH40A1400</b>	<b>FLUID DYNAMICS I</b>	<b>3 ECTS cr</b>
<b>Year and Period</b>	Virtaustekniikka I	
<b>Teacher(s)</b>	B.Sc. (Tech.) 2, Period 3	
<b>Aims</b>	Professor, D.Sc. (Tech.) Jaakko Larjola After the course the student	
<b>Content</b>	<ul style="list-style-type: none"> <li>• knows the basics of fluid dynamics including basic equations, and basics of fluid statics.</li> <li>• is able to calculate pressure loss in pipelines and ducts, including optimization.</li> <li>• knows the principle of stability of floating objects</li> </ul>	

	<ul style="list-style-type: none"> <li>• is able to calculate hydrostatic pressure</li> <li>• can select suitable measuring device to measure fluid velocity and volumetric flow.</li> </ul>
<b>Content</b>	Introduction, fluid statics, continuity and momentum equations, the Bernoulli Equation, flow measurements and diffusers, dimensional analysis, flow in pipelines, buoyant force, hydrostatic pressure, fluid flow measurements.
<b>Modes of Study</b>	3rd period: 16 h of lectures, 14 h of tutorials. Written examination.
<b>Evaluation</b>	0-5, exam 100%.
<b>Study materials</b>	Some material in Blackboard. White, F. M.; Fluid mechanics. 5th ed. Munson, B. R., Young, D. F., Okiishi, T.H.: Fundamentals of Fluid Mechanics. Bohl, W.: Teknillinen virtausoppi.
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.

### Obligatory modules from Mechanical Engineering

<b>BK20A1901</b>	<b>BASICS OF TECHNICAL DRAWING</b>	<b>2 op</b>
	<b>Teknisen piirustuksen perusteet</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 1	
<b>Teacher(s)</b>	Associate Professor, Lic.Sc. (Tech.) Raimo Suoranta	
<b>Aims</b>	After a course a student <ul style="list-style-type: none"> <li>• knows the principles of documents of technical design document</li> <li>• knows basics of the usage of computer aided drawing</li> </ul>	
<b>Content</b>	Basic knowledge of technical drawing standarts. Instructions for drawing and sizing. Process and P&I flowsheets.	
<b>Modes of Study</b>	Lectures 14 h, 1st period.	
<b>Evaluation</b>	0-5, exam 100 %.	
<b>Study materials</b>	Heikkilä, Matti: Tekniset piirustukset. Lecture notes	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

### Obligatory modules from Technomathematics and Technical Physics

<b>BM20A0000</b>	<b>MATHEMATICS SÄENKEA1</b>	<b>3 ECTS cr</b>
	<b>Matematiikka SäEnKeA1</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 1	
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Matti Alatalo	
<b>Aims</b>	After passing the course the student can <ul style="list-style-type: none"> <li>• calculate derivatives and integrals of single variable functions and apply them</li> <li>• study the behavior and extreme values of functions.</li> </ul>	
<b>Content</b>	Basics of differential and integral calculus with one-variable functions.	
<b>Modes of Study</b>	Lectures 36 h, exercises 12 h, homework, 1st period. Exam.	
<b>Evaluation</b>	0-5, examination 100%. Homework.	
<b>Study materials</b>	Online material in course's homepage. Adams, R.A.: Calculus, A Complete Course, Addison-Wesley. Råde, Lennart & Westergren, Bertil: Mathematics handbook for science and engineering, Studentlitteratur.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BM20A0200</b>	<b>MATHEMATICS SÄENKEA2</b>	<b>5 ECTS cr</b>
<b>Year and Period</b> <b>Teacher(s)</b> <b>Aims</b>	<b>Matematiikka SäEnKeA2</b> B.Sc. (Tech.) 1, Period 1-2 Professor, D.Sc. (Tech.) Matti Alatalo After passing the course the student can	
<b>Content</b>	<ul style="list-style-type: none"> <li>• calculate analytic and numeric integrals</li> <li>• apply integrals to the calculation of, e.g., areas, volumes and arc lengths</li> <li>• understand the essential concepts related to conic sections and apply them to geometry</li> <li>• use and analyze parametric curves</li> <li>• perform basic calculations with vectors and apply vectors in three-dimensional geometry</li> <li>• understand the basic concepts related to sequences and series and their convergence criteria</li> <li>• understand the basic concepts related with complex numbers.</li> </ul>	
<b>Modes of Study</b>	Basics and applications of integral calculus involving functions with one variable, theory of series, analytical geometry with vectors, and complex numbers.	
<b>Evaluation</b>	Lectures 6 h, homework, 1st period.	
<b>Study materials</b>	Lectures 42 h, tutorials 16 h, homework, 2nd period. Examination. 0-5, examination 100%. Homework.	
<b>Further Information</b>	Online material in course's homepage. Adams, R.A.: Calculus, A Complete Course, Addison-Wesley. Råde, Lennart & Westergren, Bertil: Mathematics handbook for science and engineering, Studentlitteratur.	
	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BM20A0400</b>	<b>MATHEMATICS SÄENKEB1</b>	<b>3 ECTS cr</b>
<b>Year and Period</b> <b>Teacher(s)</b> <b>Aims</b>	<b>Matematiikka SäEnKeB1</b> B.Sc. (Tech.) 1, Period 3 Professor, D.Sc. (Tech.) Matti Alatalo After passing the course the student can	
<b>Content</b>	<ul style="list-style-type: none"> <li>• calculate and use the partial derivatives of functions of several variable</li> <li>• solve simple optimization problems analytically</li> <li>• use some methods for error estimation in experimental measurements</li> <li>• understand the concept of two-dimensional integral.</li> </ul>	
<b>Modes of Study</b>	Multivariable functions in differential calculus.	
<b>Evaluation</b>	Lectures 30 h, tutorials 10 h, homework, 3rd period. Examination.	
<b>Study materials</b>	0-5, examination 100%. Online material in course's homepage. Adams, R.A.: Calculus, A Complete Course, Addison-Wesley. Kreyszig, E.: Advanced Engineering Mathematics, John Wiley & Sons. Råde, Lennart & Westergren, Bertil: Mathematics handbook for science and engineering, Studentlitteratur.	
<b>Prerequisites</b>	Recommended: BM20A0000 Matematiikka SäEnKeA1, BM20A0200 Matematiikka SäEnKeA2.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BM20A0600</b>	<b>MATHEMATICS SÄENKEB2</b>	<b>2 ECTS cr</b>
<b>Year and Period</b> <b>Teacher(s)</b> <b>Aims</b>	<b>Matematiikka SäEnKeB2</b> B.Sc. (Tech.) 1, Period 3-4 Professor, D.Sc. (Tech.) Matti Alatalo After passing the course the student can	

<b>Content</b>	<ul style="list-style-type: none"> <li>perform the basic matrix operations</li> <li>understand the concepts of inverse matrix and eigenvalues</li> <li>study and solve systems of equations using matrices.</li> </ul>
<b>Modes of Study</b>	Matrices, solving linear equations, and eigenvalue theory. Lectures 12 h, exercises 2 h, homework, 3rd period. Lectures 6 h, exercises 4 h, homework, 4th period. Examination.
<b>Evaluation</b>	0-5, examination 100%. Homework.
<b>Study materials</b>	Online material in course's homepage. Adams, R.A.: Calculus, A Complete Course, Addison-Wesley. Kreyszig, E.: Advanced Engineering Mathematics, John Wiley & Sons. Råde, Lennart & Westergren, Bertil: Mathematics handbook for science and engineering, Studentlitteratur.
<b>Prerequisites</b>	Recommended: BM20A0000 Matematiikka SäEnKeA1, BM20A0200 Matematiikka SäEnKeA2.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.

<b>BM20A0800</b>	<b>MATHEMATICS SÄENKEB3</b>	<b>3 ECTS cr</b>
<b>Year and Period</b>	<b>Matematiikka SäEnKeB3</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 1, Period 4 Professor, D.Sc. (Tech.) Matti Alatalo	
<b>Aims</b>	After passing the course the student can <ul style="list-style-type: none"> <li>solve first, second and higher order differential equation</li> <li>solve and analyze systems of differential equations</li> <li>apply differential equations to simple physics problems.</li> </ul>	
<b>Content</b>	Basic concepts of regular differential equations and their solutions. Linear differential equations with constant coefficients, equation groups.	
<b>Modes of Study</b>	Lectures 36 h, tutorials 12 h, homework, 4th period. Examination.	
<b>Evaluation</b>	0-5, examination 100%. Homework.	
<b>Study materials</b>	Online material in course's homepage. Adams, R.A.: Calculus, A Complete Course, Addison-Wesley. Kreyszig, E.: Advanced Engineering Mathematics, John Wiley & Sons. Råde, Lennart & Westergren, Bertil: Mathematics handbook for science and engineering, Studentlitteratur.	
<b>Prerequisites</b>	Recommended: BM20A0000 Matematiikka SäEnKeA1, BM20A0200 Matematiikka SäEnKeA2 and BM20A0600 Matematiikka SäEnKeB2.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BM20A1401</b>	<b>STATISTICS I</b>	<b>3 ECTS cr</b>
<b>Year and Period</b>	<b>Tilastomatematiikka I</b>	
<b>Teacher(s)</b>	B.Sc. (Tech.) 2, Period 1 Lecturer, Lic.Phil. Sirkku Parviainen	
<b>Aims</b>	After the course the student should <ul style="list-style-type: none"> <li>know the basic concepts and notation of probability and statistics</li> <li>know how to calculate probabilities and use the most common probability distributions</li> <li>draw justifiable conclusions from data by estimating parameters and testing hypotheses</li> <li>know how to fit a linear regression model to data to study the dependence between two variables.</li> </ul>	
<b>Content</b>	Random variables and basic probability distributions. Basic data analysis. Basics of statistical inference. Parameter estimation. Testing of hypotheses. Correlation and simple linear regression analysis. Use of statistical software.	
<b>Modes of Study</b>	Lectures 28 h, exercises 14 h, homework, 1st period. Exam.	
<b>Evaluation</b>	0-5, examination 100%.	

<b>Study materials</b>	Lecture notes. Hayter, A.J.: Probability and Statistics for Engineers and Scientists, Duxbury, 2002. Other literature announced by the teacher.
<b>Prerequisites</b>	Recommended: Mathematics A and B.

<b>BM20A1501</b>	<b>NUMERICAL METHODS I</b>	<b>3 ECTS cr</b>
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 3	
<b>Teacher(s)</b>	Lecturer, B.A. Pauli Welling	
<b>Aims</b>	Student is able to <ul style="list-style-type: none"> <li>• solve with Matlab the problems in content.</li> </ul>	
<b>Content</b>	Computational errors. Numerical solutions to nonlinear equations and systems of equations, linear systems of equations, interpolation, curve fitting.	
<b>Modes of Study</b>	Lectures 28 h, exercises 14 h, homework, 2nd period. Assignment. Exam.	
<b>Evaluation</b>	0-5, exam 100%. Homework and assignment.	
<b>Study materials</b>	Haataja, Juha et al.: Numeeriset menetelmät käytännössä, 2nd revised edition, CSC-Tieteellinen laskenta, 2002. 415 p. Gerald, C.F., Wheatley, P.O.: Applied Numerical Analysis, 6th Edition, Addison-Wesley, 1999. Mäkinen, Raino & Salmenjoki, Kimmo: Numeeriset menetelmät, Jyväskylän yliopisto, luentomoniste 12, 1999.	
<b>Prerequisites</b>	Recommended: Mathematics A and B.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BM20A1900</b>	<b>STATISTICS II</b>	<b>3 ECTS cr</b>
	<b>Statistics II, Tilastomatemiikka II</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 2	
<b>Teacher(s)</b>	Professor, Ph.D. Matti Heiliö	
<b>Aims</b>	The student <ul style="list-style-type: none"> <li>• acquires understanding of basic and some advanced statistical methods</li> <li>• is able to formulate models and apply these methods to various areas in technology, economics and science.</li> </ul>	
<b>Content</b>	Statistical inference: hypothesis testing, two sample tests. Nonparametric tests. Basics of analysis of variance, time series analysis and multiple regression models. Introduction to nonlinear regression. Elements decision theory. Introduction to multivariate methods. Principal component analysis. Suitable also for postgraduate studies.	
<b>Modes of Study</b>	Lectures 28 h, exercises 14 h, home assignments, 2nd period. Exam.	
<b>Evaluation</b>	0-5, examination 80%, home assignments 20%.	
<b>Study materials</b>	Will be announced at lectures.	
<b>Prerequisites</b>	Recommended BM20A1401 Tilastomatemiikka I.	
<b>Further Information</b>	This course has 6-10 places for open university students. More information on the web site for open university instruction.	

<b>BM20A2701</b>	<b>NUMERICAL METHODS II</b>	<b>3 ECTS cr</b>
	<b>Numerical Methods II, Numeeriset menetelmät II</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 4	
<b>Teacher(s)</b>	Professor, Ph.D. Heikki Haario	
<b>Aims</b>	After a course a student <ul style="list-style-type: none"> <li>• knows numerical methods for differentiation, integration, interpolation and differential equations, and numerical methods for linear systems.</li> <li>• understands the basic concepts of numerical analysis</li> <li>• is able to independently use numerical software (Matlab solvers).</li> </ul>	

<b>Content</b>	Numerical differentiation and integration. Interpolation methods in 1D and 2D. Numerical matrix calculations with applications. Over- and underdetermined linear systems, singular values of a matrix, principal components. Ill-posed linear problems and regularized solutions.
<b>Modes of Study</b>	Lectures 21 h, exercises 14 h, 4th period. Exam.
<b>Evaluation</b>	0-5, examination 100%.
<b>Study materials</b>	Will be announced at lectures.
<b>Prerequisites</b>	Mathematics A and B. Recommended BM20A1501 Numeeriset menetelmät I.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

<b>BM20A3900</b>	<b>MODELLING METHODOLOGY IN PROCESS ENGINEERING</b>	<b>6 ECTS cr</b>
	<b>Modelling Methodology in Process Engineering, Mallinnus prosessitekniikassa</b>	
<b>Year and Period</b>	M.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Researcher/Teacher, Ph.D. Tuomo Kauranne M. Sc. (Tech.) Ville Manninen Miika Tolonen	
<b>Aims</b>	Person in Charge: Researcher/Teacher, Ph.D. Tuomo Kauranne The student <ul style="list-style-type: none"> <li>• knows the principles of regression analysis and mathematical modeling in process engineering</li> <li>• is able to build simple mathematical models for chemical processes using Matlab and calibrate their parameters with measurement data.</li> </ul>	
<b>Content</b>	Types of modelling: empirical and physicochemical models and their uses. Measurement of uncertainty in experimental data. Basic concepts of regression methods for empirical models. Building physicochemical models for engineering processes from first principles. How to employ various mathematical tools to formulate and numerically solve models. Least squares methods, curve fitting, parameter estimation and data assimilation. Examples from data analysis, process modelling, pulp and paper technology, chemical engineering, and signal processing among others. Examples and exercises with Matlab.	
<b>Modes of Study</b>	Lectures 21 h, exercises 14 h, 1st period.	
<b>Evaluation</b>	Lectures 21 h, exercises 14 h, 2nd period. Practical assignment. Exam.	
<b>Study materials</b>	0-5, examination 70%, practical assignment 30%. Giordano, Frank R. - Weir, Maurice D. - Fox, William P.: A first course in mathematical modeling, Brooks/Cole, 1997. Borrelli, R., Coleman, C.: Differential Equations: A Modeling Perspective, John Wiley & Sons, 2003. Svobodny, T.: Mathematical Modeling for Industry and Engineering, Prentice Hall, 1998.	
<b>Prerequisites</b>	Mathematics A and B. Recommended BM20A1401 Tilastomatemiikka I, BM20A1501 Numeeriset menetelmät I, BM20A1601 Matriisilaskenta, BM20A2102 Differential Equations.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	

<b>BM20A4301</b>	<b>INTRODUCTION TO TECHNICAL COMPUTATION</b>	<b>4 ECTS cr</b>
	<b>Johdatus tekniseen laskentaan</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 4	
<b>Teacher(s)</b>	Researcher/Teacher, Ph.D. Tuomo Kauranne M. Sc. (Tech.) Ville Manninen Miika Tolonen	
<b>Aims</b>	After a course <ul style="list-style-type: none"> <li>• Student knows fundamentals of technical computing and programming.</li> <li>• Student can write simple computational programs and visualize results and data in MATLAB/Octave environment.</li> <li>• Student learns some specific engineering tool/programming environment (in addition to MATLAB/Octave).</li> </ul>	

<b>Content</b>	Fundamentals of technical computing and programming. Logical operations, control structures, branching, loops. Visualization. Use of functions. MATLAB/Octave as tool for computations.	
<b>Modes of Study</b>	Lectures 14 h, computer class exercises 28 h, 4th period.	
<b>Evaluation</b>	0–5 , exam 100%.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BM20A4310</b>	<b>PRACTICAL ASSIGNMENT IN TECHNICAL COMPUTATION</b>	<b>1 ECTS cr</b>
	<b>Teknisen laskennan harjoitustyö</b>	
	<b>The course will be lectured every other year, next during the academic year 2010 - 2011.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 4	
<b>Aims</b>	After a course <ul style="list-style-type: none"> <li>• Student can use some specific engineering tool/programming software</li> <li>• Student can write a report about the assignment he/she has done</li> </ul>	
<b>Modes of Study</b>	Personal assignment	
<b>Evaluation</b>	Pass/Fail	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BM30A0210</b>	<b>PHYSICS L, PART 1</b>	<b>5 ECTS cr</b>
	<b>Fysiikka L, osa 1</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 1-2	
<b>Teacher(s)</b>	Lecturer, Ph.D. Pertti Sikanen	
<b>Aims</b>	The student can <ul style="list-style-type: none"> <li>• apply Newton's laws and conservation laws to describe moving and rotating bodies</li> <li>• solve simple problems in statics.</li> </ul>	
<b>Content</b>	Mechanics: dynamics, Newton's laws, conservation laws, statics.	
<b>Modes of Study</b>	Lectures 28 h, exercises 14/28 h, 1st period. Lectures 8 h exercises 4/8 h, 2nd period. Recommended exercises 2 x 2 h/week if less than four courses of physics were taken by the student in upper secondary school. For students who have studied more physics, exercises 2 h/week.	
<b>Evaluation</b>	Two intermediate tests or alternatively a written examination. 0-5, examination 100%.	
<b>Study materials</b>	P. Sikanen, Fysiikka L osa 1, Mekaniikka.	
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.	
<b>BM30A0220</b>	<b>PHYSICS L, PART 2</b>	<b>2 ECTS cr</b>
	<b>Fysiikka L, osa 2</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1, Period 2	
<b>Teacher(s)</b>	Lecturer, Ph.D. Pertti Sikanen	
<b>Aims</b>	The student <ul style="list-style-type: none"> <li>• knows general thermal properties of materials</li> <li>• can apply basic laws of thermodynamics</li> <li>• knows basic principles of heat engines.</li> </ul>	
<b>Content</b>	Thermodynamics: Thermal properties of matter. Basic laws of thermodynamics. Heat engines.	
<b>Modes of Study</b>	Lectures 20 h, exercises 20 h, 2nd period. Recommended exercises 2 x 2 h/week if less than four courses of physics were completed by the student in upper secondary school. For students who have studied more physics, exercises 2 h/week.	
<b>Evaluation</b>	Written examination. 0-5, examination 100%.	

<b>Study materials</b>	P. Sikanen, Fysiikka L osa 2, Lämpöoppi.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.
<b>BM30A0230</b>	<b>PHYSICS L, PART 3</b> <span style="float: right;"><b>5 ECTS cr</b></span>
<b>Year and Period</b>	<b>Fysiikka L, osa 3</b> B.Sc. (Tech.) 1, Period 3-4
<b>Teacher(s)</b>	Lecturer, Ph.D. Pertti Sikanen
<b>Aims</b>	The student <ul style="list-style-type: none"> <li>• knows electric and magnetic properties of materials</li> <li>• can solve problems in electric and magnetic fields and electromagnetic induction</li> <li>• can solve problems in basic DC and AC circuits.</li> </ul>
<b>Content</b>	Electricity and magnetism: Electric and magnetic fields. Electromagnetic induction. Basic DC and AC circuits.
<b>Modes of Study</b>	Lectures 36 h, exercises 36 h, 3rd-4th period. Recommended exercises 2 x 2 h/week if less than four courses of physics have been completed in upper secondary school. For students who have studied more physics, exercises 2 h/week. Two intermediate tests or alternatively a written examination.
<b>Evaluation</b>	0-5, examination 100%.
<b>Study materials</b>	P. Sikanen, Fysiikka L osa 3, Sähköoppi.
<b>Further Information</b>	This course has 11-15 places for open university students. More information on the web site for open university instruction.

<b>BM30A0320</b>	<b>PHYSICS, LABORATORY COURSE (KETE, KOTE)</b> <span style="float: right;"><b>3 ECTS cr</b></span>
<b>Year and Period</b>	<b>Fysiikan laboratoriotyöt (KETE, KOTE)</b> B.Sc. (Tech.) 2, Period 2
<b>Teacher(s)</b>	Assistant, M.A. Elina Hujala
<b>Aims</b>	Person in Charge: Researcher/Teacher, Ph.D. Erik Vartiainen After a course a student <ul style="list-style-type: none"> <li>• knows measuring techniques</li> <li>• can write a scientific report</li> </ul>
<b>Content</b>	Scientific measurements, scientific data processing and scientific writing.
<b>Modes of Study</b>	Lectures 4 h, laboratory exercises 24 h, 1st period. Blackboard.
<b>Evaluation</b>	0-5, laboratory exercises 100%.
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

### Obligatory modules from Industrial Management

<b>CS31A0600</b>	<b>CAPITAL INVESTMENT APPRAISAL</b> <span style="float: right;"><b>5 ECTS cr</b></span>
<b>Year and Period</b>	<b>Investointilaskelmat</b> <b>Replaces the course CS30A0850 Investointilaskelmat.</b> B.Sc. (Tech.) 3, Period 1
<b>Teacher(s)</b>	Professor, D.Sc. (Tech.) Timo Kärri
<b>Aims</b>	Assistant, M.Sc. (Tech.) Sari Viskari The student can <ul style="list-style-type: none"> <li>• prepare investment proposals with different investment appraisal methods and evaluate them.</li> <li>• evaluate meanings of risk analysis and identify the need of capital.</li> </ul>

<b>Content</b>	Main content: Appraisal methods of capital investment projects. Discount rate and methods, net present value, internal rate of return, return on investment, payback period, benefit-cost ratio and profitability index. Supplementary content: Capital costs, sources of finance, initial investment and working capital, classification and selection of projects, uncertainty and risks.. Extra content: Life-cycle analysis, economic life of machines, concept of real option and use of calculation methods in specific situations.
<b>Modes of Study</b>	Lectures 26 h, exercises 21 h, peer tutoring. Blackboard online learning environment is used.
<b>Evaluation</b>	0-5, exam.
<b>Study materials</b>	Lecture notes (2 copies). Mott, Graham: Investment appraisal. Pitman Publishing, 1997, (196 p.). Kärri, Timo & Uusi-Rauva, Erkki: Investointiprojektin kustannussuunnittelun perusteet, Lappeenranta University of Technology, Lecture notes 14, 2003.
<b>Prerequisites</b>	CS31A0100 Johdon laskentatoimen peruskurssi
<b>Further Information</b>	This course has 1-5 places for open university students. More information on the web site for open university instruction.

### Obligatory modules from Language Centre

<i>FV13A1200</i>	<i>TECHNICAL SWEDISH</i>	<i>2 ECTS cr</i>
	<b>Teknisk svenska</b>	
	<b>This course is accepted as a demonstration of Swedish skills required for the technology degree.</b>	
<b>Year and Period</b>	B.Sc. (Tech.) 1-3, Period 1, 2, 3, 4	
<b>Teacher(s)</b>	Lecturer, M.A. Merja Naalisvaara-Jokinen Lecturer, M.A. Helena Söderholm Part-time Untenured Teacher, N. N.	
<b>CEF Level</b>	B1/B2	
<b>Aims</b>	By the end of the course, students <ul style="list-style-type: none"> <li>• able to read general technical texts and discuss the topics of such texts,</li> <li>• master basic grammatical structures</li> <li>• can discuss in different everyday communicational situations in swedish</li> </ul>	
<b>Content</b>	General technical articles: foreign trade, energy, IT, logistics, electricity, machines, forest engineering. Real-life situations and basic grammar. Language of instruction: Swedish.	
<b>Modes of Study</b>	Reading, writing, conversation and listening comprehension exercises. Contact hours 28, independent work approx. 24 hours. This course may also be completed in the form of independent study. Admission is based on a test. Further information available from the teachers. Written skills: passed written exercises, essay, learning diary and an exam. Oral skills: oral exercises during the lessons and an oral exam. Required attendance 80%. The evaluation of the oral skills is based both on continuous assessment and the oral exam, therefore regular attendance is expected.	
<b>Evaluation</b>	0 - 5, written part 50%, oral part 50%.	
<b>Study materials</b>	Material available on the lessons and on Blackboard.	
<b>Prerequisites</b>	If this is the student's compulsory Swedish course, the following are recommended: at least grade C in the matriculation examination, high school Swedish grade at least 7 if the matriculation exam has not been taken, course FV13A0100 or skills acquired through independent study (framework level B1). If taken as an optional course: compulsory Swedish course or language test.	
<i>FV18A1000</i>	<i>ORAL COMMUNICATION IN FINNISH</i>	<i>2 ECTS cr</i>
	<b>Puheviestintä</b>	
	<b>This course is meant for students with Finnish as their native</b>	

	<p><b>language. It is included in native language communication studies in accordance with the curricula of the university's degree programmes.</b></p>
<b>Year and Period</b>	B.Sc. (Tech.) 2, Period 1, 1-2, 2, 3, 3-4, 4
<b>Teacher(s)</b>	Lecturer, B.A. Tuure Westinen
<b>Aims</b>	<p>By the end of the course, students will</p> <ul style="list-style-type: none"> <li>• master the basics of oral communication</li> <li>• be more confident public speakers</li> <li>• know the elements that compose a natural and coherent oral presentation</li> <li>• know how meetings and negotiations are conducted.</li> </ul>
<b>Content</b>	Presentation exercises, meetings, negotiations and independent work.
<b>Modes of Study</b>	<p>Language of instruction: Finnish.</p> <p>The course consists of 28 contact hours and approximately 24 hours of independent work. The course is a compulsory part of Bachelor's studies in Energy Technology, Mechanical Engineering, Information Technology, Environmental Technology, Chemical Technology and Electrical Engineering.</p> <p>Students who have taken the course FV18A1500 Presentation Skills in Finnish are not eligible for this course.</p>
<b>Evaluation</b>	Assessment on a scale of 0 - 5: assignments 60% and independent work and exam at home 40%.
<b>Study materials</b>	Provided by the teacher during the lessons.

<b>FV18A4000</b>	<b>SCIENTIFIC WRITING IN FINNISH</b>	<b>1 ECTS cr</b>
	<b>Tekniikan tutkimusviestintä</b>	
	<p><b>This course is meant for students with Finnish as their native language. It is included in native language communication studies in accordance with the curricula of the university's degree programmes.</b></p>	
<b>Year and Period</b>	M.Sc. (Tech.) 1-2, Period 1, 2, 3, 4	
<b>Teacher(s)</b>	Lecturer, M.A. Esa Laihanen	
<b>Aims</b>	<p>By the end of the course, students will be able to</p> <ul style="list-style-type: none"> <li>• write and evaluate scientific texts in their own field</li> <li>• know what scientific writing is, what is required of scientific texts, and how a scientific text is constructed and revised.</li> </ul>	
<b>Content</b>	<p>Writing as part of the research process, how to organise writing, the elements of a scientific paper or report, summaries, headings, summaries with commentary, referencing, illustration with examples, usage.</p>	
<b>Modes of Study</b>	<p>Language of instruction: Finnish.</p> <p>Introductory lectures (6 h) in the form of intensive instruction. Independent online work (approx. 20 h), guidance and feedback.</p> <p>This course is included in Master's studies in Chemical Technology, Mechanical Engineering, Information Technology and Environmental Technology. In the degree programmes of Energy Technology and Industrial Management, this course may be included in alternative general studies in the Master's degree. It is meant for students writing their Master's thesis. It can and should be completed in parallel with the Master's thesis seminar. Students of Environmental Technology should complete it in parallel with BH10A0500 Thesis-writing Seminar for Students of Environmental Technology.</p>	
<b>Evaluation</b>	Pass/Fail. A passing grade requires successful completion of the assignments and a writing assignment related to the Master's thesis.	
<b>Study materials</b>	<p>Nykänen, Olli: Toimivaa tekstiä. Opas tekniikasta kirjoittaville.</p> <p>Hirsjärvi, Sirkka–Remes, Pirkko–Sajavaara, Paula: Tutki ja kirjoita.</p> <p>Online material: Kirjoittajan ABC-kortti (<a href="http://webcgi.oulu.fi/oykk/abc/">http://webcgi.oulu.fi/oykk/abc/</a>).</p> <p>Material provided by the teacher.</p>	
<b>Prerequisites</b>	It is assumed that students are working on their Master's thesis during the course.	