HÖGSKOLAN I BORÅS

Master Programme in Resource Recovery
Masterprogram i resursåtervinning
120 credits

Ladok Code: KMREC
Version: 2.0
Level: Second cycle
Approved by: Research and Education Board 2014-04-15
Valid from: Autumn 2015
Valid for:

General Objectives

Second level education shall essentially build on the knowledge that students acquire in first level education or corresponding knowledge. Second level education shall involve a deepening of knowledge, skills and abilities relative to first level education and, in addition to what applies to first level education, shall

- further develop the students' ability to independently integrate and use knowledge,
- develop the students' ability to deal with complex phenomena, issues and situations, and
- develop the students' potential for professional activities that demand considerable independence or for research and development work.

(The Higher Educations Act, Chapter 1, Section 9)

Objectives

Goal of the study programme

The overall goal of the study programme is to provide the student with the knowledge and skills required to develop and implement systems and techniques that favour a more resource-efficient society, primarily in the material, energy and resource recovery sectors. In this context, the programme is also to provide such knowledge and skills that allow the student to observe and critically review sustainability aspects, international aspects and ethical issues. The study programme is also intended to prepare the student for third-cycle studies.

Expected learning outcomes

1. Knowledge and understanding

- demonstrate knowledge and understanding in the field of resource recovery, which involves broad knowledge and very in-depth knowledge within certain areas of resource recovery, as well as in-depth insight into current research and development.
- The student must also demonstrate in-depth methodical knowledge in the field of resource recovery.

2. Skills and abilities

- have the ability to use complex phenomena, problems and situations concerning resource recovery to critically and systematically integrate knowledge and analyse, assess and handle this knowledge based on a technical, economic, environmental and social perspective, even if available information is limited.
- demonstrate the ability to critically, independently and creatively identify and formulate problems and plans and, with adequate methods, perform and evaluate qualified tasks within set time frames and thereby also contribute to the development of knowledge.
- be able to clearly recount and discuss – verbally and in writing – conclusions and findings and the knowledge and arguments that are the basis of these in dialogue with various groups, both in national and international contexts.
- have acquired the necessary proficiency to participate in research and development work or to independently work in another qualified field.

3. Judgement and Approach

- demonstrate an ability within the main field of study “resource recovery” to make assessments in consideration of scientific, societal and ethical aspects, and demonstrate an awareness of ethical aspects of research and development work.

- demonstrate insight into the possibilities and limitations of science, its role in society and human responsibility for its use.
- demonstrate the ability to identify the need for further knowledge and to take responsibility for their continued education.

Content

The programme comprises two years' full-time studies and has a strong link with the research conducted in the area of Resource Recovery at the University of Borås. All courses fall within the main field of study and are classed as second-cycle level.
As this area requires a multidisciplinary approach, the range of courses given during the first semester is intended to provide the students with broad knowledge and understanding of the main field of study. The students must also be given opportunities to major in one of the following areas: energy, industrial biotechnology and polymer technology. In the second year, the student further broadens their methodical knowledge and knowledge of a specialist area within Resource Recovery via the degree project; 60 credits.
Semester 1
The following courses are given during the first semester:

- Resource Recovery, 5 hec:
- Energy Recovery Processes, 5 hec
- Life Cycle Assessment, 5 hec
- Thermal Energy Recovery, 5 hec
- Biofuels & Biological Treatments of Wastes, 5 hec
- Introduction to Polymer Materials, 5 hec

The course *Energy Recovery processes* consolidates and develops the students' knowledge of technical thermodynamics and lays the foundations for upcoming courses such as Thermal Energy Recovery.
Resource Recovery provides an overview of how waste is handled internationally and nationally, of trends and legislation, and of waste characterisation, which is important in choosing the correct recovery technique. Social and economic aspects as catalysts or obstacles to resource recovery are also taken into consideration in the course.
The methodological course *Life Cycle Assessment* focuses on the LCA method along with its applications and limitations.
Various techniques for combustion and gasification of waste for electricity, heating and fuel are studied in the course *Thermal Energy Recovery*. There is also emphasis on the specific problems related to this type of fuel; the increased risk of corrosion and ash management.
The course *Biofuels & Biological Treatments of Wastes* provides the knowledge required to make assessments of the energy exchanges in various processes and suitability for the biological production of fuel; primarily biogas and bioethanol from waste and industrial waste products. The student will also gain knowledge of how to estimate the size of a bioreactor for this type of process.
An overview of how polymers are used in various industrial applications from a resource recovery perspective is an important part of the course *Introduction to Polymer Materials*.
Sustainability aspects are highlighted and discussed regularly in the various courses.
Semester 2
In this semester, the student initially chooses to major in one of the following areas: energy, industrial biotechnology and polymer technology. During the semester, there will be a greater element of laboratory assessments and large degree projects will be introduced in which more complex issues are tackled. The specialisation courses offered are described below;
Industrial Biotechnology
This specialisation broadens the student's knowledge of biological energy and material recovery, i.e., the conversion of waste and other waste products to biofuels and new materials. This course block is based primarily on the courses *Biofuels & Biological Treatments of Wastes, Resource Recovery, Life Cycle Assessment* and *Energy Recovery from Waste*.

- Biotechnology, 15 hec
- Bioprocess Design, 15 hec

The course block, with the courses *Biotechnology* and *Bioprocess Design*, looks at bacteria and microfungi with a focus on resource recovery and important products such as lactic acid, ethanol and biogas. Design of processes with flow-sheet programs constitutes an important part, as well as economic evaluation and analysis of various. The students also obtain skills in key methods for the areas of cell biology, biochemistry and microbiology.
Students with knowledge equivalent to the course Biotechnology, 15 hec, can study courses from one of the other specialisations. They are however unable to study the course Process Design - Energy Carrier Production.
This specialisation requires grounding in chemistry; see **Miscellaneous**.
Energy Technology
This specialisation provides the students with a broader knowledge of thermal energy recovery and of system design and system aspects in the production of heat, cooling and electricity from waste. The block is primarily based on the courses *Energy Recovery processes* and *Thermal Energy Recovery*, but Resource Recovery and Life Cycle Assessment are also important for the environmental impact analyses carried out.

- Introduction to Computational Modelling, 7.5 hec
- Modelling of Combustion Processes - Theory and Application, 7.5 hec

- Process Design - Energy Carrier Production, 15 hec

In the course *Introduction to Computational Modelling*, the students gain insight into modelling on a molecular level and modelling based on kinetic and thermodynamic models. Knowledge of modelling is broadened in *Modelling of Combustion Process - Theory and Application*, where the transport equations for primarily mass and heat transport are applied to the combustion process.
In *Process Design - Energy Carrier Production*, the students primarily conduct a system study in which a system for energy recovery is analysed and assessed from technical, economic and environmental perspectives.
Polymer Technology
This specialisation broadens the student's knowledge of material development and methods that facilitate opportunities for sustainable recovery of polymeric materials. The courses *Introduction to Polymer Materials, Resource Recovery* and *Life Cycle Assessment* constitute important grounding, as does *Energy Recovery processes*.

- Introduction to Computational Modelling, 7.5 hec
- Polymer Technology, 7.5 hec
- Polymer Material and Environment, 15 hec

In the course *Introduction to Computational Modelling*, the students gain insight into modelling on a molecular level and modelling based on kinetic and thermodynamic models.
The course *Polymer Technology* also goes over the key terms and concepts relevant to the use of polymeric materials and the processing necessary during recovery.
Polymer Materials and Environment looks at polymer materials' environmental impact and how they should be handled from a resource recovery perspective. The course therefore includes the material recovery of plastics, composites and textile fibres, as well as how polymer materials can be manufactured from bio-based raw materials and how polymer material waste can be managed with the use of biodegradation.
Courses, year 2 (third and fourth semesters)
Semesters 3 and 4 consist solely of a Degree Project, 60 hec.
In order to guarantee in-depth methodical knowledge and considerably broader knowledge, the student must carry out the independent work in the specialisation they have chosen; i.e. *energy, polymer technology or industrial biotechnology*.
In addition to the student's individual project, the degree project course includes tuition and seminars in information retrieval, the philosophy of science and research methodology.
The philosophy of science and research methodology are looked at both in general and more specifically in relation to each of the students' research projects.

Admission Requirements

Degree of Bachelor of Science or Bachelor of Science in Engineering with major in Mechanical Engineering, Industrial Business Economics, Energy Technology, Chemical Engineering, Biotechnology, Civil Engineering, Textile Engineering or Structural Engineering
or
bachelor's degree in physics or chemistry.
Knowledge of thermodynamics
Proficiency in English equivalent to :
IELTS (academic training), 6.5 (with no part of the test below 5.5)
or
TOEFL (Internet based): 90 (with a minimum of 20 on the written part)
or
TOEFL (paper based): 575 (with a minimum of 4.5 on the written part)
For further information about English language proficiency requirements, please view: http://www.hb.se/en/International-student/Application-and-Admission/Admission-Process/English-language-proficiency/

Degree

The programme normally leads to a degree with a major. The specialisations can be found under the study programme content. After completing studies equivalent to the requirements for each specialisation in this programme syllabus, the student can obtain the following degrees following application to the university (Swedish title):
Teknologie masterexamen med huvudområde resursåtervinning inriktning:

- polymerteknik
- energiteknik
- industriell bioteknik

English translation of the degree title:
Degree of Master of Science (Two Years) with a major in Resource Recovery specialisation

- Polymer Technology
- Energy Technology
- Industrial Biotechnology

The degree certificate is bilingual (Swedish/English). Alongside the degree certificate is the Diploma Supplement (English). The Diploma Supplement is an appendix that describes the position of the issued degree in the Swedish education system.

The degree certificate is issued upon request using a special form. Further information is available on the university's website.

Degree certificates are issued upon application on a special form. More information is available at www.hb.se.

Student Influence and Evaluation

All courses within the study programme are evaluated (see the university's policy for course evaluation). The programme coordinator is responsible for ensuring that the students' opinions on the programme are systematically and regularly collected. The programme coordinator and head of department are jointly responsible for ensuring the study programme is evaluated annually with the participation of students. The evaluation is documented in writing and the students receive feedback.

Miscellaneous

The programme is taught in English.
The choice of major is made during autumn semester one.
The industrial biotechnology specialisation requires a passing grade in a number of university-level chemistry courses.
Ref: 769-14

The language of instruction is English.