

# Curriculum for the Joint European Master in Environmental Studies- Cities & Sustainability (JEMES CiSu)

The Faculty of Engineering and Science  
Aalborg University

The School of Civil Engineering  
Technical University of Hamburg-Harburg

The Faculty of Sciences  
Autonomous University of Barcelona

The Department of Environment & Planning  
University of Aveiro

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**Preface**

Pursuant to the Danish Act 261 of March 18, 2015 on Universities (the University Act) with subsequent changes, the following curriculum for the Master programme in Environmental Studies Cities & Sustainability is stipulated. The programme also follows the Framework Provisions and the Examination Policies and Procedures for the Faculty of Engineering and Science, Aalborg University.

The Master's programme in Environmental Studies Cities & Sustainability is organised in accordance with the Portuguese Decree-Law 74/2006, 24 March. The programme also follows the University of Aveiro's procedures and regulations for the 1<sup>st</sup> and the 2<sup>nd</sup> degree studies.

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## **Chapter 1: Legal Basis of the Curriculum, etc.**

### **1.1 Basis in Ministerial Orders**

#### **1.1.1 Denmark**

The Master's programme in Environmental Studies is organised in accordance with the Ministry of Science, Technology and Innovation's Ministerial Order no. 814 of June 29, 2010 on Bachelor and Master Programmes at Universities (the Ministerial Order of the Study Programmes), Order no. 247 of March 3, 2015 on International Education Activities of Universities and Ministerial Order no. 670 of June 19, 2014 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 258 of March 18, 2015 (the Admission Order) and Ministerial Order no. 114 of February 3, 2015 (the Grading Scale Order) with subsequent changes.

#### **1.1.2 Germany**

The Master's programme in Environmental Studies is organised in accordance with the Hamburger Hochschulgesetz from 18 July 2001 (last change on 16 November 2010) and the examination regulations from 29 April 2009 of Technische Universität Hamburg-Harburg.

#### **1.1.3 Portugal**

The Master's programme in Environmental Studies (Mestrado em Estudos Ambientais) is organised in accordance with the Portuguese Decree-Law 74/2006, 24 March. It is registered in the General Direction for the Higher Education in Portugal with the number R/B-CR-67/2007) and published in the Decree-Law 220 (2)/2007, 15 November.

Following the recent development of quality assurance systems, namely those in the European space, the Portuguese state has decided to create the "Agência de Avaliação e Acreditação do Ensino Superior" (Agency for Assessment and Accreditation of Higher Education - A3ES), by means of Decree-Law no. 369/2007, of 5<sup>th</sup> November, aiming at promoting and ensuring the quality of higher education. The master programme in Environmental Studies was submitted to this Agency for Assessment and Accreditation of Higher Education and is preliminarily accredited.

#### **1.1.4 Spain**

The Joint European Master in Environmental Studies (Erasmus Mundus en Estudios Ambientals/Erasmus Mundus in Environmental Studies) is organised in accordance with the Spanish Royal Decree 861/2010, 2 July that regulates tertiary education under the framework of the European Higher Education Area and modifies the Royal Decree 1393/2007, 29 October. According to the Spanish Royal Decree 861/2010, the joint Master programmes that will be awarded with the Erasmus Mundus label by the European Commission will be automatically accredited and registered in the RUCT (The Register of Spanish Higher Education Institutions and Programmes) by the Spanish Ministry of Education. The accreditation will be effective as soon as the EACEA Agency notifies the Erasmus Mundus label awarding the consortium and the corresponding Spanish university sends the accreditation and registration request to the Spanish Ministry of Education. The previous JEMES programme was officially recognised by the Ministry of Education with the official establishment of the title published in the BOE (Official Spanish Bulletin) of June, 14 2006 (see attached certificate).

### **1.2 Faculty Affiliation**

The Master's programme falls under The Faculty of Engineering and Science, Aalborg University.

The Master's programme falls under The Faculty of Sciences, Universitat Autònoma de Barcelona

The Master's programme falls under the Department of Environment and Planning, Universidade de Aveiro.

The Master's programme falls under the School of Civil Engineering of the Technische Universität Hamburg-Harburg.

### **1.3 Board of Studies Affiliation**

The Master's programme falls under the Board of Studies of Planning & Geography under the School of Architecture, Design & Planning, Aalborg University.

The Master's programme falls under the Board of Studies of ICTA (Institut de Ciència i Tecnologia Ambientals), Universitat Autònoma de Barcelona.

The Master's programme falls under the Board of Studies of the Department of Environment and Planning, Universidade de Aveiro.

The Master's programme falls under the Board of Studies of the School of Civil Engineering (B), Hamburg University of Technology (TUHH).

## Chapter 2: Admission, Degree Designation, Programme Duration and Competence Profile

### 2.1 Admission

Admission to the Master's Programme in Environmental Studies requires:

- A Bachelor's degree or equivalent, at second-class (upper) level or higher, in an engineering, science, technology, or management subject
- An appropriate level of competence in the English language, through attaining a minimum of B2 (Independent User, Vantage) in the Common European Framework of Reference for Languages.

### 2.2 Degree Designation

The Master programme entitles the graduate to the designation Master of Science (MSc) in Environmental Studies - Cities & Sustainability (joint degree).

### 2.3 The Programme's Specification in ECTS Credits

The Master programme is a 2-year, research-based, full-time study programme. The programme is set to 120 ECTS credits.

### 2.4 Competence Profile of the Programme

The following competence profile will appear on the diploma:

The graduate will have acquired skills and competences through studies undertaken in a research environment.

On the basis of the studies, the graduate can perform highly specialized functions in the labor market. In addition, the graduate has qualifications for research (PhD studies). Compared to the undergraduate, the graduate has expanded expertise and independence, so that the graduate independently applies scientific theory and method in academic and occupational / professional contexts.

#### The graduate of the Master programme:

#### Knowledge

- Has profound knowledge in the following subject areas that, in selected topics, are based on the highest international research
  - Sustainable Development
  - Urban Planning
  - Ecological Economics
  - Environmental Processes
  - Air Pollution
  - Risk Analysis
  - Life-Cycle Assessment
  - Material and energy flow analysis
  - Environmental Management
  - Environmental Technology
- Can understand and, on a scientific basis, reflect on the subject areas' knowledge and identify scientific problems.
- In depth knowledge of relevant national and international research
- Has profound knowledge about the implications of research ethics
- Possesses expert understanding in extension of the previous degree / or a broad perspective on the discipline of the Bachelor degree / or new professional competence next to the Bachelor degree

- Possesses insight into and understanding of the societal conditions under which environmental and sustainability policies, strategies, plans, technologies and projects are implemented

#### Skills

- Excels in analysing complex urban environmental problems, designing new and innovative solutions, scientific methods and tools, and general skills related to employment within Environmental Studies
- Can evaluate and select among the subject areas' scientific theories, methods, tools and general skills and, on a scientific basis, advance new analyses and solutions
- Can communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists.

#### Competences

- Can manage work and development in complex and unpredictable situations requiring new solutions
- Can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility
- Can independently take responsibility for own professional development and specialisation
- Can act successfully in an international and inter-cultural environment

### Chapter 3: Content and Organisation of the Programme

The Master of Science in Environmental Studies – Cities and Sustainability (JEMES CiSu) is a unique 2-year programme offered jointly by the Institute of Environmental Technology and Energy Economics and Institute of Wastewater Management and Water Protection (Technische Universität Hamburg-Harburg, TUHH); the Department of Development & Planning (Aalborg University, AAU); the Institut de Ciència i Tecnologia Ambiental (Universitat Autònoma de Barcelona, UAB); and the Department of Environment and Planning (Universidade de Aveiro, UA), which enables excellent graduates with first degrees in engineering, science, management and technology to successfully deal with complex urban processes and problems across international, cultural and disciplinary boundaries.

Students study with at least two European Universities and the option of one further third country university with the programme's delivery over two years providing a greater depth of learning, more organisational engagement and a rich cultural experience.

The programme is full time over 24 months and divided into 4 semesters of study.

The programme focuses on one overarching theme: Cities & Sustainability,

The programme is divided in two sub-themes:

- Sustainability **Management & Planning** (with AAU, and UAB)
- Sustainable **Technologies & Processes** (with TUHH, and UA)

Students may start their studies at either Aalborg University or Universitat Autònoma de Barcelona and end their studies at any of the four participating universities. Students must, however, spend their second semester at either Technische Universität Hamburg-Harburg or Universidade de Aveiro. Furthermore, they will have the option to study half a semester (15 ECTS, up to three months) with associated partners (an updated list – December 2014 – is included in Annex 3 and available at all times from <http://www.jemes-cisu.eu>). A mobility overview is provided at the end of this document (Annex 1)

The programme is delivered in English, and the MSc degree is awarded jointly by all four European universities and issued by the JEMES CiSu programme coordinator, Aalborg University. The first semester focuses on providing students a strong and comprehensive foundation in understanding the complexities of urban development, globalization, sustainability and quality of life. The aim for the semester is preparation of suggestions to environmental and sustainability management improvements in the city context. The second semester offers a comprehensive focus on risk assessment and engineering solutions to various environmental, social, economic and political problem areas that cities exhibit, e.g. integrated waste management, air and water pollution, energy consumption. The aim of the semester is preparation of suggestions for technical improvements and development to solve complex problems associated with urban development and sustainability.

The 3<sup>rd</sup> semester has a strong focus on project work and gaining practical experience. It is dedicated to professional development and the semester will enable students to appreciate theoretical reflective work practice and challenges and to demonstrate proficiency in innovation and integration processes as well as management and implementation of technological and organisational change projects. The aim of the semester is to

1. Design and execute an individual project study within the topics of the programme
2. Gain practical experience within the subject field
3. Analyse and reflect on educational experiences and professional practice
4. Clarify the Master's Thesis topic.

It is the intention that the mobility to a third country and the work there is combined with comparative work in one of the European cities participating in the Master's course. This is

supported by one of the four European university partners through additional course modules, or supervision of the students' project work. During the 4<sup>th</sup> semester, the Master's Thesis is completed. In some cases and depending on the university, the Thesis may be combined with the 3<sup>rd</sup> semester in an extended Thesis. The Master's Thesis is co-supervised by at least 2 partner universities.

### 3.1 Overview of the Programme

The full programme is presented in the table below and in the following sections 3.2 to 3.5.

Semester	Module	ECTS	Grading	Exam
1 <sup>st</sup> (AAU)	Cities and Sustainability in a Management Perspective (project)	15	7-point scale	Internal
1 <sup>st</sup> (AAU)	Tools and Systems of Sustainable Development	5	Pass/fail	Internal
1 <sup>st</sup> (AAU)	Complexity, Inter-relationships, Synergies & Conflicts	5	Pass/fail	Internal
1 <sup>st</sup> (AAU)	Theories of Science and Research Designs	5	7-point scale	Internal
1 <sup>st</sup> (UAB)	Foundations of Ecological Economics	9	10-point scale	Internal
1 <sup>st</sup> (UAB)	Industrial Ecology	9	10-point scale	Internal
1 <sup>st</sup> (UAB)	Political Ecology	6	10-point scale	Internal
1 <sup>st</sup> (UAB)	Qualitative Methods for Social Science Research	6	10-point scale	Internal
2 <sup>nd</sup> (TUHH)	Waste and Energy	6	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	International Logistics and Transport Systems	6	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Management of Surface Water	6	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Urban Environmental Management	6	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Water and Wastewater Systems	6	5-point scale	Internal
2 <sup>nd</sup> (UA)	Air Pollution and Climate Change	6	20-point scale	Internal
2 <sup>nd</sup> (UA)	Natural, Technological and Industrial Risks	8	20-point scale	Internal
2 <sup>nd</sup> (UA)	Water Pollution	6	20-point scale	Internal
2 <sup>nd</sup> (UA)	Solid Waste	6	20-point scale	Internal
2 <sup>nd</sup> (UA)	Optional Course - <i>Integrated Coastal and Marine Management &amp; Planning</i> - <i>Research Methodology</i>	4 4	20-point scale 20-point scale	Internal
3 <sup>rd</sup>	Professional Development (project and/or courses) with associated partners in AUS, BR, CN, TH, USA	15	Depending on university	External
3 <sup>rd</sup> (AAU)	Option 1: Choice between course work (A) or Continued Professional Development (with or without internship) (B) - Option A o <i>Urban Development, Causes and Consequences</i> o <i>Sustainable Energy System Analysis</i> o <i>Current Topics in Research on Sustainable Development I</i> - Option B o <i>Continued Professional Development</i>	5 5 5 15	Pass/fail Pass/fail Pass/fail 7-point scale	Internal
3 <sup>rd</sup> (AAU)	Option 2: Full Semester: Courses and Research Project - Urban Development, Causes and Consequences - Sustainable Energy System Analysis - Current Topics in Research on Sustainable Development I - Business & Sustainability Management	5 5 5 15	Pass/Fail Pass/Fail Pass/Fail 7-point scale	Internal
3 <sup>rd</sup> (UAB)	Option 1 – Courses - Global Change - One of the following courses o <i>Waste Management</i> o <i>GIS</i>	9 6 6	10-point scale	Internal
3 <sup>rd</sup> (UAB)	Option 2 – Full semester - Research Project - Waste Management - Global Change - GIS	9 6 9 6	10-point scale	Internal
3 <sup>rd</sup> (TUHH)	Option 1 - Project Work	15	5-point scale	Internal
3 <sup>rd</sup> (TUHH)	Option 2 - Full semester: Combination of Research Project			



### 3.2.1 Aalborg University

#### Project Module (15 ECTS)

**Title:** *Cities and Sustainability in a Management Perspective*

**Aim:** Students passing the project module will acquire the following:

*Knowledge*

- Thorough knowledge and understanding of urban framework conditions, their challenges and roles in relation to sustainable development, and tools and systems to analyse those relevant in a city context
- Can understand and reflect on urban development with a scientific basis, as well as the ability to identify scientific problems in relation to this
- Have thorough knowledge about the complexity of interrelationships and influences between various changes in the land use and transport infrastructure of the city, and the behavioural, welfare-related, distributional, environmental and economic consequences of these changes

*Skills*

- Can identify, analyse, and evaluate project and sustainability relevant problems and consequences.
- Can understand, use and critically reflect on relevant quantitative as well as qualitative economical, sociological, environmental, and/or engineering science analysis methods, and identify interests associated to these.
- Can independently collect relevant data in relation to the project's problem and task, as well as evaluate the quality and reliability of these data.
- Can motivate, argue and disseminate the project's general structure and methods in a scientific context, and in addition be able to critically relate to sources of knowledge and information and reference these accurately.

*Competences*

- Can manage working and development situations in urban development that are complex, unforeseeable and require new solutions
- Can combine and connect relevant theories, comprehensions, methods and analyses in order for these to synthesise and form concrete strategies and plans aimed at organisations' possibilities to work with sustainable solutions in the urban context.
- Can independently initiate and implement disciplinary and interdisciplinary cooperation with relation to urban development and take professional responsibility
- Can independently take responsibility for own disciplinary development and specialisation with regard to the field of cities and sustainability

**Examination:** Oral exam in project groups and with point of departure in the project report. Internal examiner. Graded in accordance with the Danish 7-point scale.

**Evaluation criteria:** As stated in the Framework Provisions.

#### Course Modules (3 x 5 ECTS)

**Title:** *Theories of Science and Research Designs (5 ECTS)*

**Aim:** Students that complete the module acquire the following:

*Knowledge:*

- Understanding of the history and theoretical framework of theories of science at a graduate level
- Understanding of the relation between theories of science, research design and research methods at a graduate level
- Understanding of the contents and interrelation of the positions of theories of science and capability of relating critically to them
- Thorough knowledge of the relation to theories of science and research designs of own professional fields.

*Skills:*

- Capable of using the basic complex of problems of theories of science in relation to assessment of courses and references in projects at a graduate level
- Capable of independently assessing the value and reliability of own science production in relation to scientific basic complexes of problems
- Capable of using theories of science, research design and research methods within own fields at a graduate level
- Capable of imparting knowledge of theories of science and research designs to specialists as well as non-specialists.

*Competences:*

- Able to reflect critically on project-related choices of value bases, theories of science and methods
- Capable of continuous professional development through acquisition of new knowledge of the development and renewal of theories of science and research designs.

Teaching: Lectures, workshops, seminars, assignments and presentation, lecturer feedback, etc.

Examination: Written individual exam. Internal examiner. Graded in accordance with the Danish 7-point scale.

Evaluation criteria: As stated in the Framework Provisions.

**Title: *Tools and Systems of Sustainable Development (5 ECTS)***

Aim: Students that complete the module acquire the following:

*Knowledge*

- Have thorough knowledge of different types of tools and systems for promotion of a sustainable development on an organisation level
- Have understanding of strengths and weaknesses of different tools and systems in relation to the organizing context.

*Skills*

- Can analyze and assess different tools and approaches for anchoring of the environmental efforts in an organisation, just from mapping and documentation to ensure continuous environmental improvements through motivation, participation, etc.
- Can use different tools for a product-oriented environmental effort, including life cycle assessment, eco-design, etc.
- Can contribute to strengthening the social dimension in the effort around sustainability, including the introduction of Corporate Social Responsibility
- Can – by means of different tools – assess effects of both strategic and project approaches regarding sustainable development
- Can use theories on power, learning and organisation to assess which understanding of the context is embedded in different tools and systems.

### *Competences*

- Can reflect critically on project-related choices of tools and systems and their significance for the environmental work in an organisation
- Can currently adjust and adapt different tools and systems for the topical challenges and needs in an organisation.

Teaching: Lectures, seminars, workshops, simulations, assignments and presentation, lecturer feedback, etc.

Examination Written individual exam. Internal examiner. Pass/Fail.

**Title: Complexity, Inter-relationships, Synergies & Conflicts (5 ECTS)**

Aim: Students that complete the module acquire the following:

#### *Knowledge*

- Understanding of towns as complex systems, where a number of different contexts, structures, changes and states affect each other, and where the result of a single impact factor is conditional on the concurrent impact from a large number of other factors
- Understanding of how urban development approaches, which aim to meet certain needs and objectives, usually also have considerable consequences in relation to a number of other considerations and objectives
- Knowledge of mutual dependences between the nature-geographic/ecological context of towns, the built-up environment, the social life and conditions of the inhabitants and the economic framework conditions
- Thorough knowledge of important side effects of the most common strategies for promotion of social, environmental and economic considerations in the urban development
- Understanding of the challenges that the complexity of the towns imply for research into and theorizing about towns and the driving forces of urban development, processes and consequences.

#### *Skills*

- Can, on the basis of the complex connections of the town and urban development, independently combine knowledge from different relevant fields, start and carry through interdisciplinary co-operation and take a professional responsibility for interdisciplinary knowledge application when preparing solution proposals within urban planning
- Can carry out simple research investigations on urban and urban development related subjects where - in the methodical approach – the complex connections of the towns between different impact factors are taken into account.

### *Competences*

- Can critically analyze environmental, social and economic side effects of urban development approaches primarily starting from a certain need or a certain objective
- Can – on the basis of an analysis – prepare solution proposals in relation to a topical urban development problem, based on implication of knowledge and theories from different fields which cover the most important types of impact factors and consequences
- Can, in relation to complex towns, impart research-based knowledge and discuss professional and scientific problems with both colleagues and non-specialists.

Teaching: Lectures, seminars, assignments and presentation, lecture feedback.

Examination: Continuous assessment or active participation. Internal examiner. Pass/fail.

Evaluation criteria: As stated in the Framework Provisions.

### 3.2.2 Universitat Autònoma de Barcelona

#### Course Modules (2 x 9 ECTS, and 2 x 6 ECTS)

**Title:** *Foundations of Ecological Economics (9 ECTS)*

Aim: Students that complete the module acquire the following:

*Knowledge*

- The course will introduce the field of ecological economics, giving attention to theoretical, empirical and methodological issues. In particular, the course will include an overview of traditional topics of environmental economics and more recent developments within ecological economics.
- At the end of the course the student is expected to have a good understanding of:
  - i) The main themes, theories and methods addressed by ecological economics;
  - ii) The basic literature regarding ecological economics;
  - iii) The essential differences between the way environmental problems and solutions are approached in standard economics and Ecological Economics;
  - iv) New methods that have been proposed by, and are applied within, ecological economics

*Skills*

Students will be able to read research articles in ecological economics, and to prepare a research proposal for a master thesis in this field.

Teaching: Readings for each session will be assigned beforehand. Teaching time will be divided between explanation and question time. Students may be asked to prepare written essays too.

Evaluation: Essays and final exam. Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title:** *Industrial Ecology (9 ECTS)*

Aim: Students that complete the module acquire the following:

*Knowledge*

- Active interest in the study of the resource flows serving urban centres has grown dramatically in the past several years. Prompted by the broad awareness of the central role of cities to address resource scarcities, environmental degradation and global climate change, the urban metabolism framework has attracted researchers and policy-makers alike. After a brief introduction to Industrial Ecology, this module will provide the students with the tools offered by this field to assess and evaluate urban systems. The main tools addressed will be life cycle analysis and material and energy flow analysis.

*Skills*

- learn about different tools of Industrial Ecology and be able to apply them to systems at different levels, especially at urban level in order to understand and quantify its metabolism.

Teaching: Teaching and discussions will occur during class times, guided by particular readings and exercises. Some classes will be given in computer labs, and will have follow-up exercises.

Evaluation: The evaluation will be based on assistance to class, class projects, and class exercises. Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title: Political Ecology (6 ECTS)**

Aim: Students that complete the module acquire the following:  
*Knowledge*

- In this course we will explore the interdisciplinary field of Political Ecology. Political Ecology is a theoretical and methodological approach to the study of socio-ecological systems that focuses on conflict, power relationships and the unequal distribution of environmental costs and benefits. It seeks to “politicize” debates about environmental problems, and stands in contrast to a-political ecologies that explain environmental issues in terms of universal population, bio-physical, or human-behavioural drivers. This course aims to familiarize you with the key concepts and tools used by political ecologists and help you “do” political ecology. Unlike other sciences with which you might be familiar, political ecology does not work with experiments, models or quantitative analyses; it works with theoretical concepts, which it documents with case studies that combine qualitative and quantitative information in an empirically-backed narrative (“story”). Each class of this course will focus on a different key concept of political ecology, and use an important, published case-study article to illustrate how this concept is “put to work” in a real case.

*Skills*

- be able to apply theoretical and methodological approaches to the study of socio-ecological systems

Teaching: Classes will follow a seminar format with a combination of teaching by the instructor and discussion in class of assigned readings. For each class we will read and discuss two articles. Typically one of them will be more theoretical, presenting the main concept to be discussed in this class, and the second will include a case study, applying the concept in an environmental problem or conflict.

Evaluation: The final grade will be derived 70% from the exam and 30% from the group project. Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title: Qualitative Methods for Social Science Research (6 ECTS)**

Aim: Students that complete the module acquire the following:

*Knowledge*

- This module introduces the student to research methodologies in management and innovation, as well as research design, research ethics, qualitative data analysis, and qualitative computer tools. The module's purpose is to provide graduate students with the knowledge and skills they need for qualitative research (design, develop and write the report) and to evaluate the production of other researchers. Students must be able to design a qualitative study the purpose of research (epistemological and noun), choose the most appropriate sources of information (interviews, discussion meetings, life histories, visual records, biographical and autobiographical material, comments Internet), know how to use contemporary recording technology, making data analysis according to the research design and digital technologies available (computer assisted Qualitative data analysis software, CAQDAS), write an article and assess the quality of the research (its contribution to knowledge) and developed by other researchers. The seminar offers students the methodological and technological tools necessary to investigate different substantive areas of social sciences.

*Skills*

- The student should be able to apply social science methodologies for research and assess the quality of research.

Teaching: The main teaching methodology will be through lectures (approximately 65 hours) but discussions will occur during class times, guided by particular readings and exercises.

Evaluation: Evaluation will be based on assistance to class, class projects, class exercises and short exams. Graded in accordance with the Spanish 10-point scale. Internal examiner.

### 3.3 Environmental Studies, Cities & Sustainability, 2<sup>nd</sup> semester

The theme of the semester is Cities & Sustainability in an Engineering Perspective. The semester comprises workload of 30 ECTS that is either carried out at Technische Universität Hamburg-Harburg or Universidade de Aveiro.

#### 3.3.1 Technische Universität Hamburg-Harburg

##### Course Modules (5 x 6 ECTS)

**Title:** *Waste and Energy (6 ECTS)*

**Aim:** After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe and explain in detail techniques, processes and concepts for treatment and energy recovery from wastes.

*Capabilities:* Students are able to...

- select suitable processes for the treatment and energy recovery of wastes.
- evaluate the efforts and costs for processes and select economically feasible treatment concepts.
- evaluate alternatives even with incomplete information.
- prepare systematic documentation of work results in form of reports, presentations and are able to defend their findings in a group.

Personal Competence:

*Social Competence:* Students are able to...

- participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend their own work results in front of others and promote the scientific development of colleagues. Furthermore, they can give and accept professional constructive criticism.

*Autonomy:*

- Students can independently tap knowledge of the subject area and transform it to new questions. They are capable, in consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define targets for new application- or research-oriented duties in accordance with the potential social, economic and cultural impact.

**Teaching** Lectures, group work, assignments, exercises

**Examination:** Oral Exam based on project work. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** *International Logistics and Transport Systems (6 ECTS)*

**Aim:** After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- give definitions of system theory, (international) transport chains and logistics in the context of supply chain management explain trends and strategies for mobility of goods and logistics
- describe elements of integrated and multi-modal transport chains and their advantages and disadvantages

- deduce impacts of management decisions on logistics system and traffic system and explain how stakeholders influence them
- explain the correlations between economy and logistics systems, mobility of goods, space-time-structures and the traffic system as well as ecology and politics

*Capabilities:* Students are able to...

- Design intermodal transport chains and logistic concepts apply the commodity chain theory and case study analysis evaluate different international transport chains
- cope with differences in cultures that influence international transport chains

Personal Competence:

*Social Competence:* Students are able to...

- develop a feeling of social responsibility for their future jobs
- give constructive feedback to others about their presentation skills plan and execute teamwork tasks

*Autonomy:*

- Students are able to improve presentation skills by feedback of others

Teaching Lectures and assignments

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Management of Surface Water (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- define in detail the basic processes that are related to the modelling of flows in hydraulic engineering.
- describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows and waves.
- depict the concepts of nature oriented hydraulic engineering.

*Capabilities:* Students are able to...

- apply hydrodynamic-numerical models to practical hydraulic engineering tasks.
- set up flood-risk management concepts, and
- apply basic concepts of renaturation to practical problems.

Teaching Lectures and assignments

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Urban Environmental Management (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- identify and assess problems related to field of urban development by using appropriate sources/literature

- develop problem solving approaches substantiated by own ideas
- to suggest appropriate techniques for problem response (noise protection, urban water management, integration of renewable energies, urban flash flood prevention, climate change adaptation)

*Capabilities:* Students are able to...

- familiarize themselves very quickly with new urban related issues such as noise control, flood protection, integration of renewable energies, and many more
- work and write in a scientific way, to perform research work
- work on case studies by applying beforehand acquainted knowledge

Personal Competence:

*Social Competence:* Students are able to...

- prepare and hold presentations in front of an audience
- work in teams

*Autonomy:*

- plan and trace independently their work progress,
- respect and meet deadlines
- express themselves appropriately and to give ad-hoc statements

Teaching Lectures, Problem Based Learning, and assignments

Examination: Written report and presentation, evaluated by internal examiners, graded in accordance with the German 5-point scale

**Title:** ***Water and Wastewater Systems (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe the facets of the global water situation
- judge the potential of the implementation of synergistic systems in Water, Soil, Food and Energy supply.

*Capabilities:* Students are able to...

- design ecological settlements for different geographic and socio-economic conditions for the main climates around the world.

Personal Competence:

*Autonomy:* Students are able to...

- work on a subject and to organize their work flow independently. They can also present on this subject

Teaching Lectures

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

### 3.3.2 Universidade de Aveiro

#### Course Modules (1 x 8 ECTS, 3 x 6 ECTS, and option of 4 ECTS)

**Title:** *Natural, Technological and Industrial Risks (8 ECTS)*

Prerequisites: General knowledge on environmental systems

Aim: Students passing the course will acquire:

*Knowledge*

- on hazard, risk, disaster and vulnerability concepts
- on risk assessment and management;
- on risk perception and communication;
- on natural hazards (floods, droughts, fires, coastal erosion, diseases and epidemics);
- on technological hazards (major industrial accidents, accidents associated with transportation of dangerous goods, dam failure, etc);
- on social vulnerability and civil protection agency.

*Skills*

- the ability to characterise natural and technological hazards, in general, and to provide detailed information on relevant hazards at national or local level.
- to use tools in risk assessment and management in natural and technological hazards.

*Competences*

- in the field of risk assessment and management related to natural and technological hazards.
- to work in multi-disciplinary teams dealing with prevention and mitigation of natural and technological hazards

Teaching: Theoretical-practical classes, with the help of audio-visual equipment, where concepts, methods and techniques are presented analysed and debated, followed by practical applications and case studies. Student exploration of methods and techniques with teacher's support, both individually or in group

Examination: Continuous evaluation based on two moments, each of one including different elements: a) public presentation and discussion of work (50%), b) written report (50%). Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title:** *Air Pollution and Climate Change (6 ECTS)*

Prerequisites: Students must have basic knowledge on general physics and chemistry.

Aim: Students passing the course will acquire:

*Knowledge*

- on atmospheric pollutants and emission sources with an emphasis on urban air pollutants and greenhouse gases
- on basic physics and chemistry of air pollution, with a particular focus on urban areas specificities
- on air pollution effects, from the urban air quality problems to the climate change impacts, and on policy strategies to solve them.

*Skills*

- to identify, analyse and evaluate air pollution problems and consequences

- to critically reflect on air pollution problems, argue for and apply appropriate theories and practises in order to develop proposals for solutions
- to discuss about the importance of mitigation and adaptation strategies concerning climate change and the advantages and disadvantages of different policies and management tools

#### *Competences*

- to actively contribute, within a study and project air pollution context, with concrete methodologies and solutions
- to combine and connect relevant theories, comprehensions, methods and analyses to synthesise and form concrete strategies and plans to improve the quality of the air.

**Teaching:** Lectures where the concepts are exposed, with multimedia support, and discussed; analysis of problems and solution in classes (individual or in group) with a strong inter-relation work between students and the teacher. Students should prepare a monograph and present it orally. Field and laboratory experiments dedicated to the measurement of air pollutants.

**Examination:** Continuum assessment of the student's performance, including one written exam, work group reports, discussion and oral presentation of thematic work. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title:** ***Water Pollution (6 ECTS)***

**Prerequisites:** Science background including basic physics and chemistry

**Aim:** Provide the capacity for working with problems related with water quality control and management in urban context. Students passing the course will acquire the following

#### *Knowledge*

- Causes and effects of water pollution
- Processes controlling surface flow in urban areas
- Options for water and wastewater treatment

#### *Skills*

- Analyse the relation between water quality - water use - water pollution
- Use of techniques and parameters for measuring water quality and pollution loads
- Use of simple models in the analysis of the effects of water pollutants
- Selection of environmental technologies for management of urban water

#### *Competences*

- Capacity to work in projects aiming to reduce the environmental impact of urban water use

**Teaching:** Lectures, problem solving, writing a report and presenting a research topic.

**Examination:** Final exam including solving problems given during the semester. Preparing and presenting the research topic. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title: Solid Waste (6 ECTS)**

Prerequisites: Science background including basic physics and chemistry

Aim: Students passing the course will acquire the following

*Knowledge*

- Understand, analyse and characterize the solid waste management operations, in an integrated view, including technical parameters of treatment processes and environmental impact assessments, so as the main EU drivers and legislation for waste management

*Skills*

- The ability to establish mass and energy balance of the different processes of treatment
- The ability to establish processes in order to minimize costs and environment impacts, with or without material and/or energy recovery
- Apply the EU legislation about solid waste management
- Apply LCA models to integrated solid waste management

*Competences*

- Can, individually or being part of cross-disciplinary management team, define the most appropriate operations and technologies in order to manage a solid waste, supporting the decisions concerning the urban sustainability.

Teaching: Lectures, problem solving, writing a report and presenting a research topic.

Examination: Final exam including solving problems given during the semester. Preparing and presenting the research topic. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title: Integrated Coastal and Marine Management & Planning (4 ECTS) (optional course)**

Prerequisites: General knowledge of environmental systems

Aim: Students passing the course will acquire the following

*Knowledge*

- on evolution and contemporary importance of coastal issues at international, European and national level.
- concepts and definitions about the scientific and technical bases and discussion of sectorial perspectives
- on the need for coastal management – multiple coastal areas uses, benefits of coastal management
- on coastal management programmes – principles, goals and objectives, evaluation of pre-conditions to coastal zone management program development
- on coastal management actors – governmental institutions, non-governmental groups and citizens
- on coastal planning strategies – planning and management models, public policies.
- on monitoring and evaluation Instruments – sustainable development indicators, monitoring programs
- Information, training and education – the needs for information, training and education

### *Skills*

- The ability to reflection and interventional skills about coastal areas in *latus sensus*

### *Competences*

- To be able to individually or in a cross-disciplinary environment define, adapt and apply the current tools to deal with the actual spatial issues and problems of coastal and marine areas.
- To be able to define the expected scenarios of coastal issues and problems evolution.

Teaching: Lectures, facilitated problem-analysis and solving exercises in classes (individual or in group), field work, student presentations

Examination: Continuous evaluation based on written reports, oral presentations and debates (both individual and in group). Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title:** ***Research Methodology (4 ECTS) (optional course)***

Prerequisites: None

Aims Students passing the course will acquire the following

### *Knowledge*

- Introduction to research methodology as a contribution to thesis and paper preparation.
- How to do research, to present scientific work, to write a research proposal.
- Problem definition. Hypothesis formulation. State-of-the art. Aims. Planning of research. Research methodology (Experimental design/Study site/technology to implement). Data collection and analysis. Results, discussion and conclusions.

### *Skills*

- the ability to write a research proposal
- to acquire knowledge on problem formulation, research methodology, research strategy, data collection and analysis

### *Competences*

- The ability to explore research methods, data analysis and presentation of results

Teaching: Theoretical-practical classes, with the help of audio-visual equipment, where concepts, research methods and techniques are presented analysed and debated. Student exploration of research methods and techniques with teacher's support, both individually or in group

Examination: Continuous evaluation, based on discussion of scientific papers and research projects. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

### 3.4 Environmental Studies, Cities & Sustainability, 3<sup>rd</sup> semester

The theme of the semester is Professional Development. The semester comprises workload of 30 ECTS. On the 3<sup>rd</sup> semester, the student can choose between two overall options (both described in detail on the following pages). Option 1 is project (15 ECTS) at one of the programme's associated partners combined with project or coursework (a further 15 ECTS) at one of the European partner universities. Option 2 is a full semester (30 ECTS) course and project work with one of the four European partner universities, AAU, TUHH, UA, and UAB.

#### 3.4.1 Option 1:

Project (15 ECTS) at one of the programme's associated partner combined with project and/or coursework (in total of a further 15 ECTS) at one of the European universities.

The project work to be carried with an associated partner will build on the academic skills within which the student has specialized in during the 1<sup>st</sup> and 2<sup>nd</sup> semesters, and/or set the scene for the topic that the student would write her/his thesis on. The semester will include the preparation of a project report or a scientific article - perhaps with the supervisor as co-author. A semester project can be done individually or in groups of 2 to 4 students.

**Title:** *Professional Development (15 ECTS)*

**Aim:** Students who complete the module are expected to obtain the following:

#### *Knowledge*

- Must within the chosen part of his/her field have knowledge based on the highest international research
- Must be able to understand and relate critically to the knowledge of the field and be able to identify either scientific problems or practical problems in a given complex context.

#### *Skills*

- Can master the scientific methods and tools of the field as well as general skills in relation to the solution of the chosen problem
- Can assess and choose among the scientific methods, tools and general skills of the field and draw up new models of analysis and solution
- Can discuss professional and scientific problems with both colleagues and non-specialists.

#### *Competences*

- Able to manage work and development situations which are complex, unpredictable and require new solution models
- Able to independently start and carry through professional and interdisciplinary cooperation and take a professional responsibility
- Able to independently take responsibility for own professional development and specialisation.

**Teaching:** Project work, with or without integrated internship. In case of the latter, the student is included in the organisation's daily work. Concurrent to the work in the organisation, the student makes a report which is evaluated after ending the internship

**Examination:** Oral individual exam with point of departure in the project report. Internal examiner. Graded in accordance with the provisions in place at the associated partner university.

In the following sections, the possibilities for combining option 1 with course and/or project work at one of the European partner universities are described.

### 3.4.1.1 Option 1 combined with Aalborg University

Admission: Passed 1<sup>st</sup> semester of the MSc in Environmental Studies or the like, and must have participated in 2<sup>nd</sup> semester's courses, project work and exams.

Aalborg University offers the option of two focus areas on the third semester: A) urban development & sustainability and B) continued professional development (with or without an internship).

#### ***Urban Development & Sustainability***

**Title:** ***Urban Development, Causes and Consequences (5 ECTS)***

**Aim:** Students that complete the module should acquire the following:

##### *Knowledge*

- Knowledge of the social, economic and environmental consequences of urban development
- Thorough knowledge and understanding of relevant concepts, theories and models in relation to spatial development in towns and regions, including the geographic localisation of enterprises, residences, service and other facilities as well as relations between mobility and localization
- Knowledge of theories, methods and experiences as regards the relation between urban development and the social development and living conditions of the town
- Can understand and on a scientific basis reflect on the causes and consequences of urban development as well as ability to identify scientific problems in this relation.

##### *Skills*

- Can critically analyze and evaluate solution strategies and proposals concerning the spatial development in towns and regions, especially in a perspective of sustainability and climate
- Can critically analyze the social and economic consequences of urban development
- Can – on the background of an analysis – draw up alternative solution strategies and proposals in relation to handling the social, economic and environmental consequences of urban development
- Can – in relation to the causes and consequences of urban development – impart research-based knowledge and discuss professional and scientific problems with both colleagues and non-specialists.

##### *Competences*

- Can, in relation to the causes and consequences of urban development, independently start and carry through a professional and interdisciplinary cooperation and take a professional responsibility.

**Teaching:** Lectures, workshops, seminars, problem solving and presentations, lecturer feedback, etc.

**Examination:** Continuous assessment or active participation. Internal examiner. Pass/fail.

**Evaluation criteria:** As stated in the Framework Provisions.

**Title:** **Sustainable Energy System Analysis (5 ECTS)**

**Aim** Students passing the semester will acquire the following

*Knowledge*

- Thorough knowledge of the energy system from energy consumption to energy production, including energy savings, conversion technologies, fuels, renewable energy plants and localisation
- Knowledge on the operation of energy plants as well as evaluation methods and analysis tools for energy plants, including technical limitation, optimizing possibilities, environmental and economic consequences, involvement of externalities and plans
- Knowledge of public regulation of energy plants.

*Skills*

- Can understand, use and analyze theories, evaluation methods and tools in relation to technologies and energy system analysis of the environmental, economic, institutional and organizing problems of energy plants
- Can critically analyze energy-related problems for energy plants
- Can understand, use and analyze evaluation methods and tools for impact analyses for energy plants
- Can assess application fields for evaluation methods and tools, including critically assess results and conclusions on the basis of different methods and tools
- Can understand and reflect on theories, evaluation methods and analysis tools within the relevant areas.

*Competences*

- Can independently start and participate in interdisciplinary tasks and cooperation on an organisation level
- Can independently take responsibility for own professional development and specialisation

**Teaching** Lectures, workshops, seminars, assignments and presentation, lecturer feedback.

**Examination** Continuous assessment or active participation. Internal examiner. Pass/fail.

**Evaluation criteria:** As stated in the Framework Provisions.

**Title:** **Current Topics in Research on Sustainable Development I (5 ECTS)**

**Aim:** Students that complete the project specialise further in one of the two course modules given during the semester

*Knowledge*

- Have thorough knowledge of superior themes in relation to the challenges of enterprises (organisations) in relation to sustainable development
- Have knowledge of complex combinations of specific challenges on an organisation level (business level)
- Have knowledge of the different forms of interaction of the enterprises with their partners
- Have knowledge of relevant theories, understandings, methods and analyses that concretize the possibilities of the enterprise (organisation) of working with sustainable solutions.

*Skills*

- Can in an enterprise and organisation perspective identify, analyze and assess sustainable problems and consequences
- Can assess interdisciplinary planning tasks and cooperation on an organisation level (business level)
- Can uncover interests connected with the work of enterprises (or the lack of it) with sustainable development
- Can communicate and discuss superior themes which have special relevance for the work of enterprises and organisations with sustainable development
- Can reflect on relevant quantitative and qualitative economic, sociological, environmental and/or engineering methods of analysis.

#### *Competences*

- Can independently start and participate in interdisciplinary tasks and co-operate on an organisation level (business level).

Teaching: Lectures, workshops, seminars, problem solving, studio work, etc.

Examination: Continuous evaluation or active participation. Internal grading, pass/fail.

Evaluation criteria: As stated in the Framework Provisions.

### ***Continued Professional Development***

***Title:*** ***Continued Professional Development - Research project (15 ECTS)***

***Aim:*** Students who complete the module

#### *Knowledge*

- Must within the chosen part of his/her field have knowledge based on the highest international research
- Must be able to understand and relate critically to the knowledge of the field and be able to identify either scientific problems or practical problems in a given complex context.

#### *Skills*

- Can master the scientific methods and tools of the field as well as general skills in relation to the solution of the chosen problem
- Can assess and choose among the scientific methods, tools and general skills of the field and draw up new models of analysis and solution
- Can discuss professional and scientific problems with both colleagues and non-specialists.

#### *Competences*

- Able to manage work and development situations which are complex, unpredictable and require new solution models
- Able to independently start and carry through professional and interdisciplinary cooperation and take a professional responsibility
- Able to independently take responsibility for own professional development and specialisation.

Teaching: Project work, with or without integrated internship. In case of the latter, the student is included in the organisation's daily work. Concurrent to the work in the organisation, the student makes a report which is evaluated after ending the internship

Examination: Oral individual exam with point of departure in the project report. Internal examiner. Graded in accordance with the Danish 7-point scale.

### 3.4.1.2 Option 1 combined with Technische Universität Hamburg-Harburg

Admission: Passed 1<sup>st</sup> semester of the MSc in Environmental Studies or the like, and must have participated in 2<sup>nd</sup> semester's courses, project work and exams.

**Title:** *Project Work (15 ECTS)*

Aim: The students are able to work in a scientific fashion. They have the ability to complete and document research on a subject matter assignment with scientific methods independently and within a given timeframe. The students are able to develop solutions for technical problems on the basis of pure science with regards to safety, environmental, ethical and economic aspects.

Teaching: Project work

Examination: Oral individual exam with point of departure in the project report. Internal examiner. Graded in accordance with the German 5-point scale.

### 3.4.1.3 Option 1 combined with Universidade de Aveiro

Admission: Passed 1<sup>st</sup> semester of the MSc in Environmental Studies or the like, and must have participated in 2<sup>nd</sup> semester's courses, project work and exams.

**Title:** *Project Work (15 ECTS)*

Prerequisites: Admission to Project Work implies that all the remaining subjects of the first year of the Course have been (or are being) approved.

Aim: Students passing the project will acquire:

*Knowledge*

- for understanding and applying various tools in solving design and planning within technological and policy-related questions
- practical integrated knowledge in environmental aspects

*Skills*

- for critically reflect on a given problem, argue for and apply appropriate tools, theories and practices in order to develop proposals for solutions
- to discuss technological perspectives on the given option
- to identify, analyse and evaluate project-relevant sustainability related problems and consequences in an overall societal perspective

*Competences*

- to organise and manage the practical challenges related to the design, and planning of technological and policy-related strategies on a sustainable basis
- to combine and compose the application of relevant theories, understandings, methods and assessments, so these form a synthesis toward developing specific strategies and plans that allow work with environmental solutions
- to motivate, argue, and communicate the project's general structure, methodology and solution for both professionals and non-professionals

Teaching: Project work alone or in group, supervisor feedback, presentations.

Examination: based on a written report of the developed project and its presentation and discussion. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

### 3.4.1.4 Option 1 combined with Universitat Autònoma de Barcelona

Admission: Passed 1<sup>st</sup> semester of the MSc in Environmental Studies or the like, and must have participated in 2<sup>nd</sup> semester's courses, project work and exams.

### **Global Change (9 ECTS)**

Prerequisites: none.

Aim: Students that complete the module acquire the following:

#### *Knowledge*

- Understanding and explaining many of the types of impacts related to global change, covering a variety of spatial and temporal timescales
- Discern changes and impacts caused by climate vs. those with other forcing mechanisms. They will focus their studies and efforts on both terrestrial and marine impacts, biodiversity, the global carbon cycle, ocean acidification, and ecosystem impacts and repercussions. Impacts to each of the major environmental spheres will be emphasized, at past, present, and future timescales.

#### *Skills*

- Have a clear distinction between climate vs. other driving forces of impact and change

Teaching: Teaching and discussions will occur during class times, guided by particular readings and hand-outs assigned by individual instructors. There will also be a field trip to the mountainous regions of Catalonia led by 1 of the instructors.

Evaluation: There will be evaluations based on a short answer / essay exam (50%) at the end of the module. A research paper will also be required (50%). Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title:** **Waste Management (6 ECTS)** (*Optional Course*)

Aim: Students that complete the module acquire the following:

#### *Knowledge*

- This module consists of an introduction to the general context, including legislation, hazardous properties, management models, and case studies, followed by more in depth study of waste production, composition, properties, collecting systems and related sustainability indexes, available technologies, recyclable materials, and landfills.

#### *Skills*

- classify and coding wastes
- choose and propose the most suitable management system for an industrial waste according the actual legislation.
- Propose a logic sequence for automatic classification of the fractions of the municipal solid waste.
- Evaluate the possibility to apply a biological treatment for a waste according to its characteristics.
- Analyze the performance of a biologic wastewater treatment plant (WWTP) and proposing improvement and correction actions.
- Evaluate the main impact of a landfill
- Analyze the main characteristics of the composting process design and performance.

Teaching: The main teaching methodology will be through lectures (approximately 65 hours) but discussions will occur during class times, guided by particular readings and exercises. Some classes will be given in computer labs, and will have follow-up exercises. Several visits to industrial installations will be proposed.

Evaluation: Evaluation will be done separately by each professor, but in general, evaluation will be based on: assistance to class, class projects, class exercises and short exams. Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title:** **GIS (6 ECTS)** (*Optional Course*)

Aim: Students that complete the module acquire the following:

*Knowledge*

- This module introduces the students to GIS data bases, models, and tendencies, platforms, sensors, and processing of images. The more important techniques of classification (automatic and vector) will be described, as well as advanced cartographic searches via internet. Special attention will be paid to territorial planning via the integration of GIS tools and Teledetection, and the role these tools can play in environmental planning. The students at the end will compose cartographies and analyse results.

*Skills*

- be able to use GIS programs to analyze different systems; be able to obtain, analyze and manipulate geographical data

Teaching: The classes will always take place in computer lab, with time for students to work on their own while having supervision.

Evaluation: Readings and discussions represent 30% of the final grade, exercises and a final exam 70%. Graded in accordance with the Spanish 10-point scale. Internal examiner.

### 3.4.2 Option 2:

#### 3.4.2.1 Aalborg University

##### **Project Module (15 ECTS)**

**Title**                    **Business & Sustainability Management**

Aim:                        Students passing the project module will acquire the following:

*Knowledge*

- Have thorough knowledge and understanding of the framework conditions, challenges and roles of enterprises and organisations in relation to sustainable development, including also the tools and systems which are relevant on an organisation level.

*Skills*

- Can identify, analyze and assess project-relevant sustainable problems and consequences
- Can understand, use and critically reflect on relevant quantitative as well as qualitative economic, sociological, environmental and/or engineering methods of analysis and uncover the interests connected
- Can independently procure relevant data in relation to the challenge and problem of the project and assess the quality and reliability of these data
- Can motivate, argue and communicate the general structure and methods of the project in a science-theoretical connection. Must also be able to relate critically to sources and use accurate source references.

*Competences*

- Can structure and handle the complex combinations of specific challenges at an organisation level (business level) in the study and project work
- Can combine and compose the use of relevant theories, understandings, methods and analyses so that they form a synthesis towards the preparation of specific strategies and plans directed towards the possibilities of the enterprise (organisation) of working with sustainable solutions
- Can independently start and participate in interdisciplinary planning tasks and co-operation on an organisation level (business level).

Teaching:                Problem-oriented project work in groups.

Examination:          Oral exam in project groups and with point of departure in the project report. Internal examiner. Graded in accordance with the Danish 7-point scale.

##### **Course Modules (3 x 5 ECTS)**

**Title:**                    **Urban Development, Causes and Consequences (5 ECTS)**

Aim:                        Students that complete the module acquire the following:

*Knowledge*

- Knowledge of the social, economic and environmental consequences of urban development
- Thorough knowledge and understanding of relevant concepts, theories and models in relation to spatial development in towns and regions, including the geographic localisation of enterprises, residences, service and other facilities as well as relations between mobility and localisation

- Knowledge of theories, methods and experiences as regards the relation between urban development and the social development and living conditions of the town
- Can understand and on a scientific basis reflect on the causes and consequences of urban development as well as ability to identify scientific problems in this relation.

*Skills*

- Can critically analyze and evaluate solution strategies and proposals concerning the spatial development in towns and regions, especially in a perspective of sustainability and climate
- Can critically analyze the social and economic consequences of urban development
- Can – on the background of an analysis – draw up alternative solution strategies and proposals in relation to handling the social, economic and environmental consequences of urban development
- Can – in relation to the causes and consequences of urban development – impart research-based knowledge and discuss professional and scientific problems with both colleagues and non-specialists.

*Competences:*

- Can, in relation to the causes and consequences of urban development, independently start and carry through a professional and interdisciplinary cooperation and take a professional responsibility.

Teaching: Lectures, workshops, seminars, problem solving and presentation, lecturer feedback, etc.

Examination: Continuous evaluation or active participation. Internal grading. Pass/fail

**Title:** ***Sustainable Energy System Analysis (5 ECTS)***

Aim Students passing the semester will acquire the following

*Knowledge*

- Thorough knowledge of the energy system from energy consumption to energy production, including energy savings, conversion technologies, fuels, renewable energy plants and localisation
- Knowledge on the operation of energy plants as well as evaluation methods and analysis tools for energy plants, including technical limitation, optimizing possibilities, environmental and economic consequences, involvement of externalities and plans
- Knowledge of public regulation of energy plants.

### *Skills*

- Can understand, use and analyze theories, evaluation methods and tools in relation to technologies and energy system analysis of the environmental, economic, institutional and organizing problems of energy plants
- Can critically analyze energy-related problems for energy plants
- Can understand, use and analyze evaluation methods and tools for impact analyses for energy plants
- Can assess application fields for evaluation methods and tools, including critically assess results and conclusions on the basis of different methods and tools
- Can understand and reflect on theories, evaluation methods and analysis tools within the relevant areas.

### *Competences*

- Can independently start and participate in interdisciplinary tasks and cooperation on an organisation level
- Can independently take responsibility for own professional development and specialisation.

Teaching Lectures, workshops, seminars, problem solving and presentation, teacher feedback, etc.

Examination: Continuous evaluation or active participation. Internal grading. Pass/fail

**Title:** ***Current Topics in Research on Sustainable Development I (5 ECTS)***

Aim: Students passing the course will acquire the following

### *Knowledge*

- Have thorough knowledge of superior themes in relation to the challenges of enterprises (organisations) in relation to sustainable development
- Have knowledge of complex combinations of specific challenges on an organisation level (business level)
- Have knowledge of the different forms of interaction of the enterprises with their partners
- Have knowledge of relevant theories, understandings, methods and analyses that concretize the possibilities of the enterprise (organisation) of working with sustainable solutions.

### *Skills*

- Can in an enterprise and organisation perspective identify, analyze and assess sustainable problems and consequences
- Can assess interdisciplinary planning tasks and cooperation on an organization level (business level)
- Can uncover interests connected with the work of enterprises (or the lack of it) with sustainable development
- Can communicate and discuss superior themes which have special relevance for the work of enterprises and organisations with sustainable development
- Can reflect on relevant quantitative and qualitative economic, sociological, environmental and/or engineering methods of analysis.

### *Competences*

- Can independently start and participate in interdisciplinary tasks and cooperate on an organisation level (business level).

Teaching: Lectures, workshops, seminars, problem solving, etc.

Examination: Continuous evaluation or active participation. Internal grading. Pass/fail

### 3.4.2.2 Technische Universität Hamburg-Harburg

TUHH offers the option of two focus areas on the third semester: A) Energy and B) Water. Both combine project with course work.

#### Project Module (12 ECTS)

**Title:** *Project Work (12 ECTS)*

**Aim:** The students are able to work in a scientific fashion. They have the ability to complete and document research on a subject matter assignment with scientific methods independently and within a given timeframe. The students are able to develop solutions for technical problems on the basis of pure science with regards to safety, environmental, ethical and economic aspects.

**Teaching** Project work

**Examination:** Oral individual exam with point of departure in the project report. Internal examiner. Graded in accordance with the German 5-point scale.

#### Option A: Energy

**Title:** *Waste Treatment Technologies (6 ECTS)*

**Aim:** After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- possess knowledge concerning the planning of biological waste treatment plants.
- explain the design and layout of anaerobic and aerobic waste treatment plants in detail
- describe different techniques for waste gas treatment plants for biological waste treatment plants
- explain different methods for waste analytics.

*Capabilities:* Students are able to...

- discuss the compilation of design and layout of plants.
- critically evaluate techniques and quality control measurements.
- research and evaluate literature and data connected to the tasks given in der module and plan additional tests.
- reflect and evaluate findings in the group.

Personal Competence:

*Social Competence:* Students are able to...

- participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend their own work results in front of others and promote the scientific development in front of colleagues.
- give and accept professional constructive criticism.

*Autonomy:*

- Students can independently tap knowledge from literature, business or test reports and transform it to the course projects. They are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning

level and define further steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural impact.

Teaching Labwork and assignments

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Bioresources and Biorefineries (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- give an overview on principles and theories in the field's bioresource management and biorefinery technology and can explain specialized terms and technologies.

*Capabilities:* Students are able to...

- apply knowledge and know-how in the field's bioresource management and biorefinery technology in order to perform technical and regional-planning tasks.
- discuss the links to waste management, energy management and biotechnology.

Personal Competence:

*Social Competence:* Students are able to...

- work goal-oriented with others and communicate and document their interests and knowledge in acceptable way.

*Autonomy*

- Students are able to solve independently, with the aid of pointers, practice-related tasks bearing in mind possible societal consequences.

Teaching Lectures, group work

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Special Aspects of Waste Resource Management (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe waste as a resource as well as advanced technologies for recycling and recovery of resources from waste in detail. This covers collection, transport, treatment and disposal in national and international contexts.

*Capabilities:* Students are able to...

- select suitable processes for the treatment with respect to the national or cultural and developmental context.
- evaluate the ecological impact and the technical effort of different technologies and management systems.

Personal Competence:

*Social Competence:* Students are able to...

- work together as a team of 2-5 persons,
- participate in subject-specific and interdisciplinary discussions,
- develop cooperated solutions and defend their own work results in front of others and promote the scientific development of colleagues,
- give and accept professional constructive criticisms.

*Autonomy*

- Students can independently gain additional knowledge of the subject area and apply it in solving the given course tasks and projects

Teaching Assignments

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Environmental Biotechnology (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- explain methods for the detection of microorganisms in the environment
- explain the mechanisms that exist for the biological degradation of pollutants

*Capabilities:* Students are able to...

- judge, in which technical processes microbially mediated problems may occur
- propose methods for the elimination of microorganisms from the environment
- evaluate environmental problems derived from pollutants and their consequences,
- isolate bacteria from water and soil samples,
- perform and document experiments concerning biological degradation of pollutants,
- use modern molecular biology methods for the characterization of mixed bacterial communities,
- transfer the mechanisms for the degradation of environmental pollutants to new chemicals whose degradation is not known yet.

Personal Competence:

*Social Competence:* Students are able to...

- perform experiments in teams of 4 students

*Autonomy*

- Students are able to extract new knowledge from scientific articles, summarize them and compare it to the contents of the lecture

Teaching Lectures and labwork

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title: *Environmental Protection and Management (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements.
- analyse and discuss industrial processes, substance cycles and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their sound knowledge of complex industry related problems.
- judge environmental issues and to widely consider, apply or carry out innovative technical solutions, remediation measures and further interventions as well as conceptual problem solving approaches in the full range of problems in different industrial sectors.

*Capabilities:* Students are able to...

- assess current problems and situations in the field of environmental protection, consider the best available techniques and plan and suggest concrete actions in a company- or branch-specific context.
- solve problems on a technical, administrative and legislative level.

Personal Competence:

*Social Competence:* Students are able to...

- work together in international groups.

*Autonomy*

- Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can acquire appropriate knowledge by making enquiries independently.

Teaching Lectures and exercises

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title: *Wastewater Systems and Reuse (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- outline key areas of the full range of treatment systems in water and waste water management, as well as their mutual dependence for sustainable water protection.
- describe relevant economic, environmental and social factors.

*Capabilities:* Students are able to...

- pre-design and explain the available water and wastewater treatment processes and the scope of their application in municipal and for some industrial treatment plants.

Personal Competence:

*Social Competence*

- Through partial PBL students have learned to research and to interact with other students on the subjects covered.

*Autonomy*

- Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.

Teaching Lectures, assignments, exercises

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Option B: Water**

**Title:** ***Analytical Methods and Treatment Technologies for Wastewater (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:*

- The students know some non-biological processes for the treatment of water and wastewater as well as the fundamentals of mass transfer, which is essential for many treatment processes. They have knowledge about analytical procedures which can be applied even without the availability of a laboratory and which are useful for evaluating the performance of (waste)water treatment processes and the assessment of surface water quality in an economically feasible way.

*Capabilities:* Students are able to...

- select suitable processes for the treatment of wastewaters with respect to their characteristics.
- evaluate the efforts and costs for analytical procedures for the characterization of waters/wastewaters and select economically feasible analytical procedures.

Personal Competence:

*Social Competence:* Students are able to...

- plan and perform wastewater analyses together with colleagues in small groups and to efficiently distribute the respective tasks within the group.

*Autonomy*

- The students are capable to make their own decisions with respect to the selection of suitable water/wastewater treatment processes as well as economically feasible analytical procedures for water/wastewater characterization.

Teaching Lectures

Examination: Oral Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title: Wastewater Treatment and Air Pollution Abatement (6 ECTS)**

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- name and explain biological processes for wastewater treatment, characterize waste water and sewage sludge
- discuss legal regulations in the area of emissions and air quality
- classify off gas treatment processes and to define their area of application

*Capabilities:* Students are able to...

- choose and design process steps for the biological waste water treatment
- combine processes for cleaning of off-gases depending on the pollutants contained in the gases

Teaching Lectures

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title: Water Protection (6 ECTS)**

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe the basic principles of the regulatory framework related to the international and European water sector.
- explain limnological processes, substance cycles and water morphology in detail and assess complex water related problems.
- demonstrate to achieve significant improvements in the full range of existing water quality problems.
- judge environmental and wastewater related issues and to widely consider innovative solutions, remediation measures and further interventions as well as conceptual problem solving approaches.

*Capabilities:* Students are able to...

- accurately assess current problems and situations in a country-specific or local context.
- suggest concrete actions to contribute to the planning of tomorrow's urban water cycle.
- suggest appropriate technical, administrative and legislative solutions to solve these problems.

Personal Competence:

*Social Competence:* The students can work together in international groups.

*Autonomy*

- Students are able to organize their work flow to prepare themselves before presentations and discussion. They can acquire appropriate knowledge by making enquiries independently.

Teaching Lectures, assignments, exercises

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** **Membrane Technology (6 ECTS)**

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- rank the technical applications of industrially important membrane processes.
- explain the different driving forces behind existing membrane separation processes.
- name materials used in membrane filtration and their advantages and disadvantages.
- explain the key differences in the use of membranes in water, other liquid media, gases and in liquid/gas mixtures.

*Capabilities:* Students are able to...

- prepare mathematical equations for material transport in porous and solution-diffusion membranes and calculate key parameters in the membrane separation process.
- handle technical membrane processes using available boundary data and provide recommendations for the sequence of different treatment processes.
- to classify the separation efficiency, filtration characteristics and application of different membrane materials through their own experiments.
- characterise the formation of the fouling layer in different waters and apply technical measures to control this.

Personal Competence:

*Social Competence:* Students are able to...

- work in diverse teams on tasks in the field of membrane technology.
- make decisions within their group on laboratory experiments to be undertaken jointly and present these to others.

*Autonomy*

- Students will be in a position to solve homework on the topic of membrane technology independently. They will be capable of finding creative solutions to technical questions.

Teaching Lectures, exercises, labwork

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** **Process Modelling in Water Technology (6 ECTS)**

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- explain selected processes of drinking water and waste water treatment in detail.
- explain basics as well as possibilities and limitations of dynamic modeling.

*Capabilities:* Students are able to...

- use the most important features Modelica offers.

- transpose selected processes in drinking water and waste water treatment into a mathematical model in Modelica with respect to equilibrium, kinetics and mass balances.
- set up and apply models and assess their possibilities and limitations.

Personal Competence:

*Social Competence:* Students are able to...

- solve problems and document solutions in a group with members of different technical background.
- give appropriate feedback and can work constructively with feedback concerning their work.

*Autonomy*

- Students are able to define a problem, gain the required knowledge and set up a model.

Teaching Lectures and assignments

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** **Project Work/Seminar Cities (6 ECTS)**

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- demonstrate their detailed knowledge in the field of Water and Environmental Engineering.
- exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of science and society.
- develop solving strategies and approaches for fundamental and practical problems in the field of Water and Environmental Engineering.
- apply theory based procedures and integrate safety-related, ecological, ethical, and economic view points of science and society.
- describe and critically review scientific work techniques used.

*Capabilities:* Students are able to...

- independently select methods or planning approaches for the project work and to justify their choice.
- explain how these methods or approaches relate to solutions in the field of work and how the context of application has to be adjusted.
- Outline general findings and further developments.

Personal Competence:

*Social Competence:* Students are able to...

- condense the relevance and the structure of the project work, the work steps and the sub-problems for the presentation and discussion in front of a bigger group.
- lead the discussion and give a feedback on the project to their colleagues

*Autonomy*

- The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they

can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.

Teaching Lectures, seminars, project work and supervised dialogue

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Resources Oriented Sanitation Systems (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe resources oriented wastewater systems mainly based on source control in detail.
- comment on techniques designed for reuse of water, nutrients and soil conditioners.
- discuss a wide range of proven approaches in Rural Development from and for many regions of the world.

*Capabilities:* Students are able to...

- design low-tech/low-cost sanitation, rural water supply, rainwater harvesting systems, measures for the rehabilitation of top soil quality combined with food and water security.
- consult on the basics of soil building through "Holistic Planned Grazing" as developed by Allan Savory.

Personal Competence:

*Social Competence:* Students are able to...

*Autonomy*

- Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.

Teaching Lectures and labwork

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** ***Environmental Protection and Management (6 ECTS)***

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements.
- analyse and discuss industrial processes, substance cycles and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their sound knowledge of complex industry related problems.
- judge environmental issues and to widely consider, apply or carry out innovative technical solutions, remediation measures and further interventions as well as conceptual problem solving approaches in the full range of problems in different industrial sectors.

*Capabilities:* Students are able to...

- assess current problems and situations in the field of environmental protection, consider the best available techniques and plan and suggest concrete actions in a company- or branch-specific context.
- solve problems on a technical, administrative and legislative level.

Personal Competence:

*Social Competence:* Students are able to...

- work together in international groups.

*Autonomy*

- Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can acquire appropriate knowledge by making enquiries independently.

Teaching Lectures and exercises

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

**Title:** **Wastewater Systems and Reuse (6 ECTS)**

Aim: After taking part successfully, students have reached the following learning results:

Professional Competence:

*Theoretical Knowledge:* Students are able to...

- outline key areas of the full range of treatment systems in water and waste water management, as well as their mutual dependence for sustainable water protection.
- describe relevant economic, environmental and social factors.

*Capabilities:* Students are able to...

- pre-design and explain the available water and wastewater treatment processes and the scope of their application in municipal and for some industrial treatment plants.

Personal Competence:

*Social Competence*

- Through partial PBL students have learned to research and to interact with other students on the subjects covered.

*Autonomy*

- Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.

Teaching Lectures, assignments, exercises

Examination: Written Exam. Internal examiner. Graded in accordance with the German 5-point scale.

### 3.4.2.3 Universidade de Aveiro

#### Project Module (15 ECTS)

**Title:** *Project Work*

**Admission:** Admission to Project Work implies that all the remaining subjects of the first year of the Course have been (or are being) approved.

**Aim:** Students passing the project will acquire:

*Knowledge:*

- for understanding and applying various tools in solving design and planning within technological and policy-related questions
- practical integrated knowledge in environmental aspects

*Skills:*

- for critically reflect on a given problem, argue for and apply appropriate tools, theories and practices in order to develop proposals for solutions
- to discuss technological perspectives on the given option
- to identify, analyse and evaluate project-relevant sustainability related problems and consequences in an overall societal perspective

*Competences*

- to organise and manage the practical challenges related to the design, and planning of technological and policy-related strategies on a sustainable basis
- to combine and compose the application of relevant theories, understandings, methods and assessments, so these form a synthesis toward developing specific strategies and plans that allow work with environmental solutions
- to motivate, argue, and communicate the project's general structure, methodology and solution for both professionals and non-professionals

**Examination:** based on a written report of the developed project and its presentation and discussion. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

#### Course Modules (2 x 6 ECTS, and 1 x 3 ECTS)

**Title:** *Air Quality Management (6 ECTS)*

**Prerequisites:** Transport Phenomena and Atmospheric pollution knowledge's.

**Aim:** Students passing the semester will acquire

*Knowledge on*

- the concepts and definitions of air quality management and of the atmospheric pollution effects
- legislation on atmospheric pollution: international agreements and European Community directives
- air quality assessment tools: emission inventories, atmospheric pollution models, air quality monitoring networks
- atmospheric pollution and health: population exposure

*Skills:*

- to understand air quality management strategies
- to evaluate the air quality and the application of the legislated threshold values
- to select adequate air quality models

*Competencies:*

- to act in the definition and implementation of air quality management strategies aimed to reduce the effects of air pollution

Teaching: Lecturing classes for concepts and analysis exposed with multimedia support simultaneously to problems/works analysis and solution in classes (individual or in group).

Examination: Continuous evaluation of student's performance, including one written test and work group reports/discussion during the semester. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title: Measurement of Air Pollutants (6 ECTS)**

Prerequisites: Basic knowledge of analytical chemistry and instrumental analysis.

Aim: To provide students with the scientific and technical skills for the measurement of atmospheric pollutants in emission sources and ambient air in order to be able to organize and execute an air quality monitoring plan including:

- Principles of measurement of air pollutants in ambient air: passive and active methods.
- Measurement of gases, pumped systems, pre-concentration by absorption, adsorption and condensation, grab sampling, analytical methods, measurement of volatile organic compounds, real time systems, standard atmospheres and calibration.
- Measurement of particles, isokinetic sampling, filtration, gravimetric method, beta-attenuation, resonating microbalance, size fractionation sampling techniques and chemical composition of aerosol.
- Measurement of emissions from stationary sources, extractive methods and *in situ* methods.
- Quality control

*Skills:*

- to demonstrate a thorough understanding of the principles of the major methods used in air pollution monitoring and control;
- to apply and perform commonly used methods for making both physical and chemical measurements in ambient air and stationary sources;
- capable of critically appraising different methods in the application of air quality monitoring.

*Competences:*

- organize and execute an air quality monitoring plan.

Teaching: This module is based on five teaching concepts: lecturing classes where the concepts are exposed and analyzed; problems analysis and solution in classes with a strong inter-relation work between students and the teacher; laboratorial classes where students are required to apply specific measuring methods; study visits oriented toward air pollution measurement issues; students home work to go further into the covered topics of the module.

Examination: One general examination and laboratorial work reports. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

**Title:** ***Fundamental Theories of Risks (3 ECTS)***

**Aim:** Students passing the semester will acquire  
*Knowledge on*

- the risk concept taking into account the characteristics and changes of the nowadays society
- the risk concept evolution
- the current risk societies and/or the current vulnerable societies
- the social concept of uncertainty within the risk societies
- natural and technological risks as social and political alarm factors
- globalization theories and risk
- social risk perception

*Skills:*

- to work with the different risk types and concepts existent in the nowadays society
- to understand the changes on risk concept and perception within different scopes, e.g. historical, social, economic.
- to deal with the risk uncertainty in society

*Competencies:*

- to characterise the different risk perceptions and the social capacity to support and accept the risk
- to contribute to political and social solutions regarding natural and technological risks

**Teaching:** Lecturing classes for concepts and analysis exposed with multimedia support simultaneously to works analysis and solution in classes (individual or in group).

**Examination:** Continuous evaluation of student's performance, including one written test and work group reports/discussion during the semester. Graded in accordance with the Portuguese 20-point scale. Internal examiner.

### 3.4.2.4 Universitat Autònoma de Barcelona

#### Project Module (9 ECTS)

**Title:** *Research Project*

**Aim:** Students that complete the module acquire the following:

*Knowledge:*

- The overall objective is for the student to work in a public or private research institution or of a public or private company to gain knowledge of their habits
- To learn about how work is organized and how to manage him or herself at work
- To learn about teamwork with other professionals
- To gain an overall view of environmental topics that affect the research or professional work
- To learn the specific tasks and capabilities of the job developed in the hosting institution

*Skills:*

- The student should be able to communicate clearly, perform well in a team environment and organize his/her time and work.

**Teaching:** Students will be enrolled in the hosting institution system in terms of working hours and working needs. Prior to the start, a registration file will be fulfilled where the tasks to be performed by the student will be detailed. During the last week of the Practicum period, the student will present a short report describing its activity along the Practicum period

**Evaluation:** Evaluation will be performed according to the following marks: 50% by the student responsible at the hosting institution; 50% by the university tutor according to the report presented and his considered opinion. Graded in accordance with the Spanish 10-point scale. Internal examiner.

#### Course Modules (2 x 6 ECTS, and 1 x 9 ECTS)

**Title:** *Waste Management (6 ECTS)*

**Aim:** Students that complete the module will acquire the following:

*Knowledge:*

- This module consists of an introduction to the general context, including legislation, hazardous properties, management models, and case studies, followed by more in depth study of waste production, composition, properties, collecting systems and related sustainability indexes, available technologies, recyclable materials, and landfills.

*Skills:*

- classify and coding wastes
- choose and propose the most suitable management system for an industrial waste according the actual legislation.
- Propose a logic sequence for automatic classification of the fractions of the municipal solid waste.
- Evaluate the possibility to apply a biological treatment for a waste according to its characteristics.
- Analyze the performance of a biologic wastewater treatment plant (WWTP) and proposing improvement and correction actions.
- Evaluate the main impact of a landfill

- Analyze the main characteristics of the composting process design and performance.

Teaching: The main teaching methodology will be through lectures (approximately 65 hours) but discussions will occur during class times, guided by particular readings and exercises. Some classes will be given in computer labs, and will have follow-up exercises. Several visits to industrial installations will be proposed.

Evaluation: Evaluation will be done separately by each professor, but in general, evaluation will be based on: assistance to class, class projects, class exercises and short exams. Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title: GIS (6 ECTS)**

Aim: Students that complete the module acquire the following:

Knowledge

- This module introduces the students to GIS databases, models, and tendencies, platforms, sensors, and processing of images. The more important techniques of classification (automatic and vector) will be described, as well as advanced cartographic searches via Internet. Special attention will be paid to territorial planning via the integration of GIS tools and Teledetection, and the role these tools can play in environmental planning. The students at the end will compose cartographies and analyse results.

Skills

- be able to use GIS programs to analyze different systems; be able to obtain, analyze and manipulate geographical data

Teaching: The classes will always take place in computer lab, with time for students to work on their own while having supervision.

Evaluation: Readings and discussions represent 30% of the final grade, exercises and a final exam 70%. Graded in accordance with the Spanish 10-point scale. Internal examiner.

**Title: Global Change (9 ECTS)**

Prerequisites: none.

Aim: Students that complete the module acquire the following:

Knowledge: At the end of the module, the student will be capable of:

- Understanding and explaining many of the types of impacts related to global change, covering a variety of spatial and temporal timescales
- Discern changes and impacts caused by climate vs. those with other forcing mechanisms. They will focus their studies and efforts on both terrestrial and marine impacts, biodiversity, the global carbon cycle, ocean acidification, and ecosystem impacts and repercussions. Impacts to each of the major environmental spheres will be emphasized, at past, present, and future timescales.

Skills: Have a clear distinction between climate vs. other driving forces of impact and change

Teaching: Teaching and discussions will occur during class times, guided by particular readings and hand-outs assigned by individual instructors. There will also be a field trip to the mountainous regions of Catalonia led by 1 of the instructors.

Evaluation: There will be evaluations based on a short answer / essay exam (50%) at the end of the module. A research paper will also be required (50%). Graded in accordance with the Spanish 10-point scale. Internal examiner.

### 3.5 Environmental Studies, Cities & Sustainability, 4<sup>th</sup> semester

#### 3.5.1 Master's Thesis (30 ECTS)

**Title:** Master's Thesis

**Admission:** Successful conclusion of the first three semesters of the Master's Programme

**Aim:** Students who complete the module:

*Knowledge:*

- Have extant knowledge of relevant theories and methods in relation to the chosen problem area, can reflect on their opportunities and constraints, and apply them within the given area
- Have knowledge of the applied theories' theoretical and methodological foundation(s) and can reflect on these
- Have thorough knowledge of the chosen problem area's academic foundation including knowledge of the main national and international research in this area

*Skills:*

- Are independently able to plan and carry out a project on a high professional level
- Can explain possible methods to solve the project's problem formulation and to describe and evaluate the chosen method's suitability, including explaining selected boundaries and their impact on results
- Can explain the chosen problem area's relevance, including ability to explain the crux of the problem and the academic and/or professional context it occurs in
- Can analyse and describe the chosen problem through the application of relevant theories and empirical studies
- Can analyse and evaluate the results of empirical studies, whether it is the student's own or others' studies, including an assessment of the given method's impacts on the validity of results
- Can identify relevant strategies for problem improvements and/or solutions
- Can communicate knowledge about the problem for both peers and non-professionals

*Competences*

- Can provide a synthesis between the academic and/or professional work problem, theoretical and empirical studies, and undertake a critical evaluation of the formed synthesis and the project's results
- Can independently and based on a conceptualised problem take part in interdisciplinary discussions and development work
- Can independently acquire the latest knowledge within the discipline, and on this background continually develop further professional skills and competences

**Teaching:** In this module, the Master's Thesis is carried out. The module constitutes independent project work and concludes the programme. Within the approved topic, the Master's Thesis must document that the level of the programme has been attained.

**Examination:** Oral individual exam with point of departure in the thesis. External examiner. Graded in accordance with the scale at the university where the thesis is handed in:  
AAU: In accordance with the Danish 7-point scale.  
TUHH: In accordance with the German 5-point scale  
UA: In accordance with the Portuguese 20-point scale  
UAB: In accordance with the Spanish 10-point scale

Evaluation criteria: As stated in the Framework Provisions.

#### **Chapter 4: Entry into Force, Interim Provisions and Revision**

The curriculum is approved by the Dean of the Faculty of Engineering & Science and enters into force as of September 2014. In accordance with the Framework Provisions for the Faculty of Engineering & Science at Aalborg University, the curriculum must be revised no later than five years after its entry into force.

The curriculum is approved by the Scientific Council of the University of Aveiro.

The curriculum is approved by the Academic Board of Graduate Studies of the Universitat Autònoma de Barcelona (Comissió d'Estudis de Postgrau).

The curriculum is approved by the Academic Senate and the Council of the School of Civil Engineering of Hamburg University of Technology (TUHH).

## **Chapter 5: Other Provisions**

### **5.1 Rules Concerning Written Work, Including the Master's Thesis**

In the assessment of all written work, weight is also put on the student's spelling and formulation ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are considered basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination may be assessed as 'Pass' on the basis of language performance alone; similarly, an examination cannot normally be assessed as 'Fail' on the basis of poor language performance alone. The Board of Studies can grant exemption from this in special cases (e.g., dyslexia).

All written work, including the Master's Thesis must be completed in English. A summary of one to two pages (maximum) may be included and written in the student's native language. The summary is not included in the evaluation of the project as a whole.

### **5.2 Rules for Examinations**

#### **5.2.1 Denmark**

The rules for examinations are stated in the Examination Policies and Procedures published by the Faculty of Engineering & Science on its website.

#### **5.2.2 Germany**

The rules for examinations are stated in the Examination Policies and Procedures published by the Technische Universität Hamburg-Harburg on its website.

#### **5.2.3 Portugal**

The rules for examinations are stated in the Regulation on 1<sup>st</sup> and 2<sup>nd</sup> Cycle Studies approved by the Universidade de Aveiro and published on its website.

#### **5.2.4 Spain**

The rules for examinations are stated in the Examination Policies and Procedures published by the Universitat Autònoma de Barcelona- Institute de Ciència i Tecnologia Ambientals,

### **5.3 Exemption**

In exceptional circumstances, the Board of Studies study can grant exemption from those parts of the curriculum that are not stipulated by law or ministerial order. Exemption regarding an examination applies to the immediate examination.

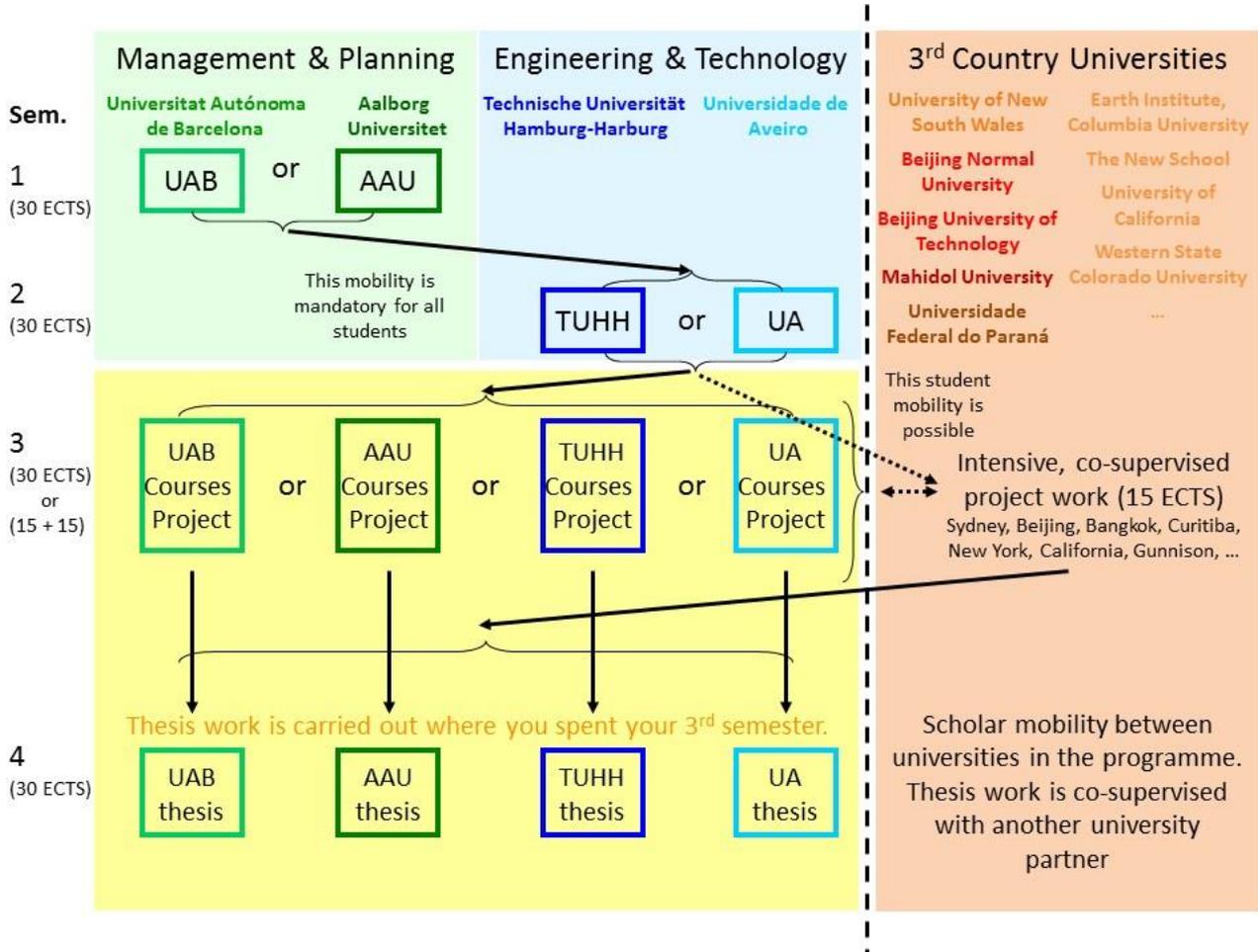
### **5.4 Completion of the Master Programme**

The Master's programme must be completed no later than four years after it was begun.

### **5.5 Additional Information**

It is assumed that the student is able to read academic texts in modern English and use reference works, etc. The current version of the curriculum is published on the websites of the respective Boards of Studies and on JEMES CiSu Consortium homepage, including more detailed information about the programme and exams.

## Annex 1: Mobility Overview





## Universitat Autònoma de Barcelona, UAB

Semester	Module	ECTS
1 <sup>st</sup>	Foundations of ecological economics	9
1 <sup>st</sup>	Industrial Ecology	9
1 <sup>st</sup>	Political Ecology	6
1 <sup>st</sup>	Qualitative Methods for Social Science Research	6
3 <sup>rd</sup>	<i>Option 1</i> - Global Change - Option of two courses o Waste Management o GIS	9 6
3 <sup>rd</sup>	<i>Option 2 – Full semester</i> - Research Project - Waste Management - Global Change - GIS	9 6 9 6
4 <sup>th</sup>	Master's Thesis	30
<b>Total</b>		<b>75-90</b>

## Universidade de Aveiro, UA

Semester	Module	ECTS
2 <sup>nd</sup>	Air Pollution and Climate Change	6
2 <sup>nd</sup>	Natural, Technological and Industrial Risk	8
2 <sup>nd</sup>	Water Pollution	6
2 <sup>nd</sup>	Solid Waste	6
2 <sup>nd</sup>	Option of two courses - Integrated Coastal and Marine Management & Planning - Research Methodology	4
3 <sup>rd</sup>	<i>Option 1 - Project work</i>	15
3 <sup>rd</sup>	<i>Option 2 – Full semester</i> - Project work - Air Quality Management - Measurement of Air Pollutants - Fundamental Theories of Risks	15 6 6 3
4 <sup>th</sup>	Master's Thesis	30
<b>Total</b>		<b>75-90</b>

### **Annex 3: Overview of Associated Partners (as of December 2014)**

#### **Australia**

University of New South Wales (UNSW), <http://www.unsw.edu.au/>

#### **Brazil**

Universidade Federal do Paraná (UFPR), <http://www.ufpr.br/portalufpr/> (agreement in process)

#### **China**

Beijing Normal University (BNU), <http://english.bnu.edu.cn/>

Beijing University of Technology (BJUT), <http://english.bjut.edu.cn/>

#### **Thailand**

Mahidol University (MU), <http://www.mahidol.ac.th/en/>

#### **United States of America**

Columbia University (CU), <http://www.columbia.edu/>

The New School (TNS), <http://www.newschool.edu/>

University of California (UC) (Davis and Santa Cruz), <http://www.universityofcalifornia.edu/>

Western State Colorado University, <http://www.western.edu/>



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