

# 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 Department of Environment & Planning  
University of Aveiro

The Faculty of Sciences  
Autonomous University of Barcelona

2012



**Preface**

Pursuant to the Danish Act 695 of June 22, 2011 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. 1389 of December 15, 2011 on International Education Activities of Universities and Ministerial Order no. 857 of July 1, 2010 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 213 of February 21, 2012 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (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) at universities in either USA, Australia or China. This mobility is mandatory for all students except 3<sup>rd</sup> country students with an Erasmus Mundus Category A scholarship. 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)	Political Ecology	6	10-point scale	Internal
1 <sup>st</sup> (UAB)	Qualitative Methods for Social Science Research	6	10-point scale	Internal
1 <sup>st</sup> (UAB)	Optional Course - <i>Climate Change</i> - <i>Global Change</i>	9 9	10-point scale	Internal
2 <sup>nd</sup> (TUHH)	Environmental Aquatic Chemistry and Toxicology	3	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Applied Surface Hydrology	4	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Applied Groundwater Engineering	3	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Water and Wastewater Systems in a Global Context	4	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Renewable Energy	3	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Waste Resources	6	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Air Pollution Abatement	2	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Sludge Treatment	3	5-point scale	Internal
2 <sup>nd</sup> (TUHH)	Practical Course in Water and Wastewater Technology II	2	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 Risk	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> (USA, AUS, CN)	Professional Development (project and/or courses)	15	Depending on university	Internal
3 <sup>rd</sup> (AAU)	Option 1: Choice between course work (A) or Continued Professional Development (with or without internship) (B) - <i>Option A</i> o <i>Urban Development, Causes and Consequences</i> o <i>Sustainable Energy System Analysis</i> o <i>Mini Project</i> - <i>Option B</i> 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 - <i>Urban Development, Causes and Consequences</i> - <i>Sustainable Energy System Analysis</i> - <i>Current Topics in Sustainability Research</i> - <i>Business &amp; Sustainability Management</i>	5 5 5 15	Pass/Fail Pass/Fail Pass/Fail 7-point scale	Internal
3 <sup>rd</sup> (UAB)	Option 1 – Courses - <i>Industrial Ecology</i> - One of the following courses o <i>Waste Management</i> o <i>GIS</i>	9 6 6	10-point scale	Internal

Semester	Module	ECTS	Grading	Exam
3 <sup>rd</sup> (UAB)	Option 2 – Full semester - Research Project - Waste Management - Industrial Ecology - 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 and option A or B below - Research Project - <i>Option A: Water</i> o Wastewater Analysis and –Treatment o Process Modelling of Water and Wastewater Treatment o Wastewater Systems – Collection, Treatment & Reuse o Groundwater Engineering - <i>Option B: Energy</i> o <i>Waste Resources Management</i> o <i>Energy from Biomass</i> o <i>Bioresource Management</i> o <i>Bio Refinery Technology</i> o <i>Advanced Topics in Waste Resource Management</i>	15 4 4 4 3 2 3 2 4 4	5-point scale 5-point scale 5-point scale 5-point scale 5-point scale 5-point scale 5-point scale 5-point scale 5-point scale	Internal
3 <sup>rd</sup> (UA)	Option 1 - Project work	15	20-point scale	Internal
3 <sup>rd</sup> (UA)	Option 2 – Full semester - Project Work - Air Quality Management - Measurement of Air Pollutants - Fundamental Theories of Risk	15 6 6 3	20-point scale 20-point scale 20-point scale 20-point scale	Internal Internal Internal Internal
4 <sup>th</sup>	Master's Thesis	30	Depending on university	External
<b>Total</b>		<b>120</b>	<b>ECTS</b>	

As per the mobility plan, first semester takes place at either AAU or UAB, second semester at either TUHH or UA, third semester at a university in USA, Australia or China, in combination with one of the four European partner universities. The master's thesis is written at the same European university where the student spent his or her third semester. Credits for the respective semester(s) are automatically transferred to the student's home university, either AAU or UAB. An overview of course plans for the partner universities' semesters is provided in Annex 2.

### 3.2 Environmental Studies, Cities & Sustainability, 1<sup>st</sup> semester

The theme of the semester is Cities & Sustainability in a Management Perspective. The semester comprises workload of 30 ECTS and is either carried out at Aalborg University or Universitat Autònoma de Barcelona.

#### 3.2.1 Aalborg University

##### Project Module (15 ECTS)

**Title:** *Cities and Sustainability in a Management Perspective (Byer og bæredygtighed i et ledelsesperspektiv)*

**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 individual exam 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 (Videnskabsteori og forskningsdesign) (5 ECTS)*

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

*Knowledge*

- Possess knowledge of the history of theory of science and theoretical frameworks at a master's level
- Must understand the relationship between theories of science, research design and research methods at a master's level
- Must at a masters' level understand the different theories of science positions' contents and relation to one another as well as the ability to relate critically to these
- In-depth knowledge about own field's relation to theories of science and research design

*Skills*

- The ability to apply the basic issues of theory science in the assessment of sources and references in projects at a masters' level

- The ability to independently assess the value and reliability of own knowledge generation in relation to basic scientific issues
- The ability to – at a research level – apply theories of science, research design and research methods within own field
- The ability to communicate knowledge about theories of science and research designs to people within as well as outside the trade

#### *Competences*

- The ability to reflect critically on project-related choice of values, theories of science and methods
- The ability to continuous professional development through acquisition of new knowledge about the development and renewal of theories of science and research designers

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 for Sustainable Development (Værktøjer og system i bæredygtig udvikling) (5 ECTS)***

Aim: Students that complete the module acquire the following:

#### *Knowledge*

- In-depth knowledge of different tools and management systems to achieve sustainable development at organisational level
- Understanding of the strengths and weaknesses of various tools and systems in relation to the organisational context.

#### *Skills*

- Can analyse and evaluate various tools and approaches to incorporate environmental efforts in an organisation ranging from mapping and documentation to ensuring continuous environmental improvement through motivation, participation, etc.
- Can use different tools for a product-oriented environmental effort, including life cycle assessment and eco-design
- Can help to strengthen the social dimension of sustainability efforts, including the introduction of Corporate Social Responsibility
- Can, with the help of various tools, assess the effects of both strategic and project-related initiatives on sustainable development
- Can apply theories of power, learning and organisation to assess the embedded understanding of context present in various tools and systems.

#### *Competences*

- Can reflect critically on project-related choices of tools and systems and their importance for environmental efforts in an organisation
- Can continuously adjust and adapt different tools and systems to the current challenges and needs of an organisation

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

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

**Title:** ***Complexity, Inter-relationships, Synergies & Conflicts (Kompleksitet, tværgående relationer, synergier og konflikter) (5 ECTS)***

Aim: Students that complete the module acquire the following:

*Knowledge*

- Understanding of cities as complex systems, where a series of different contexts, structures, changes and conditions effect each other, and where the result of each influencing factor is contingent on the simultaneous influences from many other factors
- Understanding of how urban development-related initiatives, which aim to meet certain needs and goals, usually have significant consequences in relation to a series of other considerations and goals
- Knowledge about the relationship of mutual dependence between cities' natural geographic/ecological context, the built environment, inhabitants' social lives and conditions, and economic conditions
- Thorough knowledge about the important side effects of the most ordinary strategies for promoting social, environmental and economic considerations in urban development
- Understanding of the challenges cities' complexity holds for research and theorising about cities and urban development's driving forces, processes and consequence

*Skills*

- Can critically analyse environmental, social and economic side effects of urban development initiatives, which primarily take a starting point in a particular need or have a particular goal
- Can suggest solutions in relation to the current urban development problem on the background of an analysis, drawing on knowledge and theories from different subject areas, which cover the most significant influencing factors and consequences
- Can communicate research-based knowledge in relation to the complex city and discuss professional and scientific problems with both fellow professionals and non-specialists

*Competences*

- With a point of departure in cities and the complex interrelationships of urban development, can independently combine knowledge from various relevant subject areas, initiate and implement cross-disciplinary cooperation and take professional responsibility for cross-disciplinary application of knowledge by suggesting solutions in urban planning
- Can perform simple research investigations of city and urban development-related topics, which through the methodological approach address the complex interrelationships of cities and diverse influencing factors

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

Examination: Continuous assessment or active participation. Internal examiner. Pass/fail. Graded in accordance with the Danish 7-point scale.

Evaluation criteria: As stated in the Framework Provisions.

### **3.2.2 Universitat Autònoma de Barcelona**

**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: *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.

***Climate Change (9 ECTS) (optional course)***

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

**Knowledge:** This module will describe the challenges presented by climate change: focused on discussion of the impacts caused by climate change on natural and social systems, short term solutions, adaptation and geo-engineering. Included topics are: patterns, causes and mechanism of natural climate change, impact of human activities in the present climate dynamics, possible future scenarios, tools and approaches to study the climate system. To meet these objectives, the course is structured in four blocks:

**Skills:** The student will be able to:

- Identify the concept of climate change due to natural and anthropogenic causes.
- Be able to use approaches and techniques to interpret climate change based on study and interpretation of diverse environmental registries.
- Discuss the realities of climate change and the existing evidence, and what consequences it will have in the future.

**Teaching:** Teaching and discussions will occur during class times, guided by particular readings and hand-outs assigned by individual instructors.

**Evaluation:** Evaluation will be based on assistance, participation, presentations and a final exam. Graded in accordance with the Spanish 10-point scale. Internal examiner.

***Global Change (9 ECTS) (optional course)***

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.

### **3.3 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.

#### **3.3.2 Technische Universität Hamburg-Harburg**

**Title:** *Environmental Aquatic Chemistry and Toxicology (3 ECTS)*

Aim: Students passing this course will be able to

- name the fundamental principles of environmental chemistry and toxicology
- model simple aquatic systems with modelling programmes
- describe and explain water chemical and eco-toxicological connections in natural systems
- apply simple methods on selected problems

Teaching: Lectures

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

**Title:** *Applied Surface Hydrology (4 ECTS)*

Aim: Students that complete the module acquire the following:

*Knowledge*

- basic elements of Surface Hydrology, including demonstration of hydrological cycle over ground.
- an understanding of the basic problems in Surface Hydrology and how to solve them.

### *Skills*

- ability to present the main tasks in Surface Hydrology, e.g. hydrometry, management of hydrological monitoring systems, determination of hydrological design parameters, statistics of observed hydrological parameters.

### *Competences*

- to apply the principles of Surface Hydrology to many problems in River Basin Management

Teaching: Lectures and assignments

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

### ***Title: Applied Groundwater Engineering (3 ECTS)***

Aim: Students passing this course will be able to

- solve groundwater hydraulic problems using simulation models
- construct groundwater contour lines
- calculate groundwater balances
- simulate groundwater flow regimes.

Teaching: Lectures and assignments

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

### ***Title: Water and Wastewater Systems in a Global Context (4 ECTS)***

Aim: Students passing this course will be able to understand the unique needs to water- and wastewater systems under different geographical and socio-economic conditions. On the one hand, the specifics of conventional systems will be understood; on the other hand, students will gain expertise in adequate low-cost and low-tech systems. There is a focus on regions in the world, in which there are currently no or insufficient sanitation systems. The main technical and non-technical possibilities for interventions from all over the world will be presented. Examples will equip students for their future work abroad. High-tech solutions will be included, with knowledge of the required preconditions.

Teaching: Lectures and assignments

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

### ***Title: Renewable Energy (3 ECTS)***

Aim: Students passing this course will have

- Deep knowledge of the interdisciplinary interrelationship and the classification of solar energy for heat and electricity production, wind energy for electricity production, hydropower for electricity production, ocean energy for electricity production, geothermal energy for heat and electricity production within the scientific and social environment
- Theoretical use of very demanding methods and processes within this topic of the lessons
- Assessment of different approaches for solutions within a multidimensional decision area

Teaching: Lectures

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

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

Aim: Students passing this course will acquire the following  
*Knowledge*

- Economic aspects and backgrounds of waste management
- Organisation and costs of waste collection
- Operation of facilities in economic terms
- Marketing of products
- Technical possibilities by using waste for energy production (electricity, gas, heat) and for the reduction of greenhouse gas
- The comprehension of the various interrelations by planning a holistic waste management concept

*Competences*

- Critically reflect on technological, political and social aspects and their possible influence on proposed solutions

Teaching: Lectures and assignments

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

**Title: Air Pollution Abatement (2 ECTS)**

Aim: After successful completion of the module, the student should be able to

- name the mechanisms for the distribution of emissions in the environment and to apply the models for the prediction of the distribution
- name and explain methods for the measurement of particulate and gaseous emissions
- know and understand the structure legal framework for the regulation of emissions
- transform concentration values between different units and standards
- name and explain the usual methods and processes for air pollution abatement
- develop solutions for the treatment of a flue gas

Teaching: Lectures

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

**Title: Sludge Treatment (3 ECTS)**

Aim: Students passing this course  
*Knowledge*

- Have a good command of scientific fundamentals and processes of anaerobic treatment of waste water and biomass

*Skills*

- Application of theory based demanding methods and techniques on sludge and biomass treatment.

*Competences*

- Systems-oriented reasoning, teamwork and communication skills with/towards different expert groups.

Teaching: Lectures

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

**Title: *Practical Course in Water and Wastewater Technology II (2 ECTS)***

Aim: Students passing this course

*Knowledge*

- Ability to critically understand how wastewater characteristics are generated

*Skills*

- Application of theory based demanding methods and techniques

*Competences*

- System orientated reasoning, teamwork and communication skills with/towards different expert groups.

Teaching: Assignments, lab work, etc.

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

### **3.3.1 Universidade de Aveiro**

**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: *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: *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 of*

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

*Skills for*

- 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, depending on his or her scholarship situation. Option 1 (described in more detail on the following pages) is available for all students regardless of country of origin and scholarship status. Option 2 (elaborated directly below) is **only** available to students from a 3<sup>rd</sup> country and holding a Category A scholarship from the EU Commission.

**Option 2:** In the case where a student is from a 3<sup>rd</sup> country and holds an Erasmus Mundus Category A scholarship, the student **may** (but is not obliged to) choose to spend a full semester at one of the European universities. This option is described further in Annex 3.

**Option 1:** Project (15 ECTS) at one of the associated 3<sup>rd</sup> country partner universities combined with project and/or coursework (in total of a further 15 ECTS) at one of the European universities. The associated partner universities are located in USA, Australia, and China.

The project work to be carried out in one of the 3<sup>rd</sup> countries 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 their 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 a chosen part of his/her field have knowledge at the highest level of international research
- Must understand and relate critically to the area's knowledge and must be able to identify either scientific or practical problem areas in a given context

#### *Skills*

- Must master the area's scientific methods and tools as well as master general skills linked to solving the chosen problem
- Must be able to assess and choose between the field's scientific methods, tools and general skills as well as establish new analytical and problem solving models

- Must be able to discuss professional and scientific issues with peers as well as non-specialists

#### *Competences*

- Must be able to control work and development situations that are complex, unpredictable and require new methods of solving
- Must independently be able to start and carry out professional and interdisciplinary cooperation and assume professional responsibility
- Must independently be able to assume responsibility of own professional development and specialization

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 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 – (Byudvikling, årsager og konsekvenser )(5 ECTS)***

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

- Knowledge about the social, economic and environmental consequences of urban development
- Thorough knowledge and understanding of relevant concepts, theories and models in relation to spatial development of cities and regions, including geographical location of businesses, housing, services and other facilities, as well as the relations between mobility and localisation
- Knowledge of theories, methods and experiences in terms of the relationship between urban development and the social development and living conditions of the city
- Can understand and reflect with a scientific basis on the causes and consequences of urban development, as well as the ability to identify scientific problems in relation to these

Skills:

- Can critically analyse and evaluate solutions and proposals that relate to the spatial development of cities and regions, especially with regard to sustainability and climate
- Can critically analyse the social and economic consequences of urban development
- Can suggest alternative solutions and proposals in relation to handling the social, economic and environmental consequences of urban development, on the background of an analysis
- Can communicate research-based knowledge in relation to the causes and consequences of urban development and discuss professional and scientific problems with both fellow professionals and non-specialists

*Competencies:*

- Can independently initiate and implement disciplinary and interdisciplinary cooperation with relation to the causes and consequences of urban development and take professional responsibility

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

Examination: Continuous assessment or active participation. Internal examiner. Pass/fail. Graded in accordance with the Danish 7-point scale.

Evaluation criteria: As stated in the Framework Provisions.

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

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

*Knowledge*

- In-depth knowledge of the energy system from use to production including energy savings, conversion technologies, fuels, renewable energy sources and localization
- Knowledge of the operation of energy plants and assessment methods and analytical tools for energy plants including technical limitations, optimisation potentials, environmental and economic consequences, involvement of externalities and plans
- Knowledge of public regulation of energy plants

*Skills*

- The ability to understand, apply and analyse theories, assessment methods and tools in relation to technologies and energy systems analyses of the environmental, economic, institutional and organisational problem areas of energy plants
- The ability to critically analyse energy related problem areas for energy plants
- The ability to understand, apply and analyse assessment methods and tools for consequential analyses of energy plants
- The ability to assess the field of application for assessment methods and tools including critically assess results and conclusions drawn from the use of various methods and tools
- The ability to understand and reflect on theory, assessment methods and analytical tools within relevant areas

### *Competences*

- The ability to independently start and take part in work tasks and collaborations at a company level
- The ability to independently assume responsibility of own professional development and specialisation

Teaching Lectures, work-shops, seminars, assignments and presentation, lecturer feedback.

Examination Continuous assessment or active participation. Internal examiner. Pass/fail. Graded in accordance with the Danish 7-point scale.

Evaluation criteria: As stated in the Framework Provisions.

**Title:** ***Mini Project (5 ECTS)***

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

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

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

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

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

Aim: Students who complete the module

#### *Knowledge*

- Must within a chosen part of his/her field have knowledge at the highest level of international research
- Must understand and relate critically to the area's knowledge and must be able to identify either scientific or practical problem areas in a given context

#### *Skills*

- Must master the area's scientific methods and tools as well as master general skills linked to solving the chosen problem
- Must be able to assess and choose between the field's scientific methods, tools and general skills as well as establish new analytical and problem solving models
- Must be able to discuss professional and scientific issues with peers as well as non-specialists

#### *Competences*

- Must be able to control work and development situations that are complex, unpredictable and require new methods of solving
- Must independently be able to start and carry out professional and interdisciplinary cooperation and assume professional responsibility
- Must independently be able to assume responsibility of own professional development and specialization

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.

### 3.4.2 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 (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.

### 3.4.3 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.

### 3.4.4 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.

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

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:** **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 centers 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: GIS (6 ECTS)**

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.

### **3.5 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 April 2012. In accordance with the Framework Provisions and the Handbook on Quality Management 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.

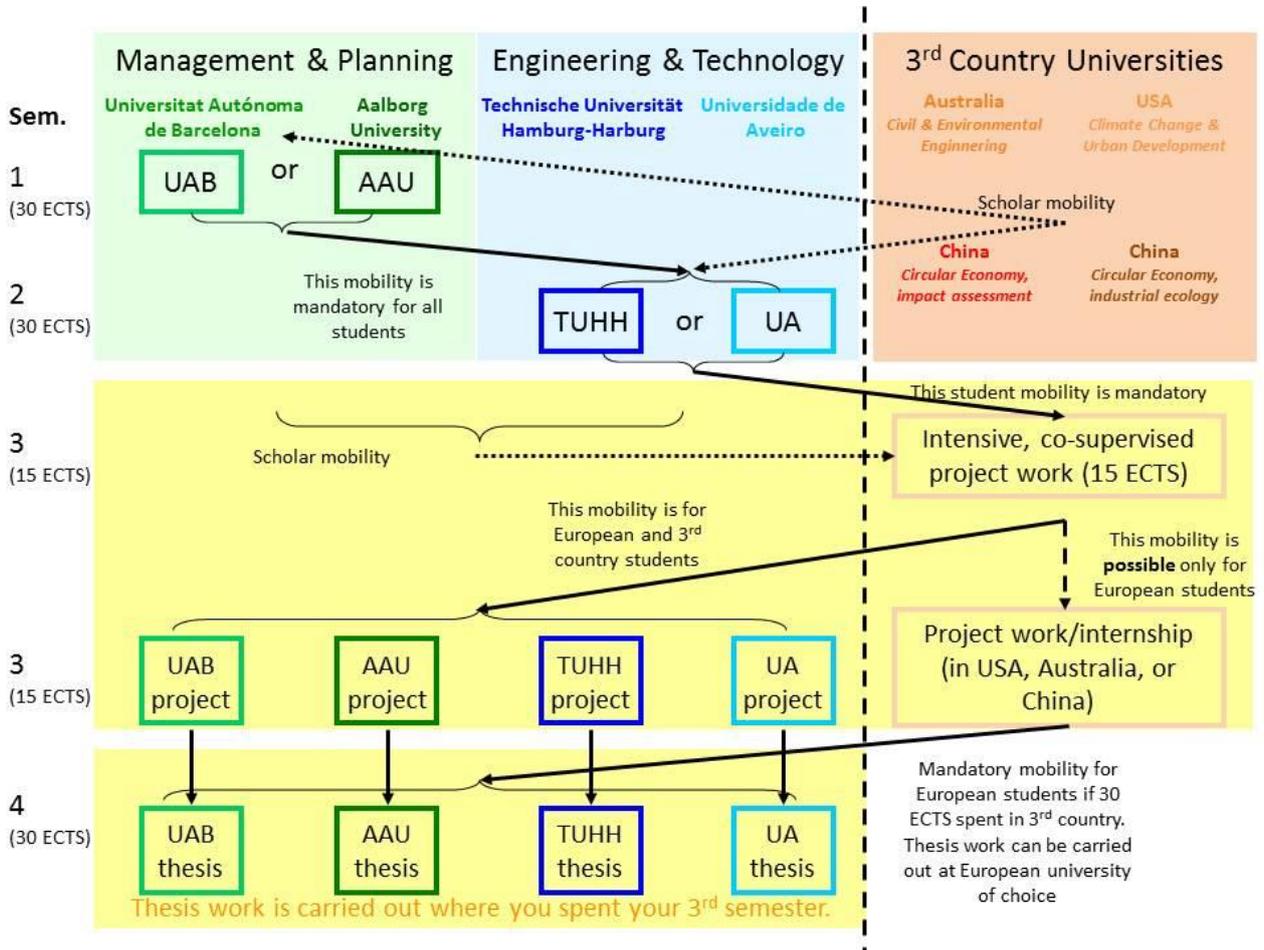
### **5.4 Completion of the Master Programme**

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



## Annex 2: Overview of Semesters at Partner Universities

### Aalborg University, AAU

Semester	Module	ECTS
1 <sup>st</sup>	Cities and Sustainability in a Management Perspective (project)	15
1 <sup>st</sup>	Tools and Systems of Sustainable Development (course)	5
1 <sup>st</sup>	Complexity, Inter-relationships, Synergies & Conflicts (course)	5
1 <sup>st</sup>	Theories of Science and Research Designs (course)	5
3 <sup>rd</sup>	<i>Option 1 – Choice between course work (A) or Continued Professional Development (with or without internship)</i> - Option A o Urban Development, Causes and Consequences o Sustainable Energy System Analysis o Mini project - Option B o Continued Professional Development	5 5 5 15
3 <sup>rd</sup>	<i>Option 2 - Full Semester</i> - Urban Development, Causes and Consequences - Sustainable Energy System Analysis - Current Topics in Sustainability Research - Business & Sustainability Management	5 5 5 15
4 <sup>th</sup>	Master's Thesis	30
<b>Total</b>		<b>75-90</b>

### Technische Universität Hamburg-Harburg, TUHH

Semester	Module	ECTS
2 <sup>nd</sup>	Environmental Aquatic Chemistry and Toxicology	3
2 <sup>nd</sup>	Applied Surface Hydrology	4
2 <sup>nd</sup>	Applied Groundwater Engineering	3
2 <sup>nd</sup>	Water and Wastewater Systems in a global Context	4
2 <sup>nd</sup>	Renewable Energy	3
2 <sup>nd</sup>	Waste Resources	6
2 <sup>nd</sup>	Air Pollution Abatement	2
2 <sup>nd</sup>	Sludge Treatment	3
2 <sup>nd</sup>	Practical Course in Water and Wastewater Technology II	2
3 <sup>rd</sup>	<i>Option 1 - Project work</i>	15
3 <sup>rd</sup>	<i>Option 2 - Full semester: Combination of project work and option A or B below</i> - Research Project - Option A: Water o Wastewater Analysis and Treatment o Process Modelling of Water and Wastewater Treatment o Wastewater Systems, Collection, Treatment & Reuse o Groundwater Engineering - Option B: Energy o Waste Resources Management o Energy from Biomass o Bioresource Management o Bio Refinery Technology o Advanced Topics in Waste Resource Management	15 15     15
4 <sup>th</sup>	Master's Thesis	30
<b>Total</b>		<b>75-90</b>

## Universitat Autònoma de Barcelona, UAB

Semester	Module	ECTS
1 <sup>st</sup>	Foundations of ecological economics	9
1 <sup>st</sup>	Political Ecology	6
1 <sup>st</sup>	Qualitative Methods for Social Science Research	6
1 <sup>st</sup>	Option of two courses: - Climate change - Global change	9
3 <sup>rd</sup>	<i>Option 1</i> - Industrial Ecology	9
	- Option of two courses o Waste Management o GIS	6
3 <sup>rd</sup>	<i>Option 2 – Full semester</i> - Waste Management	6
	- Industrial Ecology	9
	- GIS	6
	- Project	9
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 three 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	15
	- Air Quality Management	6
	- Measurement of Air Pollutants	6
	- Fundamental Theories of Risk	3
4 <sup>th</sup>	Master's Thesis	30
<b>Total</b>		<b>75-90</b>

### **Annex 3: Overview of 3<sup>rd</sup> semester option 2 at Partner Universities; Full Semester (30 ECTS)**

#### **Aalborg University**

##### ***Business & Sustainability Management (Byer og bæredygtighed i et ledelsesperspektiv)*** **(15 ECTS)**

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

*Knowledge:*

- Intensive knowledge of and understanding of businesses' and organisations' framework conditions, their challenges and roles in relation to sustainable development, and tools and systems to analyse those relevant at a company or organisational level

*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 within a study and project context structure and handle the complex composition of concrete challenges existing at and within an organisation
- 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.
- Can independently initiate and be part of cross-disciplinary planning and team work at the organisational level.

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

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

Aim: Students that complete the module acquire the following:

*Knowledge:*

- Knowledge about the social, economic and environmental consequences of urban development
- Thorough knowledge and understanding of relevant concepts, theories and models in relation to spatial development of cities and regions, including geographical location of businesses, housing, services and other facilities, as well as the relations between mobility and localisation
- Knowledge of theories, methods and experiences in terms of the relationship between urban development and the social development and living conditions of the city
- Can understand and reflect with a scientific basis on the causes and consequences of urban development, as well as the ability to identify scientific problems in relation to these

**Skills:**

- Can critically analyse and evaluate solutions and proposals that relate to the spatial development of cities and regions, especially with regard to sustainability and climate
- Can critically analyse the social and economic consequences of urban development
- Can suggest alternative solutions and proposals in relation to handling the social, economic and environmental consequences of urban development, on the background of an analysis
- Can communicate research-based knowledge in relation to the causes and consequences of urban development and discuss professional and scientific problems with both fellow professionals and non-specialists

**Competences:**

- Can independently initiate and implement disciplinary and interdisciplinary cooperation with relation to the causes and consequences of urban development and take professional responsibility

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

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

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

Aim Students passing the semester will acquire the following

**Knowledge**

- In-depth knowledge of the energy system from use to production including energy savings, conversion technologies, fuels, renewable energy sources and localization
- Knowledge of the operation of energy plants and assessment methods and analytical tools for energy plants including technical limitations, optimisation potentials, environmental and economic consequences, involvement of externalities and plans
- Knowledge of public regulation of energy plants

**Skills**

- The ability to understand, apply and analyse theories, assessment methods and tools in relation to technologies and energy systems analyses of the environmental, economic, institutional and organisational problem areas of energy plants
- The ability to critically analyse energy related problem areas for energy plants
- The ability to understand, apply and analyse assessment methods and tools for consequential analyses of energy plants
- The ability to assess the field of application for assessment methods and tools including critically assess results and conclusions drawn from the use of various methods and tools
- The ability to understand and reflect on theory, assessment methods and analytical tools within relevant areas

**Competences**

- The ability to independently start and take part in work tasks and collaborations at a company level
- The ability to independently assume responsibility of own professional development and specialisation

Teaching Lectures, work-shops, seminars, assignments and presentation, lecturer feedback etc.

Examination The course is evaluated continuously through the course, based on participation in lectures, contributions to discussion, and completion and presentation of assignments. The evaluation is based on the judgment of the lecturers and is concluded with a pass/fail

**Title:** ***Current Topics in Sustainability Research I (5 ECTS)***

Aim: Students passing the course will acquire the following

*Knowledge*

- Intensive knowledge of general themes that relate to organisations' challenges in relation to sustainable development
- Knowledge of the complexities of current and concrete challenges at an organisational level
- Knowledge of companies' interaction with their different stakeholders and the form this interaction may take
- Knowledge of relevant theories, comprehensions, methods and analyses, which concretise organisations' opportunities for working with sustainable solutions

*Skills*

- Can, at the organizational level, identify, analyse, and evaluate sustainability relevant problems and consequences.
- Can evaluate cross-disciplinary planning and team work at the organisational level
- Can identify interests linked to organisations' work (or lack thereof) with sustainable development
- Can disseminate and discuss overall themes that are of particular interest to organisations' work with sustainable development.
- Can reflect on relevant quantitative as well as qualitative economical, sociological, environmental, and/or engineering science analysis methods

*Competences*

- Can independently initiate and be part of cross-disciplinary planning and team work at the organisational level.

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

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

**Universidade de Aveiro**

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

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.

**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 Risk (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 os 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.

## Universitat Autònoma de Barcelona

### **Title: Project (9 ECTS)**

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.

### **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: *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: *Geographical Information Systems (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.

## Technische Universität Hamburg-Harburg

Besides 15 ECTS project work, TUHH offers the option of two focus areas on the third semester: 1) Water and 2) Waste & Renewable Energy.

**Title:** ***Project (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.

### **Water**

**Title:** ***Wastewater Analysis and -Treatment (4 ECTS)***

**Aim:** Students passing this course will acquire

- Fundamentals of particular (waste) water treatment unit operations;
- Conjunction between process fundamentals and appearance of the concerning apparatus
- Theoretical background for low-cost analytical procedures and testing in the laboratory

**Teaching:** Lectures

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

**Title:** ***Process Modelling of Water and Wastewater Treatment (4 ECTS)***

**Aim:** Students passing this course will be able to

- understand theory and applications of major physical, chemical and biological processes for the treatment of water and wastewater.

**Teaching:** Lectures and assignments

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

**Title:** ***Wastewater Systems – Collection, Treatment and Reuse (4 ECTS)***

**Aim:** Students passing this course will acquire the following *Knowledge*

- water management systems and their interaction
- Water and water protection, lakes and oceans
- Handling of rainwater, usage and seepage
- Wastewater drainage and treatment systems

*Skills*

- application to the situations in middle and northern Europe and other parts of the world
- Regional planning: solution options under various conditions, comparative cost method

Teaching: Lectures, assignments, field trips

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

**Title: *Groundwater Engineering (3 ECTS)***

Aim: Students passing this course will be able to

- determine the types of aquifers using geological information constructed groundwater contour lines
- visualize the ground water flow with streamlines and path lines
- determine the hydraulic conductivity and the storage capacity of the subsurface by hydraulic tests
- describe the soil transport process in mathematical terms
- basics of flow and transport in porous media.
- Ability to develop a ground water contour plan and calculate the hydraulic aquifer parameters using pumping tests.

Teaching: Lectures

Examination: Written elaboration. Graded in accordance with the German 5-point scale.

**Waste and Energy**

**Title: *Waste Resources Management (2 ECTS)***

Aim: Students passing this course will be able to

- Recognise and describe worldwide problems of waste management
- Define kinds of waste and waste streams
- Know and distinguish between different processes of waste collection, avoidance, utilisation and disposal
- Assign waste streams to treatment and utilisation processes
- Assess the quality of waste as raw material and energy resources
- Estimate the incoming waste streams of waste producers
- Develop a master plan for the identified waste streams by selecting methods of waste collection, avoidance, utilisation and disposal for the specific waste streams
- Create a scientific report and find and select literature for this purpose

Teaching: Lectures, discussions, etc.

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

**Title: *Energy from Biomass (3 ECTS)***

Aim: Students passing this course have

- Deep knowledge of the interdisciplinary interrelationship and classification of biomass as a source of energy, thermo-chemical conversion, combustion, gasification, biogas and bioethanol production within the scientific and social environment.

- Theoretical use of very demanding methods and processes within this topic of the lessons.
- Assessment of different approaches for solutions within a multidimensional decision area.

Teaching: Lectures, discussions, etc.

Examination: Written exam. Graded in accordance with the German 5-point scale.

**Title:** ***Bioresource Management (2 ECTS)***

Aim: Students passing this course will obtain

- Knowledge of aerobic and anaerobic waste treatment methods (composting, digestion, combinations), including the products produced and the treatment of the respective emissions;
- Deepened knowledge on the collection and utilization of waste paper and waste wood, the different technologies as well as possible products and residues

Teaching: Lectures, discussions, etc.

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

**Title:** ***Bio Refinery Technology (4 ECTS)***

Aim: Students passing this course will obtain

- insight into the latest developments in biorefinery technology
- an ability to see the big picture beyond system boundaries and to design complex systems allowing a complete material and energetic recovery of the resources available
- a self-initiative development of a biorefinery concept

Teaching: Lectures, discussions, etc.

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

**Title:** ***Advanced Topics in Waste Resource Management (4 ECTS)***

Aim: Students passing this course will have obtained

- Knowledge on German and European waste management regulations, systems and their financing
- Knowledge on the contribution of waste management to climate and resource protection:
- Knowledge on Waste management in developing and emerging economies

Teaching: Lectures, discussions, excursions, etc.

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