

## MATRIX – Draft of the new Master course (Polytechnic Institute of Leiria)

Name of compulsory courses	Year	Semester	Number of ECTS	Number of elective chairs	List of available elective courses	Short description	Relation between the contents and RETHINK's theme
<b>Master in Civil Infrastructure and Climate Engineering</b>							
<b>Dynamic Analysis and Earthquake Engineering</b>	1 <sup>st</sup> year	1 <sup>s</sup> semester	7	-		This course provides training in the analysis, design and assessment of structures under seismic actions and other extreme loading conditions. The syllabus covers a comprehensive set of topics related to structural dynamics, single and multiple degree freedom systems, earthquake engineering, and advanced numerical techniques	This course is concerned with the study of how earthquake-induced ground motions affect building structures, the design of such structures to resist earthquake loading, and the control of structures by using sustainable and innovative materials to improve their dynamic response to earthquake loads.
<b>Road Pavement Construction and Management</b>	1 <sup>st</sup> year	1 <sup>s</sup> semester	6	-		This course is designed to get a better understanding of the principles underlying pavement design, taking into account the physical and mechanical characteristics of materials and the performance in pavement layers, the manufacturing techniques and on-site pavement construction. It also considers the techniques for pavement maintenance and recycling, how pavements deteriorate and its life cycle performance.	From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction, low emission of greenhouse gases, and conservation of natural resources through recycling.
<b>Urban Hydraulics</b>	1 <sup>st</sup> year	1 <sup>s</sup> semester	6	-		This course is designed to provide knowledge on the management, operation and maintenance of water supply and sewerage; as well the solid waste management. Optimization problems in the field of urban hydraulics are complex by nature and difficult, so training is important to develop mathematical models for hydraulic simulation.	Understand urban water management problems including ability to: identify water systems' demand; deal with climatic and hydrologic uncertainties and/or extremes; institutional limitations; and work within a data-constrained environment; be able to make appropriate and critical use of methods, techniques and tools necessary to monitor, analyse and design urban water systems including water supply infrastructure, drinking

							water treatment and distribution, wastewater collection, treatment, transport and disposal systems and drainage systems.
<b>Computer Programming for Engineers</b>	1 <sup>st</sup> year	1 <sup>s</sup> semester	4	-		Elements of procedural and object-oriented programming. Induction, iteration, and recursion. Real functions and floating-point computations for engineering analysis. Introduction to data structures. Representative examples are drawn from mathematics, science, and engineering. This course uses the MATLAB programming language	It aims to use MATLAB programming language to solve climate engineering problems
<b>Sustainable Construction</b>	1 <sup>st</sup> year	1 <sup>s</sup> semester	5	-		Understanding and obtaining knowledge on basic methods and tools s to enhance sustainability in buildings, through a comprehensive selection of materials, processes and methods, promoting recycling and reuse whenever possible, taking into account environmental, social and economic considerations	Contributing to the development of critical thinking skills, encouraging a more ecological and sustainable approach. Stimulate intellectual curiosity, innovation openness and experimentation on sustainable construction and related areas.
<b>3D Modeling and GIS</b>	1 <sup>st</sup> year	2 semester	5			3D modeling for engineering design. This course will emphasize the use of CAD on computer workstations as a major graphical analysis and design tool. Students develop design skills, and practice applying these skills. A group design project is required. It requires creativity, teamwork, and effective communication. Remote sensing, including air photos and satellite imagery, spatial data sources, important for both GIS and environmental sciences. In this course, students will learn the theory, sensors, analysis methods, and applications of remote sensing. Hands-on analysis experience using GIS software and several types of images	3D modelling and GIS are essential tools to assist in climate changing mitigation strategies
<b>Risk analysis and extreme events</b>	1 <sup>st</sup> year	2 semester	6			Introduce students to risk analysis, leading to the conceptualisation of engineering processes and mechanics from a stochastic perspective. The definitions of risk, modelling within a risk framework, risk perception and notions of acceptable risk. Elementary statistical principles, limit theorems for stochastic processes, as well as extreme value analysis and a brief introduction to Bayesian formulations.	Objective methods are introduced for analyzing geophysical, meteorological, and climate data from observations and models. These may include linear and non-linear time series analysis, composite analysis, pattern recognition, statistical modeling approaches, and non-linear stochastic modeling. Published studies carried out with these methods will be critically evaluated

<b>Flood risk management</b>	1 <sup>st</sup> year	2 semester	5			This course explores causes and long term pressures on flood risk as well modelling and mitigation methods. The module focuses on surface water flooding from urban drainage systems as well as river flooding. Teaching delivery is a mixture of lectures, seminars, computer modelling tutorials, as well as laboratory demonstration and a field visit. It aims at developing a knowledge and understanding of flood risk management concepts in relation to river and surface water flooding. This includes an understanding on flood risk, modelling tools and limitations, as well appropriate mitigation strategies.	This course assist in the prevention and mitigation of flood risks regarding river and surface water flooding
<b>Environmental Comfort in Buildings</b>	1 <sup>st</sup> year	2 semester	5			Provide students with the technical, regulatory and regulations related to several areas of analysis of indoor environmental quality, as well the ability to integrate information on various aspects relevant to environmental quality (indoor air quality, thermal environment, noise, vibration, lighting), and perform diagnostics of the quality of the indoor environment and propose improvement measures. Develop awareness of the need to harmonize the concerns on indoor environmental quality and the need to minimize energy usage.	This course aims to improve the environmental comfort in buildings, through the definition of the design conditions of indoor environments and its assessment in existing buildings
<b>Civil systems and the environment</b>	1 <sup>st</sup> year	2 semester	6			Methods and tools for economic and environmental analysis of civil engineering systems. Focus on construction, transportation, operation, and maintenance of the built infrastructure. Life-cycle planning, design, costing, financing, and environmental assessment. Industrial ecology, design for environment, pollution prevention, external costs. Models and software tools for life-cycle economic and environmental inventory, impact, and improvement analysis of civil engineering systems.	This course aims at improving life-cycle planning, design, costing, financing, and environmental assessment
<b>Properties of materials</b>	1 <sup>st</sup> year	2 semester	5			Application of basic principles of physics and chemistry to the engineering properties of materials. Special emphasis on the relation between microstructure and the mechanical properties of metals, concrete, polymers, and ceramics, and the electrical properties of semiconducting materials.	this course aims habilitate students to get a better understanding of the basic principles of physics and chemistry to the engineering properties of materials
<b>Total</b>			60				
<b>Renewable energy technology and carbon mitigation</b>	2 <sup>nd</sup> year	semester	6			Scenarios for world energy demand and CO2 emissions, implications for climate. Assessment of technological options to respond to climate change. Overview of climate-change science; sources, sinks, and atmospheric dynamics of greenhouse gases. Current systems for energy supply and use. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration Technological opportunities for improving end-use energy efficiency. Recovery, sequestration, and disposal of greenhouse gases.	Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals..
<b>Environmental Geotechnics</b>	2 <sup>nd</sup> year	semester	6			Soil formation and identification. Engineering properties of soils. Fundamental aspects of soil characterization and response, including soil mineralogy, soil-water movement, effective stress, consolidation, soil strength, and soil compaction.Principles of environmental geotechnics applied to waste encapsulation and remediation of contaminated sites. Characterization of soils and waste,	Soil is a fundamental and ultimately finite resource that fulfils a number of functions and services for society which are central to sustainability.

						engineering properties of soils and geosynthetics and their use in typical applications. Fate and transport of contaminants. Fundamental principles and practices in groundwater remediation. Application of environmental geotechnics in the design and construction of waste containment systems. Discussion of soil remediation and emerging technologies.	Some of the most significant impacts on this resource occur as a result of climate change, and this course develops awareness and understanding of engineering properties of soils and the fundamental principles in groundwater remediation
<b>Transportation Planning and Management</b>	2 <sup>nd</sup> year	2 semester	6			Training students to analyze transportation systems and develop mobility management projects with a strong focus on urban systems. It provides students with the knowledge to understanding intelligent transportation systems and participate in the development of sustainable mobility plans by developing the capacity to integrate all the main aspects inherent to transportation planning	Traditional transport planning aims to improve mobility, reducing environmental and social impacts, and managing traffic congestion
<b>Engineering Systems and Sustainability</b>	2 <sup>nd</sup> year	2 semester	6			An introduction to key engineered systems (e.g., energy, water supply, buildings, transportation) and their environmental impacts. Basic principles of environmental science needed to understand natural processes as they are influenced by human activities. Overview of concepts and methods of sustainability analysis. Critical evaluation of engineering approaches to address sustainability.	
<b>New Technology-based Venture Creation</b>	2 <sup>nd</sup> year	2 semester	6			The creation of new ventures is a defining attribute of entrepreneurs. While the theory and principles discussed in this course can be applied to a wide range of industries, the specific focus will be on knowledge-based ventures. The course consists of classes that are working sessions with presentations by students and evaluations by students of each other's progress. It is structured such that students will develop business ideas from initial concept through to the creation of a business. Emphasis will be on actual execution of steps to achieve key milestones in developing and operating a business. Key concepts will be centered around building a value proposition, product or service and a team that will form the road map for a long term sustainable business.	The objectives are to create business models to facilitate the launch of technology-based commercial ventures: <ul style="list-style-type: none"> <li>• Develop the theoretical and practical skills necessary to develop a business concept into a viable business</li> <li>• Course focuses on application of these skills in building a business from a concept in a mentored, self-paced environment. This leads to the ability to assess, develop and deploy the capabilities and competencies necessary for future success.</li> </ul>
<b>Project</b>	2 <sup>nd</sup> year	annual	30			Development of the project work with the elaboration of the final document.	Aim: Linking the objectives of integrate civil infrastructures, climate science and entrepreneurship
<b>Dissertation</b>	2 <sup>nd</sup> year	annual	30			Development of the dissertation work with the elaboration of a final document.	Aim: Linking the objectives of integrate civil infrastructures, climate science and entrepreneurship
<b>Training</b>	2 <sup>nd</sup> year	annual				Realization of a supervised traineeship in a company that operates in the domains of this Master degree. Preparation of a final document to describe the work carried out	Aim: Linking the objectives of integrate civil infrastructures,

			30			during this traineeship and the results accomplished	climate science and entrepreneurship
<b>Total</b>			60				
<b>Total - Master degree:</b>	2 years	4 semesters	120			<p>The 2014 Climate Summit aimed at inspiring transformative action to reduce emissions and build resilience to the adverse impacts of climate change. By 2050, 80 per cent of the world population is expected to be living in cities, which calls for large scale and integrated changes to make our future cities more sustainable.</p> <p>Climate change is a global challenge affecting all regions and all economic levels, all aspects of life. At the core of this impact is the effect on civil systems, which are the foundation on which modern society operates. From transportation and water systems to power and communication systems, civil infrastructure is the foundation on which daily activities are dependent. Climate change mitigation is essential to build a safe and sustainable future. Infrastructure and communities around the world urgently need to adapt to a climate change with more frequent and more severe storms, droughts and floods.</p> <p>Combatting climate change provides an opportunity for creating new energy systems, transport networks, green economies, integrated ecosystem services, an opportunity for innovation creating new better ways of living. There is an ever increasing focus on climate change mitigation and energy costs, so major efforts are being directed at improving thermal performance of building envelopes and enhancing the energy efficiency of building services within them. To meet energy targets, and subsequent reductions in greenhouse gases, many sustainable building design and operation strategies are exploring new ways to provide comfort. Business has a critical role to play, it is fundamental to develop tools to help both businesses and communities adapt to this new reality, to allow public officials to make informed decisions regarding the vulnerability of civil infrastructure systems to climate change, to equip leaders to manage community resilience to climate change, to adopt new approaches to governance.</p>	<p>Climate change and the urgency of minimising the carbon footprint of the built environment are driving innovation. High-quality environmental design is a requisite for healthier built environments, higher, productivity and sustainability. Climate change requires innovative solutions that cross traditional discipline boundaries. The new master degree being prepared in Civil Infrastructure and Climate Change Engineering will integrate civil infrastructures, climate science and entrepreneurship.</p>