RESCO

Erasmus Mundus Master in Renewable Energy and Sustainable Construction

Programme Syllabus

120 ECTS Credits

Programme Overview

The RESCO Erasmus Mundus Joint Master Degree is a two-year programme (120 ECTS) with no elective courses, divided into four semesters of 30 credits each. In addition to 90 credits of conventional courses, the programme includes a 6 month internship in partner companies or institutions (15 credits) and a Master Thesis (15 credits), both mandatory. The programme combines expertise in renewable energy systems and sustainable construction, offering students a unique opportunity to study at multiple leading European institutions and gain international experience in the field of sustainable engineering.

Partner Institutions:

- **Budapest University of Technology and Economics** (BME), Hungary - Semester 1
- **University of A Coruña** (UDC) / **University of Minho** (UMinho), Spain/ Portugal - Semester 2
- **Université Le Havre Normandie** (ULHN), France - Semester 3
- **INSA Rouen Normandie** (administrative coordinator) - Semester 4

SEMESTER 1

Budapest University of Technology and Economics (BME), Hungary Structural Engineering

The civil engineering courses at BME aim to provide students with a solid understanding of structural engineering, especially in the context of renewable energy infrastructures (wind farms, photovoltaic and hydroelectric plants). Students will acquire skills in numerical methods, including finite element modeling and structural stability analysis, which are essential for addressing civil engineering challenges.The first semester establishes a foundation in structural design, modeling, and stability, which is further developed through team projects that enhance documentation, presentation, and cross-functional skills. Additionally, IT skills are integrated into the Numerical Methods course, where students apply programming to various civil engineering problems. Building physics and technology serve as a bridge between civil engineering and sustainability, reinforcing the interdisciplinary nature of the programme. The BME courses also include a project-based learning component, allowing students to work independently on civil engineering projects and apply their knowledge to practical scenarios.

Module	ECTS	Contact Hours	Self-Study	Main Content
Structures	4	42	78	Structural analysis, reinforced concrete and steel structures ***Dr. László Péter Kollár***
FEM for Civil Engineers	4	42	78	Finite Element Method, structural modelling and simulation ***Dr. Sándor Ádány***
Building Physics and Sustainable Construction	6	56	124	Hygrothermal behaviour of building constructions, sustainable materials, BIM ***Dr. Balázs Nagy***
Structures Project	5	28	122	Project-based learning, structural analysis and design ***Dr. László Gergely Vigh***
Numerical Methods	4	42	78	Numerical resolution techniques, programming for engineering ***Dr. Laky Piroska***
Diagnostics of Constructions	4	42	78	Structural assessment, monitoring, damage detection ***Dr. Fenyvesi Olivér***

Digital Twins of Structures	3	28	62	Digital twins, data-driven modelling, smart structures ***Dr. Attila László Joó***
TOTAL	***30***	***280***	***620***	

Learning Outcomes - Semester 1

- Graduates will know the terminology and methods of structural engineering design and construction, including calculation methods, numerical methods, optimization methods, finite element modeling, sustainability and digital twins.
- Graduates will be able to apply methods in structural engineering projects and use state-of-the-art modeling, simulation and mathematics tools.
- Graduates will be able to manage a civil engineering project, work in teams, schedule specific structural engineering tasks and create reasonable work documentation.
- Graduates will learn the standards and regulations that must be considered and followed during a civil engineering project, from design to construction.
- Students will also acquire intercultural skills and English fluency.
- Students will understand the core principles of building physics and sustainable materials, and will be able to analyse heat and moisture transfer in building structures and evaluate energy-efficient design solutions.

SEMESTER 2

University of A Coruña (UDC) / University of Minho (UMinho), Spain/ Portugal

Sustainable Construction and Energy Efficiency

During the second semester, students will receive training on sustainable civil engineering and building topics, as well as the most critical energy efficiency issues related to planning, design, construction, maintenance and preservation of civil engineering and building works. This period will focus on sustainable construction topics, such as those related to recycled materials, decarbonization of the construction sector, life cycle assessment methods, principles and tools, and sustainability to promote energy-efficient buildings and indoor air quality, as well as the importance of renewable and efficient energy sources for Sustainable Development. At the same time, various environmental aspects of engineering and construction will be examined in detail, such as those related to the SDGs, the effects of climate change, clean energy generation principles and concepts related to sustainable mobility plans or water risk management. Sustainability assessment and life cycle analysis concepts will be explicitly addressed at the building scale. In addition, different principles for improving the indoor environmental quality of buildings will be addressed, along with tools and methods to support the decision-making of building designers. Courses will be held at the facilities of UDC (A Coruña-Spain) and UMinho (Guimarães-Portugal).

Module	*ECTS*	*Contact Hours*	*Self-Study*	*Main Content / Coordinator*
Environment and Sustainability	5	35	90	Environmental impact, sustainability principles / ***Dr. Víctor Barrientos Rodríguez*** UDC)
Sustainable Construction, Recycled Materials and Life Cycle	5	35	90	Life Cycle Assessment, eco-materials, recycling / ***Dr. Isabel Martínez Lage*** (UDC)
Data Science and Research Methodology	5	35	90	Research methods, data analysis / ***Dr. José Luis Calvo Rolle*** (UDC)
Renewable Systems and Energy Efficiency	5	35	90	Renewable technologies, efficiency strategies / ***Dr. José Luis Casteleiro Roca*** (UDC)
Methods and Tools	5	35	90	Tools for sustainable design and construction /

				Dr. Luís Bragança (UMinho)
Performance of Buildings	5	35	90	Energy performance, building efficiency / ***Dr. Manuela Guedes de Almeida*** (UMinho)
TOTAL	***30***	***210***	***540***	

Learning Outcomes - Semester 2

- Master students will learn the principles of sustainability and the SDGs, policies to promote them, clean energy generation, the fundamentals of climate change and the risks of extreme weather events. They will also learn the basic concepts related to mobility plans.

- They will learn the procedures for recycling materials and their behavior. They will learn key issues in decarbonization in materials production and construction procedures, life cycle analysis of construction products and assessment of greenhouse gas (GHG) emissions reduction.

- They will learn the boundaries of a sustainability assessment, the design principles of sustainable construction and the use of different environmental labels. They will learn to use multicriteria decision-making support methods to improve the sustainability of buildings.

- They will learn the policies that promote building performance and understand the design principles that improve energy efficiency and indoor environmental quality.

- They will learn the importance of scientific research, ethical principles in research, the procedure for finding quality information, the steps of scientific methodology and data science. They will learn the importance of data science in sustainability and the environment.

- They will learn the importance of different renewable systems, their differences, their principles of operation and the procedures to design them. They will especially learn ideas to improve renewable systems in buildings and the basic concepts of battery management systems.

- Students will continue to improve intercultural skills and English fluency.

SEMESTER 3

Université Le Havre Normandie (ULHN), France
Renewable Energy Systems and Civil Engineering

The objective of the courses taught in the third semester is to offer the main ideas on the development of renewable energies. Three of the subjects are dedicated to the main renewable energy resources: wind energy, marine energy (including offshore wind), solar energy and earth energy (including biomass and geothermal). Each of them covers resource characterization, different technologies, determination of energy production and project management for the deployment of an energy installation. One subject is dedicated to the relationship of Civil Engineering with renewable energies and another subject is dedicated to electrotechnics, grid integration and the general characteristics of climate change, the geopolitics of the energy transition and the economics of renewable energies. The courses will be held at the ULHN site (Le Havre, France)

Module	*ECTS*	*Contact Hours*	*Self-Study*	*Main Content / Coordinator*
Wind Energy	6	60	90	Wind turbines, aerodynamics, wind farm design / ***Pr. Grégory Pinon***
Marine Energy	6	60	90	Offshore wind, tidal and wave energy ***Dr. Gaële Perret***
Solar and Earth Energy	6	60	90	Solar, geothermal, biomass, energy storage ***Pr. Klaus Kuhnke***
Civil Engineering	6	60	90	Foundations and infrastructure for renewable energy ***Dr. HdR Saber Imanzadeh***
Humanities and Electrotechnics	6	48	102	Grid integration energy transition, societal aspects ***Pr. Damien Guilbert***
TOTAL	***30***	***288***	***462***	

Learning Outcomes - Semester 3

- Graduates will be able to characterize the different renewable energy resources in a given location.
- They will be able to design and/or choose the appropriate technology.
- They will be able to estimate the production of an energy farm.
- They will learn the environmental, technical limitations and the administrative procedure for the development of an energy farm.
- They will be able to manage a civil works project related to renewable energies.

- They will be able to develop and deploy a renewable energy project.
- They will continue to deepen their intercultural skills and English fluency.

SEMESTER 4

Internship and Master Thesis INSA Rouen Normandie

(Administrative Coordinator), France

The fourth semester will consist of an Internship (15 ECTS) and a Master Thesis (15 ECTS), both mandatory and complementary. The Internship will consist of a 4 to 6 month supervised work period, from February/March to July/August. This internship period may be done in industry, government services, NGOs or in research (academic or R&D in a company) in Europe or all over the world. Each student will be assigned to a supervisor appointed by the company/institution. The student will not only learn the technical knowledge necessary for the workplace assigned, but will also focus especially on non-technical knowledge such as teamwork, project management, communication, presentation, documentation, self-training, and societal and economic issues. Students must demonstrate skills such as being able to fulfill duties and work schedules, demonstrate a good level of effort, be able to create high quality work, be able to demonstrate their problem-solving ability, and be able to effectively use their skills. They must also demonstrate being able to cooperate with managers and colleagues, being able to get involved and engage with the company/institution, and taking initiatives. At the end of the internship period, the supervisor will sign a form to show the students' performance in the workplace on the previously mentioned topics, which will be used in the evaluation of the module with the agreement of the academic coordinator.

The Master Thesis will be directly related to the Internship described above or will focus on another topic jointly agreed by the student and the Master Thesis academic supervisor that will be assigned to each of the students. The student should individually develop an original work and present and defend it publicly before an academic examination board. They should also identify the social, legal, security, environmental, economic and technological restrictions in the problem or project they will present. They should carry out, if appropriate, a reflection on the social or ethical responsibility linked to the development of the MT. They are expected to communicate accurately and unambiguously, both in writing and orally, knowledge, procedures, arguments, results, ideas and conclusions, to specialized and non-specialized audiences in the field of Renewable Energies and Sustainable Construction. They must integrate knowledge, procedural methodologies and previously acquired skills to solve a problem related to this field in its broadest conception. The MT will be assessed in a common framework, being defended before a jury composed of all the consortium partners (the format can be hybrid, with jury members both online and in person) at the university to which the student's academic supervisor is attached. The examination board will be accompanied by professors from all associated institutions and associated partners according to their availability. The language to be used for written documents and oral presentations will always be English. The presentation will last 20 minutes and will be followed by 10 minutes for questions. For this purpose, a hybrid online/in-person modality will be preferred. The consortium will establish a joint review procedure. A unified jury, composed of representatives from each associated university and associated partners, will deliberate on the participants' MTs.

This ensures a harmonized assessment process that respects the specific expertise of each partner, while respecting common academic standards. In addition, the consortium will develop shared guidelines and criteria for MT assessment, aligned with the agreed examination regulations and promoting a coherent approach to its progression and completion.

Module	*ECTS*	*Work Hours*	*Self-Study*	*Main Content / Coordinator*
Internship	15	375 hours	—	Professional placement in industry, lab or institution
Master Thesis Report and Defense	15	—	375 hours	Research work, thesis writing and public defense
TOTAL	***30***			

This syllabus is subject to modifications. Module coordinators are listed for reference. Please refer to the individual course coordinators for the most up-to-date information regarding specific modules.

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES ROUEN NORMANDIE
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