EUREC M.Sc. specialization semester on Ocean Energy at Instituto Superior Técnico (IST) – Technical University of Lisbon (UTL)

General learning outcomes for the specialization semester The specialization semester is organized to provide the students with sufficient technical knowledge on Ocean Renewable Energy while also providing them with a good grounding in the role of marine renewables in the energy sector.

- Sound understanding of the role of marine renewable energy technologies in the energy sector
- Basic technical knowledge on the different marine renewable energy technologies that are and will be contributing to energy supply covering the following aspects :
    - evaluation of the resource
    - conversion process
    - performance of systems in operation
    - tools for simulation and design
- Ability to make an economic evaluation of the profitability and competitiveness of marine renewable energy projects.

Ocean Energy Resources At the completion of this module, the student will:

- have an understanding of the physical mechanisms in the ocean which are on the basis of the generation of surface waves, tides and currents, and their effects
- be familiar with the statistic description of waves and currents
- use the statistical information to make evaluation of the energy resource
- use of GIS in site selection characterization.

Modelling and Control of Ocean Energy Systems At the completion of this module, the student will:

- become familiar with the linear hydrodynamic theory of wave energy systems
- become familiar with the hydrodynamic theory of marine current turbines (BEM)
- be introduced to advanced numerical hydrodynamic modelling of wave and current systems and control simulation
- be introduced to experimental testing and monitoring of OE systems
- get a basic knowledge of other forms of ocean energy and their systems as OTEC and salinity gradients.

Ocean Energy Systems Technologies At the completion of this module, the student will:

- become familiar with the electro-mechanical equipment used in wave energy systems and marine current turbines, the offshore electrical grid and connection systems
- get basic knowledge on the requirements to deploy, operate and maintain the wave and current energy systems both isolated and in arrays.

Economics, Policy and Environment At the completion of this module, the student will:

- become familiar with the basic economic analysis of ocean energy systems including the cost, financing and economic evaluation
- get basic knowledge on the general policy issues regarding ocean energy systems and more detailed knowledge on the licensing and permitting procedures for installation of OE systems and enabling mechanisms as funding, feed-in tariffs and tax incentives
- Be able to perform simple environmental impact studies for OE systems.

Project At the completion of this module, the student will:

- bring into practice the knowledge acquired through a case study in the form of a specific small project.

Title	Content	ECTS credits	Person responsible
Ocean Energy Resources Module: 6 ECTS credits	Module Content • Introduction to the ocean environment o Ocean circulation and stratification o Ocean habitat o Ocean economy • Ocean surface waves o Wave measurement o Linear wave theory o Wave spectrum o Wave energy resource • Ocean tidal currents o Current measurement o Current turbulence o Current energy resource • Site selection and characterization for ocean energy systems	6	Prof. A. Sarmento
Modelling and Control of Ocean Energy Systems Module: 6 ECTS credits	Module Content • Wave energy systems o Types of wave energy converters o Linear wave-structure interactions o Frequency domain analysis o Hydrodynamic coefficients and their computation o Time domain analysis o Phase control o Arrays o Model testing techniques • Marine current turbines o Types of marine current turbines o Hydrodynamic models (BEM, Lifting line, IBEM) o Hydrofoil data and analysis o Cavitation and strength	6	Prof. J.A.F. Campos

	○ Design criteria ○ Multiple turbine interaction • Other types of energy systems ○ Ocean Thermal Energy Conversion (OTEC) ○ Energy from salinity gradient		
Ocean Energy SystemsTechnologies Module: 7.5 ECTS credits	Module Content • Power take-off systems ○ Air turbines, ○ Water turbines ○ High pressure hydraulic systems ○ Electrical generation ○ Energy storage • Mooring and anchoring systems. • Farm layout • Offshore electrical grid and connection systems • Operation and maintenance of ocean energy devices • Offshore operations • Maritime safety issues	7.5	Prof. L.M.C. Gato
Economics, Policy and EnvironmentModule: 4.5 ECTS credits	Module Content • Economic analysis ○ Cost ○ Financing mechanisms ○ Economic evaluation ○ Life-cycle assessment • Policy issues ○ Socio-economic impact ○ Licensing & permitting ○ Environmental impact assessment	4.5	Prof. A. Sarmento

Project Module: 6 ECTS credits	Module Content • Resource characterization • Site selection • Conceptual system development • Licensing procedure • Environmental impact • Economic analysis	6	Prof. José Maria André

Laboratory
Module-2: Modelling and Control of Ocean Energy Systems:

- Wave Flume of the Civil Engineering Department of IST: Characterization of systems of regular and irregular 2D waves. Energy spectra: Duration 3 h.
- Wave Flume of the Civil Engineering Department of IST: Characterization of a floating body response RAO in a system of regular 2D waves: Duration 3 h.

Module-3: Mechanical and Electrical Equipment:

- a) Fluid Mechanics Laboratory of the Mechanical Engineering Department of IST: Testing of an air turbine for use in OWC systems: Duration 3 h.
- b) Electrical Machinery Laboratory of the Electrical and Computer Engineering Department of IST: laboratory practice on electrical generators: Duration 3 h.

Programme management:
Prof. José Alberto Falcão de Campos: M.Sc. organization & master steering committee.