REM master basic syllabus

Title:
MRENE Marine Renewable Energy

Credit value:
5 ECTS

Mandatory/Optional:
Optional

Semester:
3

Lecturers:
Antoine Ducoin, Jean-Christophe Gilloteaux, Baptiste Elie, Aurélien Babarit and Sandrine Aubrun

University:
Ecole Centrale Nantes

Department:
Fluid Mechanics and Thermodynamics

Rationale:
This part of the course will deal with the marine renewable energy resources, markets and technologies. Building on other courses dealing with hydrodynamics, it will focus on energy performance and efficiency and their assessment using techniques studied in the other courses.

Objectives:
To provide students with (i) good understanding of the fundamentals of wind turbines, tidal turbines and wave energy converters performances and (ii) a first experience with the assessment of the performance of these technologies.

Skills:

Subject skills	REM Master Skills						
	L2.1	**L2.2**	**L2.3**	**L2.4**	**L2.5**	**L2.6**	**L2.7**
L3.1. Explain and demonstrate knowledge and understanding of the resource and market for offshore wind, tidal energy and wave energy	X		X				
L3.2. Explain and demonstrate knowledge and understanding of offshore wind turbine technologies, tidal turbines and wave energy converters	X		X				
L3.3. Have knowledge of numerical and experimental methods and tools for the performance assessment of offshore wind turbines, tidal turbines and wave energy converters	X	X	X	X			
L.3.4 Apply the acquired knowledge for the design and sizing of energy convertors	X	X	X	X			

Teaching and learning methods:
Teaching and learning methods include lectures dealing with theory, which will be applied through tutorials and computer lab in small groups of students.

Allocation of student time:

	Attendance (classroom, lab,…)	Non attendance (lecture preparation, self study…)
Lectures	14 hours	48 hours
Seminars	2 hours	0 hours
Lab (computer)	17 hours	45 hours

Assessment:

Knowledge of the students acquired during the lectures and tutorials will be assessed through exams. The computer lab work will be assessed through reports followed sometimes with presentations.

Assessment Matrix:

Subject skills	Assesment method	
	Exam	Report
L3.1.	100%	0 %
L3.2.	100%	0 %
L3.3.	50%	50%
L3.4.	0 %	100%

Programme:

Lesson 1	***Fundamental of turbine performances*** *This course is an introduction to the "offshore wind turbines" and "current turbine" classes. The objective is to understand the fundamentals of turbines performances, with highlight on marine applications. We will focus on the main operating principle of turbines, followed by the understanding of flow physics and performances of turbine blades operating in marine environment.* *2h theory*
Lesson 2	***Current turbines*** *This part of the course will describe, the resource, market and advanced technologies of current turbines. Experimental and numerical methods for studying current turbines will be outlined. An overview of current activities in the field of current turbines will be given. Numerical exercises will aim at calculate the performance of a current turbine in different operating conditions.* *3h theory + 5h Lab (computer)*
Lesson 3	***Offshore wind turbines*** *Firstly, this part of the course will describe the wind resource at sea. Then, the components of a wind turbine will be detailed. Rotor technologies, drive-train and generators, control as well as bottom fixed and floating foundations will be addressed. Experimental methods will be outlined as well as park effects. Numerical exercises will be carried out in order to investigate the dynamic behaviour of floating offshore wind turbines* *6h theory + 10h Lab (computer)*
Lesson 4	***Wave energy converters***

	The objective of this part of the course is (i) to give to the student a good understanding of the current status of wave energy conversion technologies in terms of potential and actual performance. Thus, it will address first the wave energy resource and market. An historical perspective of wave energy conversion will be given and state-of-the art of the technology will be described. Fundamentals of wave energy conversion and energy performance will be highlighted. Energy performance of current technologies will be discussed as well as project development methodologies. *3h theory + 1h Lab (computer)*
Seminar 1	***Application-oriented seminar held by an industrial actor of renewable marine energy*** *2h seminar*

Resources:

Lectures, seminars and presentations require blackboard and projector in lecture hall.
Lab works are carried out in computer room.

Bibliography:

- J. Falnes (2002) *Ocean Waves and Oscillating Systems: Linear Interactions Including Wave-Energy Extraction*. Cambridge University Press.
- J. Cruz (2008) *Ocean Wave Energy: Current Status and Future Perspectives*. Springer.
- B. Multon (2011) *Marine Renewable Energy Handbook*. Wiley.
- J.J. Newman; *Marine Hydrodynamics*, MIT press, 1977.
- I.H. Abbott, A.E.Von Doenhoff, *Theory of wing section*, Courier Corporation, 1959.
- J.F. Manwell, J.G. MCGowan& A.L. Rogers (2009) *Wind energy explained – Theory, Design and Application*. Wiley.
- M. C. Brower (2012) *Wind resource assessment – A practical guide to developing a wind project*. Wiley.

Further comments: