Title:
Experimental hydrodynamics

Credit value:
5 ECTS

Mandatory/Optional:
Optional

Semester:
3

Lecturer:
Félicien Bonnefoy

University:
Ecole Centrale Nantes

Department:
Fluid Mechanics and Thermodynamics

Rationale:
Describe the experimental approaches used in Marine Renewable Energy studies. Involve the students in experimental campaigns in Ecole Centrale Nantes large-scale facilities also used e.g. in European MRE research networks (MARINET) and international MRE research partnership (Univ. Osaka).
Direct applications of the concepts introduced in the Water waves and sea states modelling course (environmental modelling), Wave-structure interactions course (structure response, diffraction-radiation, sea-keeping) and Moorings course (low-frequency response, mooring stiffness).

Objectives:
To provide students with state of the art knowledge on experimental fluid dynamics in the field of Offshore renewable energy. Despite the development of numerical modelling, the experimental approach remains a major source of knowledge development in ship hydrodynamics and marine renewable energy. The contribution to the selection of adequate hypotheses and to the validation of analytical or numerical models is of primary importance. In numerous situations, the experimental approach remains the most reliable, economical and fast way to validate new designs. Specific instrumentations and facilities are presented in this course and used in lab work.

Skills:

Subject skills	**REM+ Master Skills**						
	L2.1	**L2.2**	**L2.3**	**L2.4**	**L2.5**	**L2.6**	**L2.7**
L3.1. Understand the physics of fluid-structure interaction, link model scale experiments and full-scale prototypes (similitudes), extrapolate model scale results at full scale	X			X			
L3.2. Students are able to conduct experimental campaigns and post-process measurements and discuss physical results					X	X	
L3.3. Understand connections with numerical modelling and theoretical approach	X	X		X			
L3.4 Students are able to clearly transmit their experimental observations and their analysis of post-processing results in the field of offshore renewable energy						X	
L3.5 Students are able to update their knowledge in experimental research activities related to the field of offshore renewable energy							X

Teaching and learning methods:

Lectures are used to present state of the art experimental approaches in combination with technical visits to existing facilities.

Practical works are proposed to students in the large-scale facilities of Ecole Centrale Nantes (towing tank, wave tank with multi flap wavemaker, an optical tracking system for ship models, etc.)

Allocation of student time:

	Attendance (classroom, lab,…)	**Non-attendance (lecture preparation, self-study…)**
Lectures	11 hours	28 hours
Visit of facilities	1 hour	0 hour
Lab work	20 hours	65 hours

Assessment:

Group work during labs is evaluated through report writing.

Assessment Matrix:

Subject skills	**Assessment method**
	Report
L3.1.	100 %
L3.2.	100 %
L3.3.	100 %
L3.4.	100 %
L3.5.	100 %

Programme:

Lesson 1	***Introduction to experimental hydrodynamics*** *The students find the main topics in MRE experiments.* *2h theory + 1h visit of ECN experimental facilities*
Lesson 2	***Experimental ocean engineering*** *Experimental tests in offshore basins.* *3h theory + 8h practical classroom*
Lesson 3	***Resistance*** *Ship resistance and experiments in towing tanks. Reynolds and Froude similitude; extrapolation at full scale.* *2h theory + 4h practical classroom*
Lesson 4	***Ship manoeuvrability*** *Mathematical formulation, experimental determination of hydrodynamic coefficients. Modelling of towed structures.* *2h theory + 4h practical classroom*
Lesson 5	***Measurements and signal processing*** *Sensors and transducers, sampling theory. Signal processing, Fourier analysis.* *2h theory + 4h practical classroom*

Resources:

Lectures require Blackboard and projector in the lecture hall.
Experimental lab works are conducted in ECN experimental facilities including

- *towing tank (dimensions 130x5x3 m) with towing carriage and dynamometer*
- *small wave basin (dimensions 15x10x1 m) with wavemaker and dynamometer*
- *large wave basin (dimension 50x30x5 m) with wavemaker and optical tracking system*
- *wind tunnel*
- *stability testbed*
- *open water testbed for marine propellers*

Bibliography:

- S.A. Hughes, *Physical Models and Laboratory Techniques in Coastal Engineering*
- N. Newman, *Marine Hydrodynamics*
- O.M. Faltinsen, *Sea loads on ships and offshore structures*
- V. Bertram, *Practical Hydrodynamics*
- S. Chakrabarti, *Offshore structure modeling*

Further comments: