MaRINET2
www.marinet2.eu

Training course on: "**Integrated Tank Testing for the Offshore Renewable Industry**"

UCC MaREI, IFREMER and TECNALIA

November 25th – 29th 2019

Location: MaREI, Ringaskiddy, Co. Cork, Ireland

Course Shedule

Integrated Tank Testing for the Offshore Renewable Industry	
Monday November 25th	
9.00	
9.30	
10.00	
10.30	
11.00	
11.15	
11.30	
12.00	
12.30	
1.00	
1.30	
2.00	
2.30	
3.00	Registration & Welcome
3.30	Course Outline, Intro to Tecnalia, UCC, IFREMER
3.45	Visit to UCC Labs including Tank/Electrical Testing, Health and Safety
4.00	Fluid Mechanics // Short History of Hydrodynamics // Froude and Reynolds scaling
4.30	Overview of experimental tools (waves, wind, current)
5.00	Finish
Tuesday November 26th	
9.00	Fluid mechanics // Perfect fluid with free surface
9.30	Waves : analytical modelling (Airy, Stokes, higher order)
10.00	Waves and sea states : Regular and irregular waves; Open sea; Tank configuration : generation, reflection, absorption
10.30	Data analysis : Fourier and spectral analysis, statistical analysis
11.00	Break
11.15	Examples with some experimental data from Ifremer tank
11.30	Examples with some experimental data from Ifremer tank
12.00	Fluid mechanics // Seakeeping // General dynamics equation (added inertias, damping, sitffnesses, waves loads)
12.30	Fixed and floating bodies // Diffraction and radiation softwares // Morison approach // With examples of experimental and numerical results
1.00	Lunch
1.30	
2.00	Practical model scaling // Assessing inertias, stiffnesses with focus on mooring
2.30	Added inertias and damping effects (Froude and Reynolds scaling)
3.00	Instrumentation // Calibration // Data acquisition
3.30	Some examples of model scaling
3.45	Break
4.00	Data analysis : examples with some experimental data from ifremer and others
4.30	Data analysis : examples with some experimental data from ifremer and others
5.00	Data analysis : examples with some experimental data from ifremer and others
5.30	Discussion and preparation about the Thursday tank testing
6.00	Finish

Wednesday November 27th		
9.00	Power Conversion Alternatives	
9.30	Control Systems	
10.00		
10.30	Main control loops	
11.00	Break	
11.15	Case Study 1 : OWC modelling and control for low inertia	
11.30		
12.00		
12.30	PC Lab Session	
1.00	Lunch	
1.30		
2.00	PC Lab Session	
2.30		
3.00	Case Study 1: OWC modelling and control for high inertia	
3.30		
3.45	Break	
4.00	PC Lab Session	
4.30		
5.00	Main power quality issues in ocean energy applications	
5.30		
6.00	Finish	
Thursday November 28th		
9.00	G1 Tank testing	G2 Electrical testing
9.30		
10.00		
10.30		
11.00	Break	
11.15	G1 Tank testing	G2 Electrical testing
11.30		
12.00		
12.30		
1.00	Lunch	
1.30		
2.00	G2 Tank testing	G1 Electrical testing
2.30		
3.00		
3.30		
3.45	Break	
4.00	G2 Tank testing	G1 Electrical testing
4.30		
5.00		
5.30		
6.00	Finish	

Friday November 29th	
9.00	Data analysis, conclusions, discussion on results
9.30	
10.00	
10.30	
11.00	
11.15	
11.30	
12.00	
12.30	
1.00	Closure
1.30	
2.00	
2.30	
3.00	
3.30	
3.45	
4.00	
4.30	
5.00	
5.30	
6.00	

Legend
Theory
Case Study
Lab sessions
PC sessions

Lecture details

MONDAY

Fluid mechanics

- Short history of hydrodynamics with focus on Froude and Reynolds scaling
- Overview of experimental tools, (waves, current, winds) including MaRINET2 infrastructures

TUESDAY

Fluid mechanics

- From real fluid to perfect fluid with free surface.
- Basic problem formulation for water waves and seakeeping.

Waves and sea states

- Waves: analytical modelling (Airy, Stokes, higher order waves).
- Regular and irregular waves.
- Waves in open sea situation.
- Waves in tank configuration: generation, reflection and absorption of waves.
- Illustration in PC Lab sessions.

Seakeeping

- General dynamics equation: diffraction and radiation.
- Hydrodynamics parameters: wave loads, added inertias, damping, stiffnesses.
- Diffraction and radiation software.
- Morison approach.
- Examples of experimental and numerical results with comparisons.
- Illustration in PC Lab sessions.

Practical model testing

- Froude scaling: assessing inertias and stiffnesses.
- Reynolds effects on added inertias, damping and motions.
- Focus on mooring.
- Different ways to simulate the wind effect.

Measurements

- Instrumentation.
- Calibration.
- Data acquisition.

Data analysis

- Fourier and spectral analysis.
- Statistical analysis.
- Transfer functions.
- Illustration in PC Lab sessions.

PC Lab Sessions

- Computer session using Matlab.
- Analysis of waves in tanks: propagation, reflection, nonlinear effects.
- Analysis of fixed or floating bodies interactions with waves.

Discussion and preparation about the Thursday tank testing and Friday data analysis

- Review of the tank configuration and model to be tested.
- Description of data channels.
- List of tools needed to analyse the data.

WEDNESDAY

Power conversion alternatives

- Description of the main drive train alternatives regarding gearbox, electrical generator and power electronics for wave energy converters.
- Comparative of alternatives in terms of efficiency, controllability, cost, maintenance, grid code fulfilment etc.

Control Systems

- Overview of control scheme.
- Implications of control schemes for electrical system design and grid integration of Marine Converters.

Main Control loops

- abc-dq transformation.
- Generator-side control: dynamic equations of a PMSG, Field Oriented Control (speed and current control loops). Tuning of controllers.
- Grid-Side control: dynamic equations. Voltage Oriented Control (Voltage and current control loops).

Case study 1 and 2: OWC modelling and control (2 sessions)

- Modelling of an OWC: weak coupling.
- Power conversion system.
- Influence of the inertia in the control law decision.
- Maximum power point extraction in an OWC.
- Alternative control laws for low and high inertia.

PC Lab Sessions. Complete Modelling of an OWC

- Computer session using Matlab.
- Completion of the model including the modelling of the Wells turbine.
- Design of controls for low and high inertia cases.

Main power quality issues in ocean energy applications.

- Power System
- Power Quality.
- Grid Codes.
- Particularities of MECs for grid compliance.

THURSDAY

Wave Tank and Electrical Practical

- The Class will be divided in two groups to plan, undertake and analyse the testing of a scale model wave energy device.
- Tank testing including test schedule matrix design, data acquisition specification and analysis format.
- Electrical rig testing of the same device to develop power matrix and compare with Tank results.

FRIDAY

Wave Tank and Electrical Project Analysis

- Groups to prepare testing report.
- Each group to prepare brief presentation on results, analysis, conclusions and recommendations.

- Discussion session between each group and course tutors on the Practical and course in general.

Recommended basic knowledge on:

- mechanics
- linear algebra (matrix, eigenvalues)
- complex numbers
- Fourier analysis
- Matlab

Essential software:

Matlab and Simulink will be used during the course. Your are required to bring a laptop with Matlab already installed including the Signal processing toolbox and Simulink. There´s a 30-day free trial version you can check:

https://uk.mathworks.com/programs/trials/trial_request.html

Please, when filling in the information requested in the website, include "MaRINET - UCC-MAREI - **Integrated Tank Testing for the Offshore Renewable Industry**" as the purpose for the trial.

Recommended bibliography

- Marine Hydrodynamics. J. N. Newman. www.oapen.org/download?type=document&docid=1004046
- Handbook of Ocean Wave Energy. Pecher, Arthur; Peter Kofoed, Jens. www.oapen.org/search?identifier=1002247;keyword=wave

Contact information

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