MORE master basic syllabus

Title:
Operations and Maintenance of Marine Energy Arrays

Credit value:
3 ECTS

Mandatory/Optional:
Optional

Semester:
2

Lecturer/s:
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University:
University of the Basque Country UPV/EHU

Department:
Tecnalia Research and Innovation

Rationale:

The module deals with a wide review of methodologies for a safe design of operations and maintenance activities for offshore facilities, applied to the specific issues related to the deployment of marine energy arrays. Different maintenance strategies will be defined and investigated; therefore the different operations along the lifecycle of the marine energy array and its subsystems (electrical subsystem, mooring and foundations, offshore devices) will be identified. Failure modes and a set of parameters for different components in each subsystem will be identified in order to assess the logistic requirements of each operation in terms of vessels and infrastructures, paying attention to reliability issues as well as costs and planning.

The students will learn methods for evaluating the site accessibility both in time domain and through probabilistic approaches *and reporting (graphs) the outcomes of the operation and maintenance activities, achieving a better understanding of the economic viability of the projects.*

Objectives:

After attending the course, the students will be able to:

1. *Analyse the different phases of development of a marine energy array (installation, maintenance, decommissioning, etc.…) and identify failure modes, operations and subsequent logistics requirements;*
2. *Estimate hierarchy of the components within subsystems and related statistics (MTTF, MTTR and frequency) in order to inform the maintenance strategy (unplanned corrective, condition based maintenance, calendar based maintenance) and plan the operations consequently;*
3. *Use graphical tools for the representation of the operations and maintenance;*
4. *Provide an estimate of the site accessibility and availability of the array, in order to assess the reduction of power production due to O&M activities;*
5. *Provide figures of costs for operation and maintenance activities and evaluate their impact in the assessment of the viability of the project.*

Skills: *(according to the list of skills provided)*

Subject skills	More Master Skills						
	L2.1	**L2.2**	**L2.3**	**L2.4**	**L2.5**	**L2.6**	**L2.7**
LX.1. Ability to understand the different maintenance strategies and failure modes for components.			X		X	X	X
LX.2. Ability to handle different models for the estimation of the site accessibility of an array on a case-by-case basis.	X	X					X
LX.3. Ability to solve real case studies in order to plan operation and maintenance activities for marine energy sector.	X	X	X		X		X
LX.4. Ability to show and communicate properly the outcomes of an operation and maintenance planning.		X			X	X	
LX.5. Ability to estimate quantitative figures for evaluating the economic viability of a marine energy project.	X	X	X				

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Teaching and learning methods:

The teaching and learning strategy will be based on frontal lectures to help develop an understanding of operation and maintenance methods for Marine Energy Arrays. Mathematical and statistical models and diagrams will be used, when applicable. All the lectures will be followed by a guided tutorial -with direct involvement of the attendees- about the direct application of the lecture to real case studies pertinent to the marine energy sector. Self-study for the preparation of individual intermediate and final assignments – based on real case-studies- will complete the training.

Lectures 9 hours
Guided Tutorial 21 hours
Total 30 hours

Allocation of student time:

	Attendance (classroom, lab, …)	**Non-attendance (lecture preparation, self-study…)**
Lectures	9 hours	15 hours
Tutorial	21 hours	15 hours
Assignments		15 hours

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Assessment:

Basic description of the assessment methodology

1. *Class attendance and active participation: 50 %*
2. *Individual assignments (written exam): 50 %*

Class attendance

Attendance of students in class is highly recommended, and students who miss more than ten percent (10%) of the scheduled class meetings due to unexcused absences might not pass the course. Lectures require attention and discussion from the students; the guided tutorial will include in-class exercise, presentations and the completion of the exercise sheets handed in at the end of the lectures.

Individual assignments

Individual assignments help the students enhance their understanding of the topics of the Lecture and more generally of the models for operation and maintenance for marine energy arrays. They will reflect what

studied done during the class attendance, based on real case-studies and helping developing a problem-solving attitude towards O&M issues.

Team assignment (optional)
Depending on the development of activities in the class, team assignments may be given in order to develop team work capabilities and sharing responsibility among colleagues. Each team is required to give a presentation of the team assignment work, and the quality of the team work will be graded.

Assessment Matrix:

Subject skills	Assessment method			
	Exam	**Presentation**	**Home work**	**Report**
LX.1.	25%	%	50%	25%
LX.2.	15%	%	50%	15%
LX.3.	25%	%	50%	25%
LX.4.	%	80%	%	20%
LX.5.	15%	%	50%	35%

Programme:

Lesson 1	*Failure modes, operations and maintenance strategies* The students will learn how to hierarchically sort the system into subsystems, components and subcomponents and how to define major failure modes. The students will get introduced into operations for offshore arrays and they will learn the main characteristics of main maintenance strategies and how to implement them. Lectures will provide general information; the tutorials will go deeper in detail into the different subsystem. *Distribution (3 h theory + 7 h practical classroom + ? h computer + ? h seminar)*
Lesson 2	*Numerical methods for estimations of failures and plant availability* The students will learn how to manipulate the main statistics for different failure modes (MTTF; MTTR). Similarly, they will learn how to generate weather windows in time domain, as well as using simplified probability approaches for estimating the site accessibility. . *Distribution (3 h theory + 7 h practical classroom +? h computer + ? h seminar)*
Lesson 3	*Operation planning* The student will learn how to interpret the outcomes of previous lessons in order to plan the operation and maintenance activities in a marine energy array and how to represent them in a proper format. An overview about offshore standards and/or recommended practised for the installation and operations of offshore wind turbines and other offshore structures will be provided. *Distribution (1,5 h theory + 3,5 h practical classroom + ? h computer + ? h seminar)*
Lesson 4	*Economic Analysis of Operation and Maintenance costs* The student will learn how the operation and maintenance activities will influence the costs, in particular the effects of the availability of the array and the actual cost of the operations. The user will learn how to estimate these costs and how to use them in order to obtain indicators for estimating the viability of the project. *Distribution (1.5 h theory + 3,5 h practical classroom + ? h computer + ? h seminar)*

Resources:

Classrooms, Blackboard, laptop, projector, audio, computer room, laboratory, security issues,…

Bibliography:

For general concepts about offshore structures:

Chakrabarti, S.K., 2005a. Handbook of offshore engineering Vol. 1. Elsevier, Amsterdam

Chakrabarti, S.K., 2005b. Handbook of offshore engineering Vol. 2. Elsevier, Amsterdam

For offshore wind turbine, for example

Kaiser, M.J., Snyder, B.F., 2012. Offshore Wind Energy System Components, in: Offshore Wind Energy Cost Modelling. Springer London, London, pp. 13–30.

For ocean energy systems, for example

Equimar Project, 2011. Sea Trial Manual (No. D4.1). Grant Agreement 213380.

For reliability issues

Kapur, K.C., Pecht, M. (Eds.), 2014. Reliability Engineering. John Wiley & Sons, Inc., Hoboken, NJ, USA.

Offshore standards and recommended practice

Det Norsk Veritas, 2011, Standard for Classification of Wind Turbine Installation Units, DNV-OS-J301

Det Norsk Veritas, 2011, Modelling and Analysis of Marine Operations, DNV-RP-H103

More information about operations and maintenance

Bengtsson, M., 2007. On condition based maintenance and its implementation in industrial settings.

Maples, B., Saur, G., Hand, M., van de Pietermen, R., Obdam, T., 2013. Installation, operation, and maintenance strategies to reduce the cost of offshore wind energy. NREL Denver.

Obdam, T., Braam, H., Rademakers, L., Van De Pieterman, R., 2011. O&M Cost Estimation & Feedback of Operational Data. INTECH Open Access Publisher.

Rademakers, L., Braam, H., Obdam, T.S., vd Pieterman, R.P., 2009. Operation and maintenance cost estimator (OMCE) to estimate the future O&M costs of offshore wind farms, in: Proc. of European Offshore Wind 2009 Conference, Stockholm, Sweden. pp. 14–16.

Rausand, M., Høyland, A., 2004. System reliability theory: models, statistical methods, and applications. Wiley-Interscience, Hoboken, NJ.

SIS Förlag AB, Maintenance terminology - Svensk Standard SS-EN 13306. Stockholm, Sweden: Swedish Standard Institute, 2001.

Further comments: