REM master basic syllabus

Title:
OAMOME Operations and Maintenance of Marine Energy Arrays

Credit value:
3 ECTS

Mandatory/Optional:
Optional

Semester:
2

Lecturer/s:
Jose Luis Villate Martinez
Pablo Ruiz Minguela
German Perez Moran
Vincenzo Nava
Raul Rodriguez Arias
Joseba Lopez Mendia

University:
University of the Basque Country (Tecnalia Research and Innovation)

Department:
Automatic Control and Systems Engineering

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. *Develop and apply 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 and preparation of team reports –based on real case-studies- will complete the training.

Lectures 10 hours
Guided Tutorial 20 hours
Total 30 hours

Allocation of student time:

	Attendance (classroom, lab, …)	**Non-attendance (lecture preparation, self-study…)**
Lectures	10 hours	15 hours
Tutorial	20 hours	15 hours
Assignments		15 hours

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Assessment:

Basic description of the assessment methodology

1. *Class attendance and active participation: 40 %*
2. *Individual assignments: Multiple choice test (30%) during the fifth class*
3. *Group assignments: Final reports of 3 tutorials (10%+10%+10%). To be sent one week after of the last class*

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.

Individual and Team 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. The guided tutorial will include in-class exercise, presentations and the completion of a report reflecting what done during the class attendance, based on real case-studies and helping developing a problem-solving attitude towards O&M issues.

Assessment Matrix:

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

Programme:

Lesson 1	*Operation planning & Economic Analysis of Operation and Maintenance costs: Theoretical Lectures* *Distribution (5 h theory in three blocks 2.0+2.0+1.0)* *Lecturers: Jose Luis Villate, Pablo Ruiz Minguela, Germán Pérez Morán*
Lesson 2	*Operation planning & Economic Analysis of Operation and Maintenance costs : Tutorial* *Distribution (5 h practical classroom in three blocks 1.5+ 2.5+ 1.0)* *Lecturers: Pablo Ruiz Minguela, Raúl Rodriguez Arias*
Lesson 3	*Failure modes, operations and maintenance strategies & Numerical methods for estimations of failures and plant availability : Theoretical Lectures* *Distribution (5 h theoretical lesson into three blocks: 1.5 +1.5+2.0)* *Lecturers: Germán Pérez Morán, Raúl Rodriguez Arias, Vincenzo Nava*
Lesson 4	*Failure modes, operations and maintenance strategies & Numerical methods for estimations of failures and plant availability : Tutorial 1* *Distribution (2 h practical classroom + - 3 h computer)* *Lecturers: Germán Pérez Morán, Vincenzo Nava, Joseba Lopez Mendia*
Lesson 5	*Failure modes, operations and maintenance strategies & Numerical methods for estimations of failures and plant availability : Tutorial 2* *Distribution (5 h practical classroom)* *Lecturers: Pablo Ruiz Minguela, Vincenzo Nava, Joseba Lopez Mendia*
Lesson 6	*O&M strategies: Site Visit* *Distribution (5 h visit)* *Lecturers: Raúl Rodriguez Arias, Joseba Lopez Mendia*

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: