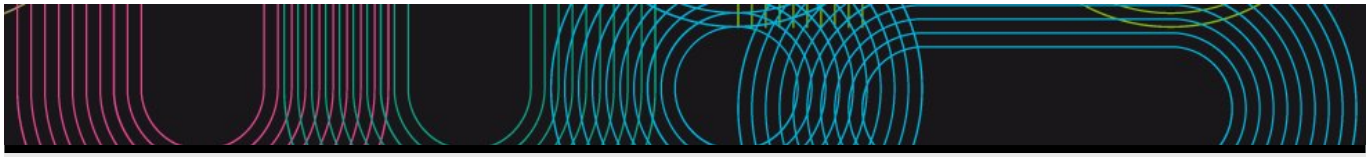

IDENTIFYING DATA				
Hydraulic resources, installations and hydro-power plants				
Subject	Hydraulic resources, installations and hydro-power plants			
Code	V09G290V01601			
Study programme	Degree in Energy Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish English			
Department				
Coordinator	Conde Fontenla, Marcos			
Lecturers	Conde Fontenla, Marcos Molares Rodríguez, Alejandro			
E-mail	mfontenla@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	The main goal of this course is to acquire the scientific knowledge and the study of the technical application concerning energy conversion devices that employ water as the exchanger fluid. The application of fluid mechanics to hydropower systems is revisited here from an industrial point of view, dealing with the most common types of water pumps and turbines.			

Competencies	
Code	
C20	Hydraulic works and installations. Planning and management of hydraulic resources
C21	Applied knowledge of the basics of fluid-mechanic systems and machines
C22	Knowledge of electrical power systems and their applications
C23	Ability to design electrical power plants
D1	Capacity to interrelate all the acquired knowledge and interpret it as components in a body of knowledge with a clear structure and strong internal coherence
D2	Capacity to develop a complete project in any field included in this type of engineering, suitably combining acquired knowledge, accessing necessary information sources, undertaking the necessary enquiries and integrating into inter-disciplinary work teams.
D3	Propose and develop practical solutions, which develop suitable strategies based on theoretical knowledge, for problem phenomena and situations that arise as everyday realities in engineering
D4	Encourage work based on cooperation, communication skills, organization, planning and recognition of responsibility in a multilingual and multidisciplinary working environment that fosters education in equality, peace and respect for fundamental rights
D5	Know what sources are available for ongoing and continual updating of all the information required to undertake their work, with access to all the current and future tools for seeking information and adapting it in the light of technological and social changes
D10	Become aware of the need for training and continual improvement in quality, developing the values associated with scientific thinking and showing a flexible, open and ethical attitude towards diverse opinions and situations, particularly in matters of non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc

Learning outcomes		
Expected results from this subject	Training and Learning Results	
Have a basic grounding in fluid machines	C20	D1
	C21	D2
	C22	D3
	C23	D4
		D5
		D10

Acquire the abilities used in the sizing process for hydraulic installations	C20 C21 C22 C23	D1 D2 D3 D4 D5 D10

Contents	
Topic	
I. Introduction about hydraulic machines	I.1 Introduction. I.2 Fluid machines classification. I.3 Singular parts of turbomachinery. I.4 Classification of turbomachines.
II. Energy balance of hydraulic machines.	II.1 Introduction. II.2 Total energy conservation. II.3 Internal energy conservation. II.4 Mechanical energy conservation. II.5 Mechanical power balance and efficiency of pumps. II.6 Mechanical power balance and efficiency of turbines. II.7 Pump and turbines heating evaluation. II.8 Pumping and turbines facilities. Head losses calculation.
III. Dimensionless analysis and similarity in turbomachines.	III.1 Introduction. III.2 Working parameters of a turbomachine. III.3 Dimensionless analysis applied to turbomachinery. III.4 Pumps performance curve. III.5 Turbines operating curve. III.6 Dimensionless parameters.
IV. General theory of hydraulic turbomachinery.	IV.1 Introduction. IV.2 Control volume approach. Conservation of mass. IV.3 Angular momentum conservation. Euler's theorem. IV.4 Euler's equation. IV.5 Bernoulli's equation in a non-inertial reference frame. IV.6 Reaction ratio.
V. One dimensional theory for hydraulic turbomachines	V.1 Hypotheses and targets of the one-dimensional approach. V.2 Continuity and meridional velocity. V.3 Eulers's equation and azimuthal velocity. V.4 One-dimensional approach for axial turbomachines.
VI. Two dimensional theory for radial turbomachines.	VI.1 Introduction. Finite number of blades. VI.2 Incompressible flow inside a centrifugal impeller. VI.3 Angular deviation of flow at the outlet of the impeller. Corrections.
VII. Two dimensional theory for axial turbomachines.	VII.1 Introduction. VII.2 Two-dimensional flow through a fixed blade cascade. VII.3 Two-dimensional relative flow through the blades. VII.4 Reaction ratio. VII.5 Radial equilibrium of an axial turbomachine.
VIII. Viscid flow and cavitation phenomena in hydraulic turbomachines.	VIII.1 Introduction. VIII.2 Viscous effects, boundary layer and secondary flows in turbomachines. VIII.3 Friction losses and fluid leaks. VIII.4 Principles and effects of cavitation. VIII.5 Cavitation conditions. VIII.6 Similarity and cavitation. Thoma's number.
IX. Actual facilities.	IX.1 Introduction. IX.2 Basics of pump design. IX.3 Pumping facilities. Working point. Pumps arrangement and working point adjustment. IX.4 Selection of hydraulic turbines. Performance curves as a function of volumetric flux and rotating velocity. Fink's distributor effect. IX.5 Classification and general description of power plants, dams and reservoirs. IX.6 Pumped-storage hydroelectric plants IX.7 River flow control. Electric energy production and consumption. Automatic control of hydroelectric power plants.

Planning			
	Class hours	Hours outside the classroom	Total hours

Laboratory practical	2	0	2
Problem solving	18	39.5	57.5
Studies excursion	3.5	0	3.5
Lecturing	26.5	40	66.5
Problem and/or exercise solving	0	6	6
Report of practices, practicum and external practices	0	12	12
Essay questions exam	2.5	0	2.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Laboratory practical	Mainly, laboratory practices will consist of experimental activities in order to clarify the theoretical concepts seen on the previous master classes. Additionally, they can also include: Simulation Solution of problems Team working
Problem solving	Problem and exercise solving. They will apply the concepts tackled in the lectures. It includes activities such as: Readings Seminars Solution of problems Team working Study of actual cases
Studies excursion	The realization of the formative activity "Studies excursion", will be organized by the School board, according to the porposal of the teaching staff about the type of facility or company to visit.
Lecturing	The basics of the theory are explained in these sessions. They are mainly comprised of lectures but can also include: Readings Bibliographic review Exercise solving Conferences Technical films Oral presentations

Personalized assistance

Methodologies	Description
Lecturing	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorships. Updated information of the tutorships timetables will be given to the students during first week of class. Tutorshiping will take place both in face-to-face or distance modes, by means of the e-learning applications offered by the University of Vigo or equivalent methods. The tutorial sessions will be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement, in all teaching modalities.
Laboratory practical	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorships. Updated information of the tutorships timetables will be given to the students during first week of class. Tutorshiping will take place both in face-to-face or distance modes, by means of the e-learning applications offered by the University of Vigo or equivalent methods. The tutorial sessions will be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement, in all teaching modalities.

Assessment

	Description	Qualification	Training and Learning	Results
Problem and/or exercise solving	Resolution of proposed problems and/or exercises, that might include: - a number of weekly deliveries (no face-to-face) - face-to-face resolutions during class time LEARNING RESULTS: Have a basic grounding in fluid machines. Acquire the abilities used in the sizing process for hydraulic installations.	20	C20 C21 C22 C23	D1 D2 D3 D4 D5 D10

Report of practices, practicum and external practices	Written report about the activities developed in the laboratory sessions, including experimental results and data analysis. LEARNING RESULTS: Have a basic grounding in fluid machines. Acquire the abilities used in the sizing process for hydraulic installations.	10	C20 C21 C22 C23	D1 D2 D3 D4 D5 D10
Essay questions exam	Written test that may consist of: - theoretical questions - practical questions - exercises solving - specific point to be developed LEARNING RESULTS: Have a basic grounding in fluid machines. Acquire the abilities used in the sizing process for hydraulic installations.	70	C20 C21 C22 C23	D1 D2 D3 D4 D5 D10

Other comments on the Evaluation

Assessment methodology:

- There will be two continuous assessment quizzes, eachof them assessed from 0 to 1 points (2 points maximum). [C_pec]

- There will be two lab sessions, with handed over labwork and report, each of them assessed up to 0.5 points (1 point maximum).[C_lab]

- There will be a final exam, to be graded from 0 to 10 points. [C_ex]

To compute the final grade (C_actas), the followingformula will be used, where C_actas has to equal 5 or above to pass the course:

Continuous assessment mode: C_actas = (C_pec + C_lab) +C_ex * (1 - (C_pec + C_lab)/10)

Non-attendance mode (officially aproved): C_actas = C_ex

The same assessment methodology will apply in summer exam.

Calendar of examinations: Verify /consult of up to dateform in the page web of the centre:

http://minaseenerxia.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

Round, George F., **Incompressible Flow Turbomachines. Design, Selection, Applications, and Theory**, 1ª ed., Elsevier - Gulf Professional Publishing, 2004

Agüera Soriano, José, **Mecánica de fluidos imcompresibles y turbomáquinas hidráulicas**, 5ª ed., Editorial Ciencia 3, S.L., 2002

Mataix Plana, Claudio, **Mecánica de fluidos y máquinas hidraúlicas**, 2ª ed., Ediciones del castillo, S.A., 1986

Hussian, Z. and Abdullah, Z. and Alimuddin, Z., **Basic Fluid Mechanics and Hydraulic Machines**, 1ª ed., CRC Press, 2009

Modi, P. N. and Seth, S. M., **Hydraulics and Fluid Mechanics Including Hydraulic Machines (In SI Units)**, 15ª ed., Standard Book House, 2004

Complementary Bibliography

Mataix Plana, Claudio, **Turbomáquinas hidráulicas**, 2ª ed., ICAI, 2009

Girdhar, P. and Moniz, O., **Practical Centrifugal Pumps. Design, Operation and Maintenance**, 1ª ed., Elsevier - Newnes, 2005

Hernandez Krahe, Jose Maria, **Mecánica de Fluidos y Máquinas Hidráulicas/Unidades Didácticas V y VI**, 1ª ed., UNED, 1995

Kothandaraman, C. P. and Rudramoorthy, R., **Fluid Mechanics and Machinery**, 2ª ed., New Age International (P) Ltd., Publishers, 2007

Vasandani, V. P., **Theory and Design of Hydraulic Machines Including Basic Fluid Mechanics**, 11ª ed., Khanna Publishers, 2010

Gülich, Johann F., **Centrifugal Pumps**, 3ª ed., Springer, 2014

Kumar, P., **Hydraulic Machines: Fundamentals of Hydraulic Power Systems**, 1ª ed., CRC Press, 2012

Bansal, R. K., **A Textbook of Fluid Mechanics and Hydraulic Machines (in SI units)**, 1ª ed., Laxmi Publications, 2005

Gupta, S. C., **Fluid Mechanics and Hydraulic Machines**, 1ª ed., Pearson Education Canada, 2006

Patra, K. C., **Engineering Fluid Mechanics and Hydraulic Machines**, 1ª ed., Alpha Science Intl Ltd, 2012
de Lamadrid Martínez, Abelardo, **Máquinas hidráulicas. Turbinas Pelton. Bombas centrífugas**, 1ª ed., Servicio de Publicaciones, ETSII - UPM, 1986

Recommendations

Subjects that it is recommended to have taken before

Fluid mechanics/V09G290V01305

Contingency plan

Description

Considering the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University establishes an extraordinary planning that will be activated when the administrations and the institution determine it. It is based on safety, health and responsibility, and it guarantees teaching in an online or semi-presential modalities. These already planned measures will guarantee, at the required time, the development of teaching in a more agile and effective way, because they will be known in advance by students and teachers through the standardized tool for teaching guides DOCNET.

1. Semi-presential modality
Once the semi-presential teaching is required, it would mean a reduction of the capacity of the teaching spaces used in the face-to-face modality. Therefore, as the first measure of the centre, the capacity of the teaching spaces would be reformulated and informed to the teachers, in order to proceed to reorganize the formative activities for the rest of the semester. It should be noted that the reorganization will depend on the moment throughout the semester in which this semi-presential modality is activated. For the reorganization of the teaching activities, the following guidelines would be followed:

Through the FaiTIC platform, all the students will be informed about the new conditions under which the formative activities and assessment tests will be carried out at the end of the semester.

The tutorial sessions will be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement.

Once some of the students have carried out experimental or computer laboratory practices in the face-to-face modality, if it is possible, the rest of the students will have the possibility to perform the same or equivalent activities in the same modality.

For the rest of the activities until the end of the semester, it should be done a proper identification of those formative activities which can be done under face-to-face modality and those which will be carried out remotely.

Regarding the potential tools to be applied for the formative activities during the online mode, CampusRemoto and the FaiTIC platform will be used.

2. Online modality
In the event that the non-face-to-face teaching modality is required (suspension of all face-to-face formative and assessment activities), the tools currently available at the University of Vigo, CampusRemoto and the FaiTIC platform will be used. The reorganization will depend on the moment throughout the semester in which this online modality is activated. In the reorganization of the teaching activities, the following guidelines would be followed:

2.1. Communication
Through the FaiTIC platform, all the students will be informed about the new conditions under which the formative activities and assessment tests will be carried out at the end of the semester.

2.2. Adaptation and / or modification of teaching methodologies
As the teaching methodologies have been conceived for the face-to-face teaching modality, the teaching methodologies that would be kept and those which would be modified or replaced in the online modality are indicated below.

The teaching methodologies that would be kept, since they can be used in face-to-face and online teaching mode

Conventional lectures, practicum and seminars will be substituted by virtual ones, in the UVigo e-learning system. Practicum lessons contents will be adapted to allow the development of the self-tasks in common computers. New activities will focus in algorithms development and knowledge application to common tasks, basic skill adquisition and know-how adquisition, closely related with the main topics of the course. Tasks under evaluation will be performed at home, using GNU

software or licensed software to the student available at the university at no extra charge.

2.3. Adaptation of tutorial sessions and personalized attention
The tutorial sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement

2.4. Evaluation
The same weights for the different parts of the course will remain unchanged.
All the remaining tests and quizzes will be developed in the e-learnig platform of the UVigo (Moodle and so).

2.5. Bibliography or additional material to facilitate self-learning
Additional references (students self-learning improvement)
Mastering VBA for Microsoft Office 365 - Autor: Richard Mansfield; 944 páginas, Editor: John Wiley & Sons Inc; Edición: 2019; ISBN-10: 1119579333; ISBN-13: 978-1119579335)
Introducción a la programación en Matlab: para ingenieros civiles y mecánicos Autor: Luis E. Suarez; 168 páginas; Publisher: CreateSpace Independent Publishing Platform; 1 edition; ISBN-10: 1490482393; ISBN-13: 978-1490482392)