UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

WIND POWER PLANTS

Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	ING-IND/03 (FLIGHT MECHANICS)
Department	DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING
Course	ELECTRICAL ENGINEERING
Curriculum	Energetica
Year of study	1°
Period	2nd semester (08/03/2021 - 14/06/2021)
ECTS	3
Lesson hours	23 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	ESPA PAOLO (titolare) - 3 ECTS CROCE ALESSANDRO - 3 ECTS
Prerequisites	Hydropower Plants: Fundamentals of hydraulics, hydrology, and, possibly, water turbines Wind Power Plants: -
Learning outcomes	The course is subdivided into two independent sections: Hydropower Plants and Wind Power Plants. These sections are equivalent in terms of classroom activity, and equally contribute to the final exam grade. Hydropower Plants: At the end of the course, the student will acquire knowledge and understanding concerning: hydropower generation at local (Italy), and global scale; basic operating principles and computation of energy

generation of the more common hydropower schemes; essentials of environmental impact of hydropower; essentials of water turbines; essentials of damming structures. Moreover, the student will apply knowledge and understanding to perform: estimate of reservoir storage for different operating rules, assessment of the operating rule for given reservoir storage; estimate of the energy output for peak energy plants (reservoir, high head) and run-of-the-river plants (low/high head); preliminary design of water turbines (diameter and spinning speed of the runner) for given flow/head, and cavitation assessment for reaction turbines.

Wind Power Plants:
The course aims to provide a general overview of wind power plants, specifically on the wind turbines. It will introduce the principles of operation and will provide the tools, mostly theoretical, necessary to size the parts that make up the plant. It will also deal with the regulatory aspects and the economic convenience of the construction and operation of the plant.

Course contents

Hydropower Plants:
Hydropower projects and related energy output, at local (Italy), and global scale; basics of hydropower development of a catchment (with specific reference to an Alpine catchment in Lombardy); basic operating principles and computation of energy generation of selected hydropower schemes (reservoir/high-head, run-of-the-river high and low-head); essentials of environmental impact of hydropower; essentials of water turbines; essentials of damming structures.

Wind Power Plants:
• Introduction to the course: wind energy systems; the wind turbine; the main components of a wind turbine; HAWT and VAWT; definition and meaning of the power coefficient.
• Principles of aerodynamics: definition of aerodynamic forces and moments; Buckingham's theorem; aerodynamic force coefficients; Reynolds and Mach number; airfoils; lift, drag, aerodynamic moment; 3D aerodynamics.
• Rotor aerodynamics: one-dimensional momentum theory, Betz limit, wake rotation, blade element momentum theory, blade shape for ideal rotor, aerodynamic of VAWT.
• Wind: definition; measurements; averages; turbulence; probability and mathematical models.
• Wind turbine control: motivation and classification of control systems; active and passive controls; yaw control.
• Elements of structural calculation: loads acting on a wind turbine; eigenfrequencies and modes of vibration; Campbell diagram; design of a wind turbine blade.

Teaching methods

Hydropower Plants:
Classroom lectures and exercises. Standard exercises supplied by the teacher. Solution of the problems by spreadsheets.

Wind Power Plants:

	Lectures
Reccomended or required readings	Hydropower Plants: Texts, exercises, websites, further scientific references (to support advanced research) are supplied by e-mail Wind Power Plants: Basic books: • Rodolfo Pallabazzer , “Sistemi Eolici”, Ed. Rubettino, 2004 ISBN 978-8849810677 or • Rodolfo Pallabazzer , “Sistemi di Conversione Eolica”, Ed. Hoepli, 2011 ISBN 978-8820347864 Detailed books: • Martin O. L. Hansen, “Aerodynamics of Wind Turbines” , Earthscan Publications Ltd., January 2001, ISBN 978-1902916064. • J. F. Manwell, J. G. McGowan, A. L. Rogers, “Wind Energy Explained: Theory, Design and Application”, John Wiley & Sons, Ltd, April 2002, ISBN 978-0471499725. • D.M. Eggleston, F.S. Stoddard, “Wind turbine engineering design”, Van Nostrand Reinhold, 1987, ISBN: 978-0442221959 Slides related to the topics covered in the course will be provided for all the lectures.
Assessment methods	Hydropower Plants: Oral exam of approx. 0.5 hours, with discussion of the exercitations and – in case – of the supplementary research-work carried out by the student (teamwork is warmly suggested). Wind Power Plants: Written exam. An oral may be requested by the instructor for further evaluation, following the written.
Further information	Hydropower Plants: For any further information, please contact: paolo.espa@unipv.it Wind Power Plants: -
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile