Syllabus

Course Description

Course Title	Hydropower and wind power Systems
Course Code	45532
Course Title Additional	
Scientific-Disciplinary Sector	
Language	English
Degree Course	Master in Energy Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Lorenzo Battisti, Lorenzo.Battisti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/32901 Prof. Maurizio Righetti, Maurizio.Righetti@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/33740 dr. Giuseppe Roberto Pisaturo, GiuseppeRoberto.Pisaturo@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38803
Teaching Assistant	
Semester	First semester
Course Year/s	2
CP	12
Teaching Hours	120
Lab Hours	12
Individual Study Hours	0
Planned Office Hours	
Contents Summary	This course provides an in-depth introduction to two major renewable energy technologies: run-of-the-river hydro power plants and wind power systems. Divided into two comprehensive

	modules, the course blends theoretical knowledge with practical design approaches, encouraging students to engage with real-world challenges in sustainable energy production. In Module 1, the focus is on run-of-the-river hydroelectric systems. Students will explore the fundamental components and functioning of these plants, supported by detailed case studies of existing installations. The module covers essential topics such as optimal site selection, hydrological analysis, and the hydraulic design of key structures, including weirs, intakes, and silting basins. Further, students will examine the design and operation of penstocks, the impact of water hammer, and the layout and engineering of turbine houses. Module 2 shifts attention to wind energy. Beginning with a historical and technological overview of wind power, the course delves into the complete design process of wind turbines. This includes rotor aerodynamics and geometry, power control strategies, mechanical design, and testing procedures. Students will also study methods for assessing wind resources and evaluating suitable sites. Additional topics include the design of small wind turbines, wind farm layout, and an introduction to the economic and financial aspects of wind energy projects. Throughout the course, students will develop a solid understanding of the engineering principles behind renewable energy systems, supported by real examples and tools used in professional practice. This course is ideal for those aiming to work in the renewable energy sector or seeking a strong technical foundation in sustainable power generation.
Course Topics	Module 1: 1. Description of Run-of-the-river Hydro Power plants, also through the detailed analysis of different plants already built 2. Optimal plant site assessment and hydrological analyses 3. Hydraulic design of Weir, intake, minimum vital flow outlet 4. Hydraulic design of headrace silting basin, forebay 5. Penstock and water hammer, water turbine house analysis and design. Module 2:

	1. Description of wind power plants, history, classification, uses, technology. 2. Wind turbine design, steps and tools; (key elements of the design, definition of the activities and organization of time, budget management, technical norms); 3. The fluid dynamic and geometric design of the rotor. 4. The power control. 5. The mechanical design and testing of the machine. 6. Elements of analysis of wind resources and site assessment. 7. Small wind turbines. 8. Wind farms design. 9. Economic and financial analysis.
Keywords	Hydropower, run of the river HPP, wind power, turbines, rivers
Recommended Prerequisites	
Propaedeutic Courses	
Teaching Format	Frontal lessons, laboratory and exercises
Mandatory Attendance	Not mandatory.
Specific Educational Objectives and Learning Outcomes	Learning Outcomes: (1) Knowledge and understanding: The Hydro Power module provides the knowledge for run-of-the-river (RoR) hydro power plant analysis and design. The frontal lessons and laboratory exercises will give the necessary in-depth analysis of hydraulic design of each component of a RoR Hydro Power Plant (and assistance to design during laboratory hours). Wind energy course provides the basic knowledge for wind energy systems analysis and design. Main technical, and economical aspects for the proper selection and design will be faced and discussed. Small wind turbines application area and large wind farm design will be developed through two dedicated projects. (2) Applying Knowledge and understanding: During one or two visits to large and/or mini hydro power plants (scheduled during the course), the elements which compose the hydroelectric system will be analyzed and understood, through practical examples. The wind power course makes use of lectures, with introduction and discussion of the general aspects of wind turbine design,

	project assignment, work in laboratory with commercial codes and group meetings to review the progress of the projects assigned. (3) Making judgments: Students will be able to analyze and evaluate the potential performances of an HPP. Students will acquire the ability to analyze technical and economic feasibility of small wind projects and large wind farm projects. (4) Communication skills: Students will improve their communication skills by learning how to write and discuss a technical auditing report after a visit to a plan (5) Learning skills Student will learn (second part of the "Hydropower systems" module) to develop in detail the hydraulic design of each compartment constituting a mini hydro power plant, including: weir, intakes, settling basin, head race, surge tank/forebay, penstock. The course will transfer knowledge and methods for the design of small wind turbines and wind farms. The draft design of a wind farm will be developed. Two visits will be organized.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Oral exams and exercises/report. - Formative assessment: Report: during the course; ILOs assessed: (2), (3), (5). - Summative assessment: 100% oral examination, including presentation and discussion of the report: about 1 hour; ILOs assessed: all except (5).
Evaluation Criteria	The exam of hydro power module and of wind power module consists of oral presentation and discussion of the projects and deliverables of the individual working groups, with the identification and evaluation of the contributions of individual participants.
Required Readings	• Hydraulic structures (Novak) • Hydraulic design of stilling basins (Peterka)0

	• Dam hydraulics (Vischer & Hager) • Slides and course materials
Supplementary Readings	• L.Battisti. GLI IMPIANTI MOTORI EOLICI Ed. Lorenzo Battisti Editore. 2012 • L. Battisti Esercizi sulle turbine eoliche (edizione in corso) • T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi, WIND ENERGY HANDBOOK ed. Wiley 2001 • J.F. Manwell, J.G. McGowan, A.L. Rogers, WIND ENERGY EXPLAINED ed. Wiley 2002 • R.Harrison, E. Hau, H. Snel, LARGE WIND TURBINES, ed John Wiley & Sons, 2000 • M.O. Hansen, AERODYNAMICS OF WIND TURBINES, Ed. James & James, 2003 • R. Pallabazzer, SISTEMI EOLICI, Ed. Rubettino 2002
Further Information	Connections with other courses: A strict connection with the course of Environmental Fluid Mechanics / Hydropower Plants, Fluid Machines Engineering and Electrical System Engineering, all of them preparatory for the design of Run of the River Hydro Power Plants. Professional applications of the covered topics: The topics studied will allow the student to find employment in companies, public and private bodies and professional firms for the design, planning, construction and management of works and plants for hydroelectric production, for the management of environmental and energy resources.
Sustainable Development Goals (SDGs)	Affordable and clean energy, Industry, innovation and infrastructure, Climate action, Responsible consumption and production, Sustainable cities and communities

Course Module

Course Constituent Title	Wind power systems
Course Code	45532A
Scientific-Disciplinary Sector	ING-IND/08
Language	English
Lecturers	Prof. Lorenzo Battisti, Lorenzo.Battisti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-

	staff/person/32901
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	120
Lab Hours	12
Individual Study Hours	0
Planned Office Hours	
Contents Summary	
Course Topics	1. Description of wind power plants, history, classification, uses, technology. 2. Wind turbine design, steps and tools; (key elements of the design, definition of the activities and organization of time, budget management, technical norms); 3. The fluid dynamic and geometric design of the rotor. 4. The power control. 5. The mechanical design and testing of the machine. 6. Elements of analysis of wind resources and site assessment. 7. Small wind turbines. 8. Wind farms design. 9. Economic and financial analysis.
Teaching Format	Frontal lessons, laboratory and exercises.
Required Readings	· Slides and course materials
Supplementary Readings	

Course Module

Course Constituent Title	Hydropowers systems
Course Code	45532B
Scientific-Disciplinary Sector	ICAR/02
Language	English
Lecturers	Prof. Maurizio Righetti, Maurizio.Righetti@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-

	sciences/academic-staff/person/33740 dr. Giuseppe Roberto Pisaturo, GiuseppeRoberto.Pisaturo@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38803
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	120
Lab Hours	12
Individual Study Hours	0
Planned Office Hours	
Contents Summary	
Course Topics	1. Description of Run-of-the-river Hydro Power plants, also through the detailed analysis of different plants already built 2. Optimal plant site assessment and hydrological analyses 3. Hydraulic design of Weir, intake, minimum vital flow outlet 4. Hydraulic design of headrace silting basin, forebay 5. Penstock and water hammer, water turbine house analysis and design.
Teaching Format	Frontal lessons, laboratory and exercises.
Required Readings	· Hydraulic structures (Novak) · Hydraulic design of stilling basins (Peterka) · Dam hydraulics (Vischer & Hager) · Slides and course materials
Supplementary Readings	