Wind Power Plants Technology

Course Code:	46346
Course type:	Theoretical
Credits:	3
Course Status:	Elective Specialized Course
Prerequisite:	Fundamentals of Electrical Engineering (B.Sc.) and Supervisor Approval

***Aim/Scope/Objectives*:** The aim of this course is to overview the fundamental topics in wind energy systems and familiarizes the graduate students with the theory and practical aspects of wind power plants.

Course Outline:

1- Introduction

Historical uses of wind, History of wind electric generation, Horizontal axis wind turbines (HAWT), Vertical axis wind turbines (HAWT), Innovative wind turbines, Wind farms.

2- Wind Characteristics

Meteorology of wind, World distribution of wind, Wind speed distribution in Iran, Atmospheric stability, Wind speed variation with height, wind speed statistics, Weibull statistics model,

3- Wind Measurements

Anemometer instruments, Different type of anemometers (conventional and innovative), Wind direction instruments, and Laser type wind measurements.

4- Wind Turbine Power, Energy and Torque

Power output from an ideal turbine, Blade aerodynamics, Power output from practical turbines, Transmission and generator efficiencies, Energy production and capacity factor, Torque at constant speeds, Starting a Darrieus turbine, Turbine shaft power and torque at variable speeds, Wind turbine mathematical models.

5- Different components of a vertical axis wind turbine

Rotor, Aerodynamic control of blade, The Hub, Drive train, Couplings, Gearbox, Brakes, Yaw system, Main frame and nacelle, Tower.

6- Mathematical Modeling of wind turbine

Wind torque (deterministic and statistic components), Modeling of a VAWT with variable pitch, Mechanical subsystem, Aerodynamic subsystem, Electrical subsystem, Pitch subsystem, Mean wind speed subsystem.

7- Control objectives and strategies

Control objectives, Mechanical loads, Power quality, Turbine modes of operation, Turbine control strategies, Fixed-speed fixed-pitch, Fixed-speed variable-pitch, Variable-speed fixed-pitch, Variable-speed variable-pitch.

8- Grid Integration of offshore wind farms

Grid connection standards, Grid connection methods, HVAC, Line commutated convertor LCC-HVDC, Voltage source convertor VSC-HVDC, Case studies.

Grading: 70% Final exam, 10% Homework, 20% Research Project

References:

- Gary L. Johnson, "Wind Energy Systems", Manhattan, Kansas State University, 2006.
- David A. Sepra, "Wind turbine Technology, Fundamental concepts of wind turbine Engineering", ASME press, 2009. J. F. Manwell, J. G. Mcgowan, "Wind Energy Explained, theory design and application", Wiley, second edition, UK, 2009.
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- Sathyajith Mathew, Getta S. Philip, "Advances in wind energy conversion", Springer, 2011.
- Fernando D. Bianchi, Hernan D. Batissta, "Wind turbine control systems, principles modeling and gain scheduling design", Springer, 2007.
- Wind Energy – The Facts: A Guide to the Technology Economics and Future of Wind Power (European Wind Energy Association), 2009.
- Martin O. L. Hansen, "Aerodynamics of wind turbine", second edition, Earthscan, UK, 2008.
- S. M. Muyeen, Junji Tamura, "Stability Augmentation of a Grid-connected Wind Farm", Springer, 2009.
- Volker Quaschning, "Understanding Renewable Energy Systems", Carl Hanser Verlag GmbH & Co KG, 2005.
- Manfred Stiebler, Wind Energy Systems for Electric Power Generation", Springer, 2010.
- Paul Gip, "Wind Energy Basics: A Guide to Home- and Community-Scale Wind-Energy Systems", 2nd edition, Chelsea Green Publishing, 2009.
- Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, "Wind Energy Handbook", John Wiley, 2001.