

Course Title: Wind Energy (Elective Course)

Course Code: ESE-817

Objectives: Main objective of this course is to provide a general introduction to wind turbines including the history and development of the wind energy industry, components of wind turbines, and how they work together to produce energy. An analysis of how the turbine converts wind to electrical power will be covered also.

Learning Outcomes:

On successful completion of the module the student will be able to perform Evaluation of wind turbine blade design; computation of the degree of energy transfer; assessment of mechanical loads & design/construction of windmill platforms and Transmission systems appraisal.

Contents:

Energy conversion process in Wind Turbines: An overview of wind resource as input for a wind energy converter, aero-dynamic and mechanical aspects of wind turbines, construction principles of wind turbines, power characteristics of wind turbines, control systems

Evaluation of Wind Resources: Weibull-Distribution, wind velocity measurements to determine energy yield, WASP-method, partial models using WASP, MCP method of long-term corrections of wind measurement data in correlation to long-term reference data, conditions for stable, neutral, and instable atmospheric conditions, wind yield from wind distribution and the power curve and appraising the yearly wind yield from a wind turbine.

Wake Effect and Wind Parks: Detailed study on recovery of original wind fields in the downstream of wind turbines, RISØ models, spacing and efficiency in wind parks, foundation of offshore wind turbine, positive and negative effects of wind parks.

Wind Energy Technology: Detailed study on electrical system, rotation speed, steep installation, mechanical load and moment, mechanical load, electrical system rotation speed, variable installation, measurements from load and moment, strain gauge test bridge, fatigue extrapolation, wind diesel systems in small island grids (ca. 30kw), actuator disc theory, horizontal axis wind turbine theories, vertical axis wind turbine optimization theories.

Wind Park Business: Analysis of income from the energy yield from wind parks, three-pillar model of sustainability: "magic triangle", profit optimization by increase of energy production.

Wind Flow, Origin and potential of atmospheric energy movements, heat balance of the atmosphere, physical laws of atmospheric flow, wind circulation in the atmosphere, local winds, wind flow in atmospheric layers (vertical structure, Ekman layer), assessment of wind potential (European wind atlas: model, concept).

Types of wind energy conversion systems: Dutch windmills, multiblade water-pumping windmills, high-speed propeller-type wind machines, the savonius rotor, the Darrius rotor. new developments: small turbines; large turbines. Applications

Recommended Books

- Wind Power Plants: Fundamentals, Design, Construction and Operation- Gasch, Robert & Tewe, Jochen
- Wind Turbine Engineering Design-Eggleston
- Wind Energy: Fundamentals, Resource Analysis and Economics – Mathew Sathyajith
- Wind Energy: Renewable Energy and the Environment- Vaughn C. Nelson