

CE7J01: J1 – Wind Energy [5 credits]

Module Co-ordinator(s): Asst. Prof. Breiffni Fitzgerald (fitzgeb7@tcd.ie)

Lecturer(s): Prof. Biswajit Basu (basub@tcd.ie); Asst. Prof. Breiffni Fitzgerald (fitzgeb7@tcd.ie);

Module organisation

Department of Civil, Structural and Environmental Engineering

Module description, aims and contribution to programme

The aims of the module are:

1. To foster problem solving and critical thinking skills by requiring students to apply the theory learnt on wind energy to real life projects and engage in discussions with the other experts.
2. To enable students to communicate well in engineering contexts in relation to wind energy, both when discussing about projects, plans and problems, and when writing, reporting and communicating about these.
3. To achieve a pro-active engagement in wind energy problems.
4. To enable students to identify, formulate, analyse and solve engineering problems by applying the theory of wind energy both analytically and computationally.
5. To solve real world engineering problems by carrying out feasibility analysis using real wind and weather data from sites.
6. To solve real world engineering problems by applying the theory and employing aeroelastic software packages FAST and WindFarmer.

Learning outcomes

On successful completion of this module, students should be able to:

1. Explain the impact of surface roughness and orography on wind speed profiles.
2. Calculate wind speed at a given height using the log law and power law.
3. Carry out micro-siting assessment.
4. Derive the Betz equation for wind power extraction using an idealized wind turbine.
5. Calculate power curve to analyse the impact of various control systems in a wind turbine.
6. Explain concepts related to wind turbine design.
7. Carry out analysis of gearbox for stresses generated and fatigue design.
8. Demonstrate ability to carry out aerodynamic analysis for a wind turbine.
9. Analyze noise generated by wind turbines and its impact.
10. Model wake effects for wind farms.
11. Analyze offshore wind turbines for joint wind wave loading.
12. Demonstrate ability to carry out economic analysis for wind energy technology.

Module content

To develop a detailed foundation of the issues associated with the development of wind energy for electrical energy supply. The module will focus on the current state of wind energy technology domestically and internationally and will consider the future development of wind resources. Content will include:

- Overview of wind energy and introduction to wind flow
- Fluid mechanics for wind energy
- Wind resources and micro-siting
- Ideal wind turbines and practical constraints, Power Curves
- Turbine design (tower, blades, gearbox, foundations)
- Aerodynamics and aeroelasticity
- Wake effects and wind farm design
- Controls in wind turbines
- Fixed and variable speed operation
- Offshore wind turbines, Joint wind and wave effects
- Wind turbine economics, lifecycle cost
- Grid integration and transmission

Teaching strategies

- Lectures
- Coursework
- Mini projects

Assessment

The assessment for this module is made of the following components:

- Written examination (worth 80%)
- Coursework and project work during semester (worth 20%).

The students are required to carry out a project involving data analysis and application of the principles of wind energy assessment for a site based on available real weather data.

Required textbook

Wind Energy Explained: Theory, Design and Application (2009) Manwell, McGowen and Rogers, Wiley, 2nd Edition.

Wind Energy Handbook (2001) Burton, Sharpe, Jenkins, Bossyani, John Wiley, New York.

Wind Power Generation and Wind Turbine Design (2010) Tong (Ed.), WIT Press, Boston.

Offshore Wind Farms: Technologies, Design and Operation (2016) Ng and Ran (Eds.), Woodhead Publishing Ltd., Cambridge.

Renewable Energy Resources (2006) Twidell and Weir, Taylor and Francis, London.

Further information

<https://www.tcd.ie/Engineering/>