

~~FIRST~~/ SECOND SEMESTER 2022-2023

Course Handout Part II

Date: 09-01-2024

In addition to part I (general handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course no : ME F483

Course title : Wind Energy Instructor in charge : M. Srinivas

# Course Description

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a prospective site, Constructional features of various systems and sub-systems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

# Scope and objective

A state of the art treatment of wind energy resource, engineering and technological aspects would be presented in a greater detail in the course. This would be complemented by economic, commercial and social aspects of wind energy harnessing and utilization. At the end of the course the student would be able to apply the principles learnt to (a) identify the sites for wind energy harnessing (b) design wind energy harnessing systems for various applications (c) perform necessary techno- economic analyses for selecting appropriate wind energy systems.

# Text books

* 1. Sathyajith Mathew, Wind Energy - Fundamentals, Resource Analysis and Economics, Springer-Verlag Berlin Heidelberg 2006

# Reference books

* 1. J. F. Manwell and J. G. McGowan, Wind Energy Explained- Theory, Design and Application, John Wiley & Sons Ltd, West Sussex, United Kingdom, 2009
  2. John D Holmes, Wind Loading of Structures, 2nd Edition, Taylor & Francis, 2007
  3. A R Mohanty, Machinery Condition Monitoring: Principles & Practices-CRC Press
  4. Ahmad Hemami, Wind Turbine Technology, Cengage Learning, 2012

# Course plan

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| **Lecture** | **Learning objective** | **Topics to be covered** | **Chapter in the Text Book** |
| 1 | Introduction | History of wind energy, Current status and future prospects | 1 of TB1 |
| 2-5 | Basics of Wind Energy Conversion | Power available in the wind spectra, Wind turbine power and torque, Classification of wind turbines, Horizontal axis wind turbines, Vertical axis wind turbines; Darrieus rotor; Savonius rotor; Musgrove rotor | 2 of TB1 |

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| **Lecture** | **Learning objective** | **Topics to be covered** | **Chapter in the Text Book** |
| 6-10 | Characteristics of wind rotors, Aerodynamics of wind turbines | Airfoil, Aerodynamic theories, Axial momentum theory, Blade element theory, Strip theory, Rotor design, Rotor performance | 2 of TB1 |
| 11-13 | Analysis of wind regimes | The wind: Local effects; Wind shear; Turbulence; Acceleration effect; Time variation | 3 of TB1 |
| 14-15 | Measurement of wind | Ecological indicators, Anemometers: Cup anemometer; Propeller anemometer; Pressure plate anemometer; Pressure tube anemometers; Sonic anemometer; Wind direction | 3 of TB1 |
| 16-18 | Analysis of wind data | Average wind speed; Distribution of wind velocity Statistical models for wind data analysis, Weibull distribution, Rayleigh distribution | 3 of TB1 |
| 19-20 | Energy estimation of wind regimes | Weibull based approach; Rayleigh based approach | 3 of TB1 |
| 21-22 | Wind energy conversion systems | Wind electric generators: Tower; Rotor; Gear box; Power regulation; Safety brakes; Generator; Induction generator& Synchronous generator; Fixed and variable speed operations; Grid integration | 4 of TB1 |
| 23-25 | Wind farms, Offshore wind farms,  Wind pumps | Wind powered piston pumps, Limitations of wind driven piston pumps: The hysteresis effect;  Mismatch between the rotor and pump  characteristics; Dynamic loading of the pump’s lift rod; Double acting pump; Wind driven roto-dynamic pumps; Wind electric pump | 4 of TB1 |
| 26-28 | Performance of wind energy conversion systems | Power curve of the wind turbine; Energy generated by the wind turbine: Weibull based approach; Rayleigh based approach | 5 of TB1 |
| 29-32 | Performance of wind powered pumping systems | Wind driven piston pumps, Wind driven roto- dynamic pumps, Wind electric pumping systems | 5 of TB1 |
| 33 | Wind energy and Environment | Environmental benefits of wind energy | 6 of TB1 |
| 34-35 | Life cycle analysis | Net energy analysis; Life cycle emission | 6 of TB1 |
| 36-37 | Environmental problems of wind energy | Avian issues; Noise emission; Visual impact | 6 of TB1 |
| 38-39 | Economics of wind energy | Factors influencing the wind energy economics: Site specific factors; Machine parameters; Energy market; Incentives and exemptions | 7 of TB1 |
| 40-42 | The ‘present worth’ approach, Cost of wind energy, Benefits of wind energy Yardsticks of economic merit | Initial investment; Operation and maintenance costs; Present value of annual costs, Net present value; Benefit cost ratio; Payback period; Internal rate of return | 7 of TB1 |

**Evaluation Scheme:**

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| **Component** | **Duration** | **Weightage**  **(%)** | **Date & Time** | **Nature of**  **Component** |
| Mid semester Test | 90 Minutes | 30 | 12/03 - 4.00 - 5.30PM | CB |
| Surprize tests/quizzes\* | 10 Minutes | 20 | To be announced | OB |
| Written reports on assignments/projects@ | Take home | 10 | To be announced | OB |
| Comprehensive Examination | 180  Minutes | 40 | 09/05 AN | CB |

\* Best 4 out of 5. Other details would be communicated separately.

@ No of assignments/projects is one, the topic of which would be given to the students. Two reports are to be submitted in hand written format. Other details would be communicated separately

**Chamber Consultation Hour:** To be announced in the class.

**Notices:** All notices concerning this course shall be displayed on the CMS (the Institute’s web based course management system). Students are advised to visit regularly CMS for latest updates.

**Make-up Policy:** Make-up shall be given only to the genuine cases with prior confirmation. Request for the make-up tests, duly signed by the students, should reach the under signed well before the scheduled test.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

# Instructor-in-Charge

ME F483