

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI – HYDERABAD CAMPUS
INSTRUCTION DIVISION
FIRST SEMESTER 2016-17
COURSE HANDOUT (Part II)

Date:01/08/2016

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

1. 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.

2. 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.

3. Text books

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

4. 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

5. Course plan

Lecture	Learning objective	Coverage	To be covered from (Text book chapters)
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
6-8	Analysis of wind regimes	The wind: Local effects; Wind shear; Turbulence; Acceleration effect; Time variation	3 of TB1
9-10	Measurement of wind	Ecological indicators, Anemometers: Cup anemometer; Propeller anemometer; Pressure plate anemometer; Pressure tube anemometers; Sonic anemometer; Wind direction	3 of TB1
11-13	Analysis of wind data	Average wind speed; Distribution of wind velocity	3 of TB1

Lecture	Learning objective	Coverage	To be covered from (Text book chapters)
		Statistical models for wind data analysis, Weibull distribution, Rayleigh distribution	
14-15	Energy estimation of wind regimes	Weibull based approach; Rayleigh based approach	3 of TB1
16-17	Characteristics of wind rotors, Aerodynamics of wind turbines	Introductory airfoil theory Airfoil, Aerodynamic theories, Axial momentum theory, Blade element theory, Strip theory, Rotor design, Rotor performance	2 of TB1
18-20	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
21-22	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
23-24	Performance of wind powered pumping systems	Wind driven piston pumps, Wind driven roto-dynamic pumps, Wind electric pumping systems	5 of TB1
25	Wind energy and Environment	Environmental benefits of wind energy	6 of TB1
26-31	Wind turbine Installation	Wind structure interaction, Basic bluff body aerodynamics, Interference effects, Wind turbine aerofoil design, Wind turbine foundation characteristics, terrain effects, Wind loadings	4 of TB1, 4,11,15 of RB2
32-34	Wind turbine mechanical systems and materials	Gear Box fundamentals, speed and torque relations, force loads on gears, Material considerations and characteristics of materials for various components of wind turbines	9 of RB4
35-37	Wind turbines Condition monitoring	General problems of gears and gear failure, Vibration, acoustics, lubricating oil monitoring of gear boxes in wind turbines	RB3
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

6. Evaluation scheme

Evaluation component	Duration	Weightage	Date/Time/Venue	Evaluation type
Test I	60 min	20%	13/9, 2.30--3.30PM	Closed book
Test II	60 min	20%	21/10, 2.30--3.30PM	Closed book
Project & Viva		20%		Open book
Comprehensive Examination	3 hours	40%	13/12 AN	Closed book

7. **Chamber consultation hours** To be announced in class.

8. **Course notices** To be displayed on ME notice board only.

Instructor-in-charge
ME F483