B.Tech III Year II Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AME64d – SOLAR AND WIND ENERGY SYSTEMS

(Professional Elective-II)

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Course Objectives: The objectives of the course are to make the students learn about

- Familiarize with basics of solar radiation, available solar energy and its measurement.
- Familiarize with solar collectors, construction and operation of solar collectors.
- Understand solar energy conversion systems, applications and power generation.
- Familiarize the wind energy sources assessment
- Explain basics of designing aerofoil

UNIT – I: Solar radiation and collectors **12 Hrs**

Solar radiation and collectors: Solar angles – Sun path diagrams – Radiation - extra terrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - testing methods-evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

Solar thermal technologies: Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – Solar cooker : domestic, community – Solar pond – Solar drying.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the basic concepts of solar radiation and solar collectors **L2**
- Develop sun path diagrams **L3**
- Explain the concepts of tracking systems **L2**
- Discuss the working principles of solar thermal technologies **L6**
- Develop design and operation of solar heating and cooling systems **L3**
- Explain the principles of thermal storage systems **L2**

UNIT – II: Solar PV fundamentals **10 Hrs**

Solar PV fundamentals: Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetro junctions - metal-semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature - efficiency measurements - high efficiency cells – Solar thermo-photovoltaics.

SPV system design and applications: Solar cell array system analysis and performance prediction-Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - centralized and decentralized SPV systems - stand alone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the properties of a semiconductor **L2**
- Apply the principles of solar thermo photo voltaics **L3**
- Outline the applications of SPV system **L2**

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- Analyze the performance of a solar cell array system **L4**
- Utilize centralized and decentralized SPV systems **L3**

UNIT – III: Introduction to wind energy **10Hrs**

Introduction: Historical Perspectives on Wind Turbines- Indian Energy Scenario - Global Energy Scenario - Introduction to Indian Wind Industry - Wind Energy potential of India and Global Wind Installations.

Basics of Wind Resource Assessment: Power in the wind –Wind Characteristics - Measurement of wind using anemometers (cup anemometer, propeller anemometer, pressure plate anemometer, pressure tube anemometer, sonic anemometer and other remote wind speed sensing techniques) – Turbulence-Wind Power Density –Average wind speed calculation - Statistical models for wind data analysis (Weibull and Rayleigh distribution). Energy estimation of wind regimes – Wind Rose, Wind Monitoring Station Siting and Instrumentation.

Learning Outcomes:

At the end of this unit, the student will be able to

- Recall historical perspective of wind turbines **L1**
- Relate Indian and global energy requirements. **L1**
- Interpret power in the wind **L2**
- Classify different wind speed measuring instruments **L2**
- Apply different statistical models for wind data analysis **L3**

UNIT – IV: Wind Energy Conversion Systems **8 Hrs**

Wind Energy Conversion Systems: Types - Components of Modern Wind Turbine (HAWT and VAWT) - Fixed and Variable Speed operations - Power Control (Passive stall, Active pitch, Passive pitch and Active stall) - Electrical aspects of wind turbine, Safety of wind turbines.

Learning Outcomes:

At the end of this unit, the student will be able to

- Utilize different wind parameters for design of rotor **L3**
- Make use of power curve for energy estimation **L3**
- List different components of modern wind turbine **L1**
- Explain how to control the power of a wind turbine **L2**
- Name different safety measures of wind turbine **L1**

UNIT – V: Wind Farm Design and Health (Condition) Monitoring **8 Hrs**

Wind Farm Design and Health (Condition) Monitoring: Planning of wind farm, Site selection, Micro siting, Grid Integration, Power evacuation, Wind Farm Feasibility Studies, Preparation of DPR, Environmental Benefits and Impacts.

Small Wind Turbines: Water pumping wind mills, offshore wind energy, Wind turbine testing, future developments.

Learning Outcomes:

At the end of this unit, the student will be able to

- Plan the wind farm **L3**
- Analyze the feasibility of wind farm **L4**
- List the environmental benefits and impacts **L1**
- Explain about small wind turbines **L2**

Text Books:

1. Goswami D.Y., Kreider, J. F. and Francis., "Principles of Solar Engineering', Taylor and Francis, 2000.
2. Chetan Singh Solanki, "Solar Photovoltatics – Fundamentals, Technologies and Applications", PHI Learning Private limited, 2011.

Reference Books:

1. Sathyajith Mathew, Wind Energy Fundamentals, Resource Analysis and Economics, Springer Publications, (2006).
2. Sukhatme S.P.,. Nayak.J.P, 'Solar Energy – Principle of Thermal Storage and collection", Tata McGraw Hill, 2008.
3. Wei Tong, Wind Power Generation and Wind Turbine Design, WIT Press, (2010).
4. Wind Power, Revised Edition: Renewable Energy for Home, Farm, and Business, Paul Gipe, 2004, Chelsea Green Publishing.
5. R. Jha, Wind Turbine Technology, CRC Press, (2010).

Course Outcomes:

At the end of this Course the student will be able to

- Understand with basics of solar radiation, available solar energy and its measurement **L2**
- Illustrate the solar collectors, construction and operation of solar collectors. **L3**

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