

Course Curriculum

SUBJECT: RENEWABLE ENERGY (SOLAR PV and WIND)

STD: XII as replacement/elective with Industrial Electronics and Instrumentation (ET) and Electronic and Electrical Measurements (MREEDA)

Topics

1. Non-conventional energy scenario in India

- a. Introduction to conventional and non-conventional sources of energy
 - b. Differentiates between conventional energy and non-conventional energy
 - c. Limitations of conventional energy and non-conventional energy
 - d. Advantages and disadvantages of non-conventional energy
 - e. Solar energy
- (i) Resistance for accepting non-conventional energy
(ii) Avenues for development of non-conventional energy in India

Periods – 4, Marks – 3

2. Solar Radiation and solar cells

- a. Solar spectrum
- b. Extra-terrestrial radiation
- c. Radiation on the earth's surface,
- d. Global and diffused radiation,
- e. Solar radiation at given location,
- f. Daily radiation pattern,
- g. Earth's movement and annual variations in solar radiation,
- h. Optimal tilt for solar equipment's,
- i. Monthly average global radiation at optimal tilt,
- j. Photoelectric effect
- k. Photovoltaic effect
- l. Solar cells-Types, Advantages & disadvantages
- m. Generating more power using PV
(Pg 41. & 42 of Chetan S. Solanki)
- n. Solar PV module rating
- o. Solar Tracking –Definition
- p. Tracking over period of 1 year
- q. Tracking changes the power generation
- r. Maximum power point tracking
- s. Mechanism of tilting (2 & 3 dimensional tracking)

Periods – 15, Marks – 10

3. PV system designing and applications

- a. Component arrangements, circuitry for solar PV set up.
- b. Case study for power calculations and designing a PV system.
- c. Solar Street lights –stand alone type,
- d. Solar rooftop lighting,
- e. Solar Lanterns,
- f. Solar water Pumps,
- g. Operation and maintenance of the solar PV set ups

Periods – 8, Marks – 6

4. Operation of large scale or megawatt level plants

- a. Grid connected system- array configuration, power output modulation, operation and maintenance

- b. AC distribution box, AC energy and net metering,
(Chetan S. Solanki Pgs. 249 to 252,255,256)

Periods – 4, Marks – 4

Wind Energy

5. Wind and wind Turbines

- How wind flows?
Land breeze, sea breeze the Coriolis effect
- Early uses of wind power
- What is wind power? Forces on blades*, shapes and aerodynamic profiles of the blades*
Betz law,
- Vertical axis & horizontal axis wind turbines, upward and downwind type, classification by speed control method, classification by turbine wind class
- How a wind turbine works?
- Wind data*, Power output at different wind speeds*

Major components of wind turbine, brushless alternator design, magnets, armature and winding, wind turbine frame / nacelle, the tail boom, yaw shaft, protection from high wind speed, wind-charge controller

Periods – 11, Marks – 8

6. Wind Tower components

- Wind turbine towers- types, advantages and disadvantages, fatigue and damage,
- Wind farms, arrays and distribution

Periods – 4, Marks - 2

7. Auxiliaries

- Basics of current conduction, resistance, voltage drop,
- Cable description, single core and multicore cables, and rating, SWG measure, effect of temperature on wire selection, junction box, (Chetan S. Solanki Pgs. 188-217)
- Testing instruments like portable power analysis with clamp meter, multi-meter, tongue tester, etc.
- Crimping tools
- Earthing arrangements for solar PV set ups. Lightning arrestors and their functioning

Periods – 8, Marks – 4

8. Energy storage systems

Batteries

- Lead acid batteries, Li-Ion batteries, other types of batteries, flooded, VRLA types, ,Battery ratings
- Construction of batteries, chemical reactions, charging and discharging, flow of current
- Efficiency and cost comparison
- Battery maintenance, maintenance free batteries,

Capacitors

- Capacitors construction, functioning and use,
- Ultra capacitors, construction, applications and advantages

Periods –8, Marks – 4

9. Inverters and their ratings

- Inverters,DC to AC conversion, rectifiers AC to DC conversion, circuit diagrams,
- Inverter ratings, specifications, costs, Power inverters
- Overall efficiency and functioning of inverter in the renewable energy systems.
- Charge controller- features, functioning typical specifications, types
(Chetan S. Solanki Pgs. 172 to 184)
- Fault findings and troubleshooting

(Chetan S. Solanki Pgs. 163 to 167, 177)

Periods – 8, Marks – 4

10. Safety measures

- a. Handling of modules, mechanical safety

Periods – 3, Marks – 3

11. Central Govt. Policies

- a. Ministry of new and renewable energy sources (MNRE), Indian Renewable Energy Development Agency (IREDA),
b. Subsidy schemes available for solar PV program, eligibility criteria for beneficiaries, soft loans and bank and state subsidies etc.

Periods – 2, Marks - 2

Reference books

Solar

1. Solar Photovoltaic Technology and Systems, Chetan Singh Solanki, PHI Learning, Delhi 110002
2. Solar Energy Technology: A User's Handbook, Chetan Singh Solanki, I. I. T Mumbai 400076
3. Energy storage, a note by Prof. JayeshPriolkar, Goa Engg. College, personal communication,
4. Lead Acid Batteries in Critical Applications, Erik Jones, CD Technologies, Power point presentation, to be down loaded from web with permission.
5. Ultra capacitors: A Paradigm Change in Energy Applications, Presentation by M/s AARTECH Solonics Limited

Wind

1. Opeartion and maintenance of the Solar-Wind Hybrid systems, special note prepared by Shri Rajarshi Sen, Luminous Renewable Energy Solutions Pvt. Ltd. Pune
2. Non-conventional Energy Sources, G. D. Rai, Khanna Publishers, Delhi 2008
3. Non-conventional Energy Sources, G. S. Sawhney, PHI Learning PVt. LTD. New Delhi 2012
4. Wind Energy Technology – 13th National Training course material, Centre for Wind Energy Technology, Chennai 600100, 2012

List of Experiment for Solar PV curriculum

- 1) Arrangement of Photovoltaic cells.
- 2) Setting up of the Photovoltaic panel with the help of the given settings to get the maximum exposure of the sunlight.
- 3) Measurement of V/I Characteristics of the monocrystalline cells
- 4) Measurement of V/I Characteristics of Polycrystalline cells
- 5) Connecting of Photovoltaic cells in series and measuring their V/I Characteristics.
- 6) Connecting of Photovoltaic cells in Parallel and measuring their V/I Characteristics.
- 7) Connecting of Monocrystalline and polycrystalline cells in series and parallel and measuring their characteristics
- 8) Connecting a battery to the inverter and measuring the output using a meter
- 9) Connecting a battery to the inverter and observing the waveform using a oscilloscope
- 10) Doing exp no 8 & 9 with different loads
- 11) Connecting a solar panel with inverter and measuring the output using meter.
- 12) Connecting a solar panel with inverter and observing the output using Oscilloscope.

Materials required

- 1) Digital Multimeters for measurements upto 200V AC, 100V DC, 5 Ams D C,
- 2) Tong tester
- 3) Oscilloscope 20 Mhz Dual trace
- 4) Analogue multimeter
- 5) Rheostats
- 6) Cables
- 7) Solar Panel etc

List of Experiment for wind energy curriculum

1. Working of an anemometer

A week long training at CWET R&D centre in Tamilnadu.