Renewable Energy and Energy Harvesting
DSE (Electronics) Sem III
(For Physics and Electronics as core subjects)

Credit: 04 (Theory-02, Practical-02)

Course Objective

1. To provide knowledge and practical learning experiences about various alternative energy sources.
2. To explore methods of harnessing energy from wind, solar, mechanical, ocean, geothermal, and other sources, and review the functioning of different energy harvesting systems installed globally.

Course Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes:

1. Gain knowledge of various energy sources for harvesting.
2. Understand the necessity of energy conversion and the different methods of energy storage.
3. Develop a thorough understanding of various renewable energy systems and their components.
4. Acquire knowledge about renewable energy technologies, different storage technologies, distribution grids, smart grids, including sensors, regulation, and control.
5. Design models for wind energy or solar energy plants.
6. Gain hands-on experience with:
   - Different types of alternative energy sources.
   - Converting vibration into voltage using piezoelectric materials.
   - Converting thermal energy into voltage using thermoelectric modules.

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Unit 1 (3 Lectures)

Fossil fuels and Alternate Sources of energy: Fossil fuels, their limitation, need of renewable energy, non-conventional energy sources. An overview of energy conversions using Offshore Wind Energy, Tidal Energy, solar energy, biomass, bio-gas generation, geothermal energy tidal energy, Hydroelectricity.

Unit 2 (10 Lectures)

Solar energy: Solar energy, its importance, solar spectrum and AM 1.5 radiation, storage of solar energy, solar pond, applications of solar pond and solar energy, Principle & working of solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell. Need and characteristics of photo-voltaic (PV) systems, PV models and equivalent circuits.

Unit 3 (3 Lectures)

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Unit 4 (7 Lectures)

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide Energy Technologies, Ocean Thermal Energy, Ocean Bio-mass. Geothermal Energy: Geothermal Resources.
Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Rain water harvesting.

Unit 5 (7 Lectures)

Piezoelectric Energy harvesting: Principle of piezoelectric effect, polarization tensor, and strain parameters, Piezoelectric materials (ZnO and PZT) and their characteristics, Piezoelectric generators and energy harvesting applications,

Electromagnetic Energy Harvesting: Linear generators, recent applications: Carbon captured technologies.

PRACTICALS

"Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the lab, including necessary precautions.

Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab."

Teacher may give a long duration project based on this paper.

Demonstrations and Experiments:

1. Demonstration of Training modules on Solar energy,etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage-driven thermo-electric modules.
4. Demonstration of wind energy modules.

References for Theory/ Essential Readings

1. Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.
2. Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press.

Additional Readings

1. Solar Energy: Resource Assessment Handbook, P Jayakumar, 2009
2. J.Balfour, M.Shaw and S. Jarosek, Photo-voltaics, Lawrence J Goodrich (USA).
3. http://en.wikipedia.org/wiki/Renewable_energy

References for Laboratory

1. Non-conventional energy sources, B.H. Khan, McGraw Hill 60