

Govt. Degree College (Autonomous), Baramulla

B.Sc. (Honors) Physics – 4 years (8th Semester)

COURSE NAME: RENEWABLE ENERGY

COURSE NO. PHYC3822M

TOTAL CREDITS = 04

THEORY = 04

PRACTICAL = 02

Course Objectives:

- Understanding physical principles of renewable sources like solar radiation, wind kinetics, and geothermal heat transfer etc.
- Analyze energy conversion efficiencies using concepts such as p-n junctions, Betz limit, and entropy.
- Evaluate Storage Technologies.
- Analyze the environmental and economic aspects of renewable energy.
- Promote research and innovation in sustainable energy solutions.

Course Learning Outcomes:

Students will:

- Understand the need for renewable energy.
- Analyze energy consumption patterns.
- Explain basic concepts of energy conversion.
- Pursue higher studies/research/industry roles.

UNIT I: Energy Fundamentals and Energy Scenario

(15 Lectures)

Energy: Definition, forms, units, and conversions; Global energy scenario and challenges; Indian energy scenario with focus on Jammu & Kashmir; Conventional energy sources: Coal, oil, gas – advantages and disadvantages; Green House Effect; Environmental impacts: Global warming and climate change; Sustainable development and energy security; Introduction to renewable energy sources; Forms of renewable energy; Solar, Wind, Biomass, Geothermal, Ocean Tidal, Small Hydro and Ocean Wave Energy etc.; Energy demand–supply gap and future projections.

UNIT II: Solar Energy Systems

(15 Lectures)

Sun as source of energy; Spectral Power Distribution of Solar Radiation; Sun-earth energy relationship; Solar Constant and Albedo; Absorption and Scattering of solar radiation; Concept of Airmass; Measurement of solar radiation (pyranometer, pyrheliometer and sunshine recorder); Annual Average Direct Normal Irradiance in India; Solar thermal energy: Basics and applications; Flat plate collectors: Design and performance; Effect of various parameters on its performance; Solar concentrators (Cylindrical parabolic, Paraboloidal Dish Collector, Central Tower Receiver); Solar Water Heater; Solar Passive Space Heating and Cooling Systems; Solar Cooker (Box Type, Paraboloidal Dish Type); Solar Greenhouse (Regulation of its internal environment); Solar Dryer; Solar Pond.

UNIT III: Solar PV Systems and Wind Energy

(15 Lectures)



Solar photovoltaic (PV) principle; Types of solar cells (mono, poly, amorphous Si, and thin film etc.); V-I Characteristics of a Solar Cell; Maximum Power Point, Short Circuit Current, Open Circuit Voltage, Fill factor; Energy losses and Efficiency of Solar Cell; Solar PV Module, Solar PV Panel, Solar PV Array; Balance of system components (inverter, battery, charge controller and wiring etc.); Standalone vs grid-connected PV systems; Hybrid PV System; Solar PV Applications (Power Generation, Water Pumping, Lighting, Telecommunication and Signaling etc.)


Wind energy basics; Origin of winds (Global and local winds); Wind Speed Classification (Beaufort Scale); Variation of Wind Speed with Height; Relation between Power and Wind speed; Wind energy conversion systems (WECS); Types of wind turbines (HAWT, VAWT); Power Extraction from wind (Betz limit); Environmental Aspects of WECS.

UNIT IV: Renewable Energy Systems and Emerging Technologies (15 Lectures)

Biomass resources and classification; Biogas production and plants; Biomass conversion (combustion, gasification); Waste-to-energy technologies; Biofuels (ethanol, biodiesel); Energy Farming; Geothermal energy: Principles and applications; Geothermal Energy in India; Ocean energy (tidal, wave, OTEC); Small Hydro Resources; Layout of a Micro-Hydro-scheme; Hydrogen energy and fuel cells (PAFC, AFC, Hydrogen-Oxygen); Smart grids and microgrids; Hybrid renewable energy systems; Electric vehicles and renewable integration; Challenges of renewables; Renewable energy policies in India; National Solar Mission and other schemes (Solar Roof top etc.); Renewable energy in rural development.

Practicals:

1. Study of Solar panel and evaluate its parameters under NO LOAD and LOAD conditions.
2. Study the charging of batteries using Solar panel and evaluate its parameters.
3. Study the charging of batteries using inverter in absence of solar light and evaluate its parameters.
4. Study the switching action of charging of batteries from solar to inverter and evaluate its parameters.
5. Study the discharging of batteries using inverter on load with and without mains and evaluate its parameters.
6. Determine efficiency of a Solar panel.
7. Study working and efficiency of Flat Plate Solar Collector
8. Evaluate performance of box-type solar cooker.
9. Estimate DNI using basic measurements.
10. Study Wind Direction and Speed at a given location.
11. Study relation between wind speed and power.
12. Study classification of Wind Speed using Beaufort Scale
13. Study variation of wind speed with height.
14. Determine the moisture content of given sample of biomass.
15. Determine the Calorific Value of given sample biomass.
16. Determine the coefficient of thermal conductivity of rock/soil.
17. Make field study for wind energy potential estimation at a site.
18. Make field visit to a site of wind energy harvesting installation/wind energy potential site.
19. Make field visit to a Solar Energy farm/ Solar Energy harvesting site.
20. Make field visit to a Small Hydro Resource harvesting site and study layout of a Micro-Hydro-scheme.



21. Make field visit to a Biogas production plant.

Reference Books:

1. Non-Conventional Energy Sources: B H Khan; McGraw Hill Education (India) Private Ltd., Chennai.
2. Non-Conventional Energy Sources: G D Rai; Khanna Publishers, New Delhi.
3. Solar Energy: S P Sukhatme and J K Nayak; McGraw Hill Education (India) Private Ltd., Chennai.
4. Handbook of Solar Energy-- Theory, Analysis and Applications: G.N. Tiwari, Arvind Tiwari and Shyam; Springer Nature, Singapore.
5. Wind Energy Explained--Theory, Design and Application: J. F. Manwell and J. G. McGowan; John Wiley & Sons Ltd.
6. Non-Conventional Energy Resources: N K Bansal, Vikas Publishig House.
7. Renewable Energy Resources: John Twidell, Tony Weir; Taylor & Francis.
8. Renewable Energy: Powering a Sustainable Future: Godfrey Boyle; Oxford University Press.
9. Bioenergy: Biomass to Biofuels: Anju Dahiya; Academic Press (Elsevier)
10. Biomass for Renewable Energy, Fuels, and Chemicals: Donald L. Klass; Academic Press
11. Introduction to Biomass Energy Conversions: S.V.V.S. Murthy, G. Naidu: TERI Press
12. Biomass Gasification and Pyrolysis: Prabir Basu; Academic Press
13. Geothermal Energy- An Alternative Resource for the 21st Century: Haraldur Sigurdsson; Springer
14. Marine Renewable Energy Technology and Environmental Interactions: Shengtao Li; CRC Press
15. Tidal Energy Systems: Design, Optimization and Control: Vikas Khare; Academic Press

