MINOR COURSE- MN 2C	Renewable Energy and Energy Harvesting	(Theory Credit -03) (Total Marks=60+15)

Course Objective:

1. **To introduce the students** to the concepts of conventional and non-conventional energy sources, focusing on the need for renewable energy in the current energy landscape.
2. **To provide an understanding** of the different renewable energy sources such as solar, wind, ocean, geothermal, hydro, and biomass, with a focus on their working principles, technologies, and applications.
3. **To explore energy harvesting technologies** that enable efficient collection and storage of energy from natural sources, including piezoelectric, electromagnetic, and other innovative techniques.
4. **To develop critical understanding** of the environmental and social impacts of renewable energy systems and the importance of sustainability in energy harvesting.
5. **To equip students with knowledge** of the design and operation of energy systems such as solar photovoltaic systems, wind turbines, ocean energy devices, and hydroelectric power generation.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. **Understand the limitations of fossil fuels** and nuclear energy and appreciate the importance of renewable energy for sustainable development.
2. **Explain the working principles and technologies** behind different renewable energy systems, including solar, wind, tidal, geothermal, and biomass energy.
3. **Design and analyze basic renewable energy systems** such as solar water heaters, photovoltaic cells, wind turbines, and hydroelectric power plants.
4. **Analyze and compare energy harvesting methods** such as piezoelectric energy generation, electromagnetic energy harvesting, and bio-mass conversion systems.
5. **Evaluate the environmental impact** of different energy harvesting techniques and apply sustainability concepts in the design and implementation of energy systems.
6. **Understand the integration of renewable energy** into the grid, including challenges and solutions related to energy storage, power electronics, and interconnection topologies.
7. **Critically assess current trends** and future directions in renewable energy, including offshore wind energy, ocean thermal energy, and innovative energy harvesting solutions.

Course Contents:

Fossil fuels and Alternate Sources of energy (08 HRS): Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy, Conversion, solar energy, biomass, biochemical conversion, bio gas generation, geothermal energy tidal energy, Hydroelectricity.

Solar energy (08 HRS): Solar energy, its importance, storage of solar energy, solar pond, nonconvective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting (04 HRS): Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy (04 HRS): Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics (04 HRS): Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy (02 HRS): Geothermal Resources, Geothermal Technologies.

Hydro Energy (03 HRS): Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting (07 HRS): Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric Energy harvesting applications, Human power.

Electromagnetic Energy Harvesting (05 HRS): Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford
5. University Press, in association with The Open University.
6. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009

MINOR COURSE- MN 2C	Renewable Energy and Energy Harvesting	(Practical Credit -01) (Total Marks=25)

1. Demonstration of Training modules on solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.
4. Performance testing of solar cooker.
5. Measurement of I-V characteristics of solar cell.
6. Study the effect of input light intensity on the performance of solar cell,
7. Study the characteristics of wind.
8. Study charge and discharge characteristics of storage battery.
9. Performance estimation of fuel cell.