MARWADI UNIVERSITY
MASTER OF TECHNOLOGY
DEPARTMENT OF ELECTRICAL ENGINEERING

Subject Code: 01OE9002
Subject Name: Sustainable Energy

Objective: The course introduces various sustainable energy sources including solar, wind and biomass energy as a potential source of energy for present and future needs.

Credits Earned: 3 Credits

Course Outcomes: After completion of this course, student will be able to

- **CO1 - Differentiate** among various types of energy sources. (Analyze)
- **CO2 - Identify** challenges and strength of various energy conversion technologies (Evaluate)
- **CO3 – Analyse** solar and wind energy technologies from system perspective. (Apply)
- **CO4 - Understand** various methods to generate energy from biomass and other renewable resources (Understand)
- **CO5 - Articulate** various challenges associated with the use of renewable energy sources. (Understand)

Pre-requisite of course: Basic Electrical Engineering, Physics

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	Mid Sem (M)	Internal (I)	Viva (V)	Term work (TW)	
3	0	0	3	50	30	20	0	0	100

Contents:

Unit	Topics	Contact Hours
1	**Introduction to Sustainable energy** Introduction; sustainability principle, classification of energy resources, factors affecting energy resource development, environmental aspects of energy, Needs of renewable energy, advantages and limitations of renewable energy, energy strategy for the future, scenario in India.	7
2	**Solar Energy and Thermal applications** Energy available from the sun, spectral distribution, solar radiation outside the earth's atmosphere and at the earth's surface, Instruments for solar radiation measurements-pyranometer, pyrheliometer, sunshine recorder. measurement of solar radiation, solar energy conversion into heat, types of solar collectors, solar pumping, solar cooker, solar still, solar drier, solar refrigeration and air conditioning, solar pond.	8

3	**Solar Photovoltaic System** Introduction, solar cell fundamentals, photovoltaic effect, solar cell, module, panel and array, solar cell characteristics and equivalent circuit, classification and types of solar cell, series and parallel arrays, solar PV system: standalone, grid connected & hybrid, Solar Water Pumps, Solar street lights.	**10**
4	**Wind Energy** Energy available from wind, basics of lift and drag, basics of wind energy conversion system, effect of density, angle of attack and wind speed, types of wind mill: horizontal and vertical axes rotors, drag, lift, torque, and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance curves, wind energy potential, and site selection, basics of wind farm, Safety and environmental aspects, wind energy potential and installation in India.	**12**
5	**Bio Energy** Introduction, energy plantation, biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants & their comparisons, types of biogas plants.	**5**
	Total Hours	42

References:

1. G.S. SAWHNEY, “Non-Conventional Energy Resources”, Prentice Hall of India, 2012.
2. Shobh Nath Singh, “Non-Conventional Energy Resources”, Pearson Education India, 2016.
3. B. H. Khan, “Non-Conventional Energy Resources”, McGraw Hill Education (India), 2017.
4. John Twidell and Tony Weir, " Renewable Energy Resources ", Routledge, 2006.
5. Jefferson W. Tester, " Sustainable Energy Choosing Among Options ", The MIT Press, Cambridge, England, 2012.
6. Gilbert M. Masters , “Renewable and Efficient Electric Power Systems”, 2d edition, Wiley, 2004.
7. B.K.Hodge , “Alternative Energy Systems & Applications”, Wiley, 2010.
8. J.C.Sabonnadiere, “Renewable Energy Technologies”, Wiley, 2009.
9. Twidell& Weir, "Renewable Energy Sources", CRC Press.
10. S.P. Sukhatme, Solar Energy", Tata McGraw-Hill.
11. K M. Mittal, "Non Conventional Energy Systems", A H Wheeler Publishing Co Ltd.
12. Ramesh & Kumar, "Renewable Energy Technologies", Narosa publication.

Suggested Theory distribution:

The suggested theory distribution as per Bloom’s taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process:

Distribution of Theory for course delivery and evaluation					
Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
20%	30%	25%	15%	10%	0%