Semester: I/II			
Course Title	Renewable Energy Sources	**CIE Marks**	50
Course Code	BMEETC105 / 205E	**SEE Marks**	50
Course Type	Theory	**Total Marks**	100
Course Category	ETC	**SEE Duration**	03 hrs
Hours Per Week	3L : 0T : 0P	**SEE Type**	Written
Total Hours	40 hrs	**Credits**	03

Course Learning Objectives
This course will enable the students to
• Understand energy scenario, energy sources and their utilization.
• Explore society's present needs and future energy demands.
• Study the principles of renewable energy conversion systems.
• Exposed to energy conservation methods.
• Acquiring a basic insight into future mobility and automation.
Pre-Requisites
• Foundational understanding of different types of non-conventional energy resources
• Significance of the Power Generation System.

Module-1: Introduction Renewable Energy Source	**(8 hrs)**
Introduction: Principles of renewable energy; energy and sustainable development, fundamentals and social implications. Worldwide renewable energy availability, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy. **Self-Study Component:** Worldwide renewable energy availability.	
Module-2: Solar Energy	**(8 hrs)**
Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer. Solar Thermal systems: Flat plate collector; Solar distillation; Solar Pond electric power plant. **Solar electric power generation**- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system. (No Numerical) **Self-Study Component:** Applications of solar photovoltaic system	
Module-3 : Wind Energy	**(8 hrs)**
Wind Energy: Properties of wind, wind velocity and power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multi-blade system. Vertical axis system, Simple Numericals. **Biomass Energy:** Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass gasification**.** **Self-Study Component:** Urban waste to energy conversion	
Module-4: Tidal Power	**(8 hrs)**
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations. **Ocean Thermal Energy Conversion:** Principle of working, OTEC power stations in the world, problems associated with OTEC. **Self-Study Component:** Mechanism of harnessing tidal energy and OTEC power.	

Module-5: Green Energy	(8 hrs)
Green Energy: Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy**.** **Self-Study Component:** Mechanism of hydrogen production technologies.	
Text Books:	
1.	"Nonconventional Energy sources", G D Rai, Khanna Publication, Fourth Edition,
2.	"Energy Technology", S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solar energy, Subhas P Sukhatme, Tata McGraw Hill, 2nd Edition,1996.
Reference Books:	
1.	"Principles of Energy conversion", A. W. Culp Jr.,, McGraw Hill, 1996
2.	"Non-Convention Energy Resources", Shobh Nath Singh, Pearson, 2018
3.	"A Text book of Power System Engineering", A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, Dhanpat Rai Publication.
4.	"Renewable Energy Technologies", Solanki, Chetan S. , PHI Learning, New Delhi, 2011
5.	"Wind Power Technology, Earnes"t, Joshua, PHI Learning, New Delhi, 2013
6.	"Renewable Energy Sources for Sustainable Development", N.S. Rathore and N. L. Panwar, New India Publishing Agency, New Delhi
7.	"Wind Power in Power System", Thomas Ackermann, John Willey &Sons, 2005

Course Outcome Statements: After the successful completion of the course, the student will be able to	
CO1	Describe the Environmental Aspects of Renewable Energy Resources, their Prospects and Limitations in comparison with Conventional Energy Systems
CO2	Apply the fundamental of solar energy and solar collectors used in the energy conversion and power generation.
CO3	Evaluate the conversion mechanisms of wind, tidal, biomass, and green energy sources.
CO4	Acquire the foundational knowledge of ocean thermal energy conversion and hydrogen energy.
CO5	Conduct survey, collect data, and prepare a prototype model for a renewable energy source.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	-	-	1	3	2	-	-	-	-
CO2	3	3	1	3	1	2	2	1	-	-	1	1
CO3	3	3	1	2	1	1	1	1	-	-	-	-
CO4	1	2	-	1	-	2	2	-	-	-	1	2
CO5	-	-	-	-	-	-	1	1	2	2	1	3
Avg.	**2**	**2.5**	**1**	**2**	**1**	**1.5**	**1.8**	**1.25**	**2**	**2**	**1**	**2**

3: High, 2: Medium, 1: Low

Suggested Activity Based Assessment (ABA) Methods

- **Model Building:** Students can construct working models or prototypes of renewable energy systems such as solar panels, wind turbines, or hydroelectric generators. This hands-on approach allows them to understand the principles behind renewable energy technologies.
- **Field Trips:** Organize visits to renewable energy facilities like solar farms, wind farms, or hydroelectric plants. Students can observe the practical implementation of renewable energy systems and interact with professionals working in the field.
- **Data Analysis Projects:** Assign students tasks that involve collecting and analysing data related to renewable energy production, consumption and trends. They can use tools like spreadsheets or data visualization software to interpret the information and draw conclusions.