Approval: 9th Senate Meeting

Course Number: EN-502
Course Name: Emerging Energy Sources
Credits: 3-0-0-3
Prerequisites: Instructor's consent
Intended for: UG/PG
Distribution: Compulsory foundation course for M.Tech. (Energy Engineering) and elective for other students
Semester: Odd/Even
Preamble: The world's energy demand is growing exponentially with population and refining standards of living. Hence, the global energy demand will rise by 30% in 2040 compared to 2010. It is presumed with this consumption rate that the world will run out of conventional sources of energy within this century. Therefore there is huge need to utilize clean energy sources such as solar, wind, biomass, and ocean. This course intends to provide and overview, prospects and present status of emerging clean energy sources. This course will contribute to a comprehensive understanding of energy conversion techniques, review energy sources for established power plants, advantages and limitations of different non-conventional power plants.

Course Outline: The objective of the course is to introduce the students of different engineering backgrounds to fundamental system working, performance, emissions, economics, and challenges related with non-conventional energy sources.

Course Modules:

Module 1: Introduction -Different types of emerging energy sources, potential and installed capacities of these new generation energy sources, Conversion technologies for different primary energy sources, sustainability benefits, and challenges related with reliability, policy dependence, socio-economic advantages and disadvantages **(6 L)**

Module 2: Biomass Energy - Organic matters available on renewable basis like forests, agricultural, mill and industrial wastes etc., direct fired plants, co fired power plants, gasification, fixed bed gasifiers, small version of gasification or directly fired plants for modular bio power **(8L)**

Module 3: Wind power -Wind energy availability and basic working principle of wind turbines, wind turbine- rotor blades, tower, nacelle house- electrical generator, power control and other mechanical equipment, resource assessment overview, modern wind turbines, installations and wind farms, advantages and limitations of wind farms **(8L)**

Module 4: Solar power–potential of solar energy reaching earth surface, collecting sunlight, solar photovoltaic and solar thermal techniques, solar cell efficiencies and theoretical limits, solar power plants, future challenges **(8L**)

Module 5: Ocean Energy –Availability in Indian context, Ocean Thermal Energy Conversion, wave energy conversion, Tidal power basic conversion principle, and challenges related with

material corrosion, intermittent primary energy supply, sustainability assessment and improvement. (**4L)**

Module 6: Hybrid renewable systems **(2L)**

Module 7: Fuel cell - Proton exchange membrane, PEM chemical reactions, alkaline fuel cells, molten carbonate fuel cell their working reactions and advantages, solid oxide fuel cells- their working reactions and advantages **(6L)**

Text Books:

1. K. R. Rao - Energy and Power Generation Handbook: Established and Emerging Technologies, American Society of Mechanical Engineers, U.S. (2011)

2. Aldo V.da Rosa, Fundamental of Renewable Energy Processes, Elsevier Press(2009)

3. Jahangir Hossain, Mahmud Apel, Large Scale Renewable Power Generation: Advances in Technologies for Generation, Transmission and Storage (Green Energy and Technology), Springer; (2014)

4. Y. Goswami, Principles of Solar Engineering, CRC Press, 2013.

5. R. Ehrlich, Renewable Energy: A First Course, CRC Press, 2013.

6. D. Spera, Wind Turbine Technology, ASME, 2009.

7. S. Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer, 2006.

8. D. A. J. Rand and R. M. Dell, Hydrogen Energy: Challenges and Prospects, RSC Publishing, 2008.