COURSE CODE	COURSE TITLE	L	T	P	C
1152AE150	APPLIED UNCONVENTIONAL ENERGY ENGINEERING	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This course introduces the various unconventional energy sources and its applications in the field of aeronautical engineering.

b. Prerequisite Courses:

Nil

c. Related Courses:

Project work

d. Course Educational Objectives :

- To explain concept of various forms of conventional and unconventional energy.
- To apply the energy derived from the unconventional sources to engineering.

e. Course Outcomes :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the conventional energy sources and the need for unconventional energy.	K2
CO2	Explain various aspects of unconventional energy sources for engineering applications.	K2
CO3	Describe the construction and working principle of solar energy systems.	K2
CO4	Explain various biomass energy conversion technologies and its applications.	K2
CO5	Explain various hydrogen generation/storage technologies and various fuel cells.	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	**L**	**H**			**M**	**H**					M
CO2	L	**L**	**H**			**M**	**H**					M
CO3	L	**L**	**H**			**M**	**H**					M
CO4	L	**L**	**H**			**M**	**H**					M
CO5	L	**L**	**H**			**M**	**H**					M

H- High; M-Medium; L-Low

g. Course Content :

UNIT I CONVENTIONAL ENERGY **L-9**

Conventional energy resources - Coal, Oil, Natural gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – need for unconventional energy.

UNIT II UNCONVENTIONAL ENERGY L-9

Solar energy – wind energy – bio-energy – hydrogen and fuel cells - ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plant - ocean wave energy conversion - tidal energy conversion – small hydro - geothermal energy - geothermal power plant – construction and applications.

UNIT III SOLAR ENERGY L-9

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – list of solar thermal applications –principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications:– solar powered aircraft: selection of battery and size of collector for UAV - electric Aircraft.

UNIT IV BIO-ENERGY L-9

Biomass resources and their classification - Biomass conversion processes – biomass gasification - pyrolysis and liquefaction - anaerobic digestion - types of biogas plant - applications – bio diesel production – Urban waste to energy conversion – Aviation biofuel - Aircrafts with biofuel and bio-gas, storage of gaseous fuels.

UNIT V HYDROGEN AND FUEL CELLS L-9

Hydrogen – physical and chemical properties - Production of hydrogen. Hydrogen storage options. Safety and management of hydrogen - Fuel Cell - History – principle - working – performance evaluation of fuel cell – comparison on battery Vs fuel cell - applications of Hydrogen and Fuel cells - Hydrogen powered aircraft – Fuel cell powered aircraft.

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Total: 45 Periods

h. Learning Resources

References:

1. Anthony San Pietro, "Biochemical and Photosynthetic aspects of Energy Production", Academic Press, 1980.
2. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK 2005.
4. Bent Sorensen , "Renewable Energy", Elsevier, Academic Press, 2011.
5. Bridgurater A.V., "Thermochemical processing of Biomass", Academic Press, 1981.
6. Godfrey Boyle, "Renewable Energy Power for a Sustainable Future", Oxford University Press, U.K, 1996.
7. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
8. Kishore V.V.N., "Renewable Energy Engineering and Technology", Teri Press, New Delhi, 2012.
9. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996.
10. Kreith F. and Kreider J.F., "Principles of Solar Engineering", McGraw-Hill, 1978.
11. Peter Gevorkian, "Sustainable Energy Systems Engineering," McGraw Hill, 2007.
12. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
13. Sukhatme S.P., "Solar Energy", Tata McGraw Hill, 1984.

14. Twidell J.W. and Weir A., “Renewable Energy Sources”, EFN Spon Ltd., 1986.
15. Veziroglu T.N., Alternative Energy Sources”, Vol 5 and 6, McGraw-Hill, 1990.