22MEHO105	ADVANCED ENERGY STORAGE TECHNOLOGIES				
	CATEGORY	L	T	P	C
	BS	3	0	0	3

COURSE OBJECTIVES

1	To understand the various types of energy storage technologies and its applications
2	To study the various modeling techniques of energy storage systems using TRNSYS
3	To learn the concepts and types of batteries
4	To make the students to get understand the concepts of Hydrogen and Biogas storage
5	To provide the insights on Flywheel and compressed energy storage systems

UNIT I	INTRODUCTION	9	0	0	9

Necessity of energy storage–types of energy storage–comparison of energy storage technologies–Applications

UNIT II	THERMAL STORAGE SYSTEM	9	0	0	9

Thermal storage–Types–Modelling of thermal storage units–Simple water and rock bed storage system– pressurized water storage system–Modelling of phase change storage system–Simple units, packed bed storage units

UNIT III	ELECTRICAL ENERGY STORAGE	9	0	0	9

Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries–Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and Lithium Battery

UNIT IV	HYDROGEN AND BIOGAS STORAGE	9	0	0	9

Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides ,chemical Storage, Bio gas storage- comparisons. Safety and management of hydrogen and Bio gas storage- Applications

UNIT V	ALTERNATE ENERGY STORAGE TECHNOLOGIES	9	0	0	9

Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage –Applications

TOTAL(45L) : 45 PERIODS

REFERENCE BOOKS:

1	Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, JohnWiley&Sons2002
2	James Larminieand Andrew Dicks, Fuelcell systems Explained, Wiley publications, 2003
3	Luisa F. Cabeza, Advances in Thermal Energy Storage Systems: Methods and Applications,ElsevierWoodheadPublishing,2015
4	Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2ndedition, Springer,2015
5	Ru-shiliu, Leizhang, Xueliangsun, electrochemical technologies for energy storage and conversion,Wileypublications,2012

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom Taxonomy Mapped**
CO1	Identify the energy storage technologies for suitable applications	Analyze
CO2	Analyze the energy storage systems	Analyze
CO3	Recognize the concepts and types of batteries	Understand
CO4	Diagnose the principle of operations of Hydrogen and Bio gas storage	Understand
CO5	Analyze the concepts of Flywheel and compressed energy storage systems	Analyze

COURSE ARTICULATION MATRIX

COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	0	0	1	1	0	1	0	0	0	0	3	1	1
CO2	2	3	1	1	1	0	1	0	1	0	0	0	0	0	3
CO3	3	2	0	1	0	0	1	1	0	0	1	0	3	0	0
CO4	3	1	2	1	1	2	1	0	0	2	0	0	1	1	0
CO5	2	3	1	1	0	0	0	0	1	0	0	0	0	1	1
Avg	**2.6**	**2.2**	**0.8**	**0.8**	**0.6**	**0.6**	**0.6**	**0.4**	**0.4**	**0.4**	**0.2**	**0.0**	**1.4**	**0.6**	**1**

3/2/1 – indicates strength of correlation (3 – high, 2- medium, 1- low)