HYDROGEN AND FUEL CELL TECHNOLOGY

Course Code		Year	IV	Semester	I
Course Category	Professional Elective-V	Branch	Mechanical	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	NIL
Continuous Internal Evaluation:	30	Semester End Evaluation:	70	Total Marks:	100

Course Outcomes		
Upon successful completion of the course, the student will be able to		Blooms Level
CO1	Understand the properties of hydrogen as a fuel and describe the infrastructure requirements for its production, storage, and utilization.	L2
CO2	Analyze various hydrogen production methods including thermal, electrochemical, and biological processes.	L3
CO3	Evaluate different hydrogen storage technologies such as compressed, cryogenic, and solid-state systems with their respective merits and challenges.	L3
CO4	Examine the applications of hydrogen in IC engines, power generation, domestic usage, and hybrid fuel systems.	L3
CO5	Understand the working principles, types, performance, and applications of various fuel cells and distinguish them from conventional batteries.	L3

Strength of Correlation between CO – PO , CO- PSO in scale of 1-3- Course Articulation Matrix

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	-	2	2	-	-	-	-	3	2
CO2	3	3	2	3	-	2	2	-	-	-	-	3	2
CO3	3	3	2	3	-	2	2	-	-	-	-	3	2
CO4	3	3	2	3	-	2	2	-	-	-	-	3	2
CO5	3	3	2	3	-	2	2	-	-	-	-	3	2

SYLLABUS		
Unit No.	**Contents**	**Mapped CO**
I	**INTRODUCTION OF HYDROGEN ENERGY SYSTEMS:** Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production, storage, dispensing, utilization, safety and hydrogen production plants.	**CO1**
II	**HYDROGEN PRODUCTION PROCESSES**: Thermal-Steam reformation, thermo chemical water splitting, gasification-pyrolysis, nuclear thermal catalytic and partial oxidation methods, Electrochemical-Electrolysis, photo electro chemical, Biological-Anaerobic digestion, fermentation micro organism, PM based electrolyser.	**CO1, CO2**
III	**HYDROGEN STORAGE**: Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, carbon based materials for hydrogen storage.	**CO1, CO3**
IV	**HYDROGEN UTILIZATION:** Overview of hydrogen utilization, IC Engines, gas turbines, hydrogen burners, power plant, domestic cooking gas, marine applications, hydrogen dual fuel engines.	**CO1, CO4**
V	**FUEL CELLS**: History – principle - working - thermodynamics and kinetics of fuel cell process –performance evaluation of fuel cell – comparison on battery Vs fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, microbial fuel cells, relative merits and demerits and application of fuel cells.	**CO1, CO5**

Learning Recourses

Text Books:

1. Sorenson B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005).
2. Hordeski MF, Hydrogen and Fuel Cells: Advances in Transportation and Power, The Fairmont Press, Inc. (2009)
3. Busby RL, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Books (2005).

References:

1. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation,
3. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
4. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA 2002.
5. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.