ME422 Fuel Cell										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: The key objective of this course is to acquaint the students with electrochemical energy, electrode kinetics and solid oxide fuel cells.

Syllabus		**Contact Hours**
Unit-1	**Introduction and Thermodynamics:** **Introduction:** Basic Operating Principles – Historical Highlights – Classification. **Thermodynamics:** Electrochemical Energy Conversion – Theoretical Efficiency – Electrochemical Energy Conversion – Factors Affecting Electrochemical Energy Conversion	**6**
Unit-2	**Electrode Kinetics:** Electrode Double Layer – Electrolyte Double Layer – Double Layer Models (Helmoltz Model, Gouy-Chapman Model, Stern Model, Grahame Model – Bockris, Devenathan and Muller Model, and Chemical Models)– Solid Metallic Electrode – Semiconductor Electrode –Specific Adsorption – Zero Potential	6
Unit-3	**Alkaline Fuel Cells & Phosphoric Acid Fuel Cells:** **Alkaline Fuel Cells:** Working Principle – Components – Modules and Stacks – Performance Characteristics (Power Density, Space Applications, Atmospheric Pressure Cells) – Limitations and R&D Challenges – System Issues – Ammonia as Fuel. **Phosphoric Acid Fuel Cells:** Cell Reactions – Electrodes (Stability of Catalysts, Electrode Fabrication – Fuel Cell Performance) – Stacks and Systems	8
Unit-4	**Solid Oxide Fuel Cells & Molten Carbonate Fuel Cells:** **Solid Oxide Fuel Cell:** Principle of Operation – Benefit sand Limitations – Cell Components (Electrolytes, Zirconia Systems, Ceria Based Electrolytes, Perovskite-Based Systems)– Cathode Materials – Anode Materials Interconnects –Fuel Reactions –Configurations and Performance Tubular, Monolithic, Planar) – Environmental Impact –Applications. **Molten Carbonate Fuel Cell:** General Principle – Components (Electrolyte and Matrix, Cathode and Anode Materials) – Electrode Reactions – Life Time	8
Unit-5	**Direct Methanol Fuel Cells & Proton Exchange Membrane Fuel Cells:** **Direct Methanol Fuel Cells:** Operating Principle– Noble Metal Issue – Electro-Oxidation of Methanol (Catalysts, Oxygen Electro-Reduction, Electrolyte, Non-Catalytic Aspects) - Methanol Crossover – Catalyst Optimization – Vapour Feed Versus Liquid Feed Cells. .	**8**
Unit-6	**Proton Exchange Membrane Fuel Cells:** Operating Principle (Membranes, Electrodes and Electrolysis, Optimization of Membrane and Electrode Assembly Impurities) – Technology Development (Single Cell and Stacks, Composite Plates) – Fuel Processing – Modeling Studies (Membrane, Electrode, Membrane-Electrode Assembly, Fuel Cell, Stack and System) – Technology Development and Applications	6
	Total	**42**

Reference Book:	
1	Viswanathan, B. and AuliceScibioh, M., Fuel Cells Principles and Applications, Universities Press (India) Pvt. Ltd., Hyderabad, 2006, ISBN:9781420060287 02871420060287
2	Hoogers, G., Edr., Fuel Cell Technology Handbook, Crc Press, Washington D. C., 2003, ISBN:9780849308772

Course Outcomes

CO1	Understand and identify different routes for hydrogen production and its storage.
CO2	Apply fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer to design different components of fuel cells and fuel cell systems.
CO3	Analyze and simulate the performance of different type of fuel cells.
CO4	Estimate and calculate various losses in fuel cells and propose corrective measures to reduce it.
CO5	Classify materials for electrodes and testing of different cells
CO6	Demonstrate the processing of fuels for the fuel cell

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3