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Course Objectives:

- To make the student understand basic electrochemical principles such as standard electrode potentials, EMF and applications of electrochemical principles in the design of batteries.
- To understand the basic concepts of processing and limitations of fossil fuels and Fuel cells & their applications.
- To impart knowledge to the students about fundamental concepts of hydrogen storage in different materials and liquefaction method
- Necessity of harnessing alternate energy resources such as solar energy and its basic concepts.
- To understand and apply the basics of calculations related to material and energy flow in the processes.

UNIT – 1: Electrochemical Systems**9 Hrs**

Galvanic cell, standard electrode potential, application of EMF, Electrode mechanism, polarization, Batteries-Lead-acid and Lithium ion batteries.

Learning Outcomes:

At the end of this unit, the student will be able to

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| • Solve the problems based on electrode potential | L3 |
| • Describe the Galvanic Cell | L2 |
| • Differentiate between Lead acid and Lithium ion batteries | L2 |
| • Illustrate the electrical double layer | L2 |

UNIT – II: Fuel Cells

Basic design of fuel cell, Fuel cell working principle, Fuel cell efficiency Classification of fuel cells, Polymer electrolyte membrane (PEM) fuel cells, Solid-oxide fuel cells (SOFC), and their applications

Learning Outcomes:

At the end of this unit, the student will be able to

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| • Describe the working Principle of Fuel cell | L2 |
| • Explain the efficiency of the fuel cell | L2 |
| • Discuss about the Basic design of fuel cells | L3 |
| • Classify the fuel cell | L2 |

UNIT – III: Hydrogen Storage

Hydrogen Storage, Chemical and Physical methods of hydrogen storage, Hydrogen Storage in metal hydrides, metal organic frame works (MOF), Carbon structures (Carbon nano tubes, fullerenes), metal oxide porous structures, hydrogen storage by high pressure methods. Liquefaction method

Learning Outcomes:

At the end of this unit, the student will be able to

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| • Differentiate Chemical and Physical methods of hydrogen storage | L2 |
| • Discuss the metal organic frame work | L3 |
| • Illustrate the carbon and metal oxide porous structures | L2 |
| • Describe the liquification methods | L2 |

UNIT – IV: Solar Energy

Solar energy introduction and prospects, photovoltaic (PV) technology, concentrated solar power (CSP), Solar Fuels – Hydrogen: Ammonia & Hydrazine, Solar cells (Si-Te & Cd-Te), advantages and disadvantages.

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply the photo voltaic technology L3
- Demonstrate about solar energy and prospects L2
- Illustrate the Solar cells L2
- Discuss about concentrated solar power L3

UNIT – V: Photo and Photoelectrochemical Conversions

Photochemical cells and applications of photochemical reactions, specificity of photo electrochemical cell, advantage of photoelectron catalytic conversions.

Learning Outcomes:

At the end of this unit, the student will be able to

- Differentiate between Photo and Photo electrochemical Conversions L2
- Illustrate the photochemical cells L2
- Identify the applications of photochemical reactions L3
- Interpret advantages of photoelectron catalytic conversion L2

Text Books:

1. Bahl and Bahl and Tuli, Essentials of Physical Chemistry, S. Chand Publications, New Delhi, 28th Edition, 2020.
2. US Department of Energy (EG&G technical services and corporation), Fuel Cell Hand Book 7th Edition, 2004.

Reference Books:

1. Ira N. Levine, Physical chemistry 6th Edition, McGraw Hills Education, New Delhi, 2009.
2. Silver and Atkins, Inorganic Chemistry, , 7th Edition, Oxford University Press, 2018.
3. Michael Hirscher, Hand book of Hydrogen Storage: New materials for future energy, storage, Wiley-VCH Verlag GmbH & Co. KGaA, 2010
4. Klaus Jager et.al., Solar energy fundamental, technology and systems, UIT-Cambridge publishers, 2016

Course Outcomes:

At the end of this Course the student will be able to

- Understand to perform simultaneous material and energy balances L1
- Lists about various electrochemical and energy systems L1
- Classify solid, liquid and gaseous fuels L3
- Analyze the energy demand of world, nation and available resources to fulfill the demand L3
- Evaluate the conventional energy resources and their effective utilization L3
- To be able to understand and perform the various characterization techniques of fuels L1
- Explain knowledge of modern energy conversion technologies L2
- To be able to identify available nonconventional (renewable) energy resources and techniques to utilize them effectively L1