National University of Sciences and Technology

Course Description

Course Title	Course Code	Credit Hours
Hydrogen and Fuel Cell Engineering	ME-846	3 – 0

Textbook:

- M. M. Mench, “Fuel cell engines”, 2nd edition, John Wiley & Sons, 2008.

Reference Books:

- R. P. O'Hayre et. al., “Fuel cell fundamentals”, John Wiley & Sons, 2006.
- M. Ball, Wietschel, Martin, "The hydrogen economy opportunities and challenges”, Cambridge University Press, 2009

Course Objectives:

- Understand the physical foundations of fuel cells, operational principles of different fuel cell types and their practical applications as well as to the key areas of hydrogen technology at a level adequate for needs found in practical or academic environments.

Course Outline:

- Hydrogen: Global energy scenario, energy security, hydrogen as energy carrier, hydrogen economy, impact on environment, hydrogen properties, hydrogen safety and 27 WP No.57-66th ACM-1sep 2023 standards.
- Hydrogen production and storage: Hydrogen production technologies, Electrolysis, Reformers, Out-board and on-board fuel processing, renewable hydrogen production, hydrogen storage by compressed gas, cryogenic liquid, hydride storage, hydrogen delivery infrastructure.
- Fuel cell fundamentals: Principle, classification of fuel cells and their fuels, Faraday’s Laws, thermodynamics of fuel cell, Nernst equation, Efficiency of fuel cell. Fuel cell irreversibility’s: Fuel cell reaction kinetics, activation polarization, Ohmic losses, mass transport losses, Butler–Volmer Equation, Tafel Equation, polarization curve. Proton Exchange Membrane (PEM) fuel cell: Hydrogen PEM fuel cell, PEM fuel cell membrane, catalyst, electrodes and their materials, water and thermal management, flow field configurations and stack design. High temperature fuel cells: Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), and Solid Oxide Fuel Cell (SOFC). Fuel cell characterization: Electrochemical characterization techniques, Electrical analogues, fuel cell modelling strategies.

ASSESSMENTS

Description	Percentage Weightage (%)
Assignments	05-10%
Quizzes	10-15%
Mid Semester Exams	30-40%
End Semester Exam	40-50%