Course Title: Fuel Cell **(Elective Course)**
Course Code: ESE-814

Course Objectives: This course is intended to introduce students to the concepts of hydrogen economy, fuel cells, their types, and their application in stationary and portable devices. To highlight the advancements in the field of fuel cell science & technology specifically related to materials and the development of hybrid systems.

Course Outcomes:
On completion of the course, the students will be able to uunderstand the potential of hydrogen production from competitive sources and its use in a fuel cell to produce electric energy.
The student will become abreast of the fact that the fuel cell route is currently plagued with low energy intensity despite being promising, hence will generate the knowledge and spirit to resolve the underlying causes.

Detailed Contents:

Hydrogen as Fuel
Hydrogen as a Fuel, Different Hydrogen Production Methods, Hydrogen Storage

Fuel Cells
Fuel Cell Working Principle, Thermodynamics and Electrochemical principles, V-I Diagram, Components of Fuel Cells.

Types to Fuel Cells
Basis of Classification, Polymer Electrolyte Membrane (PEM), Direct Methanol Fuel Cells (DMFC), Alkaline Fuel Cells, Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells, Solid Oxide Fuel Cells (SOFC)

Materials in Fuel Cells and their advancements
Fuel Cell Materials, Electrolytes, Fuel Cell Electrodes, Substrates, Fuel Cell Stacks

Fuel Cells Applications
Fuel Cell Applications for Power, Fuel Cell Applications for Transportation. Fuel Cells for Stationary Devices, Fuel Cells for Portable devices

Fuel Cell Process Design
Operating and design variables
Examination of process flow diagrams
Theoretical and practical efficiencies: trade-off of heat and work
Rankine and Brayton cycles
SOFC - gas turbine combined cycle system
PEM system: material recycle and heat integration.

Fuel Cell Advancements
Micro Fuel Cells, Fuel cells usage in Submarine and Satellites

Text/Ref Books:

Ryan O'Hayre et al. Fuel Cell Fundamentals - Third Edition, John Wiley & Sons (2016)
Bengt Sunden. Hydrogen, Batteries and Fuel Cells – 1st Edition, Elsevier (2019)
Bent Sorensen & Giuseppe Spazzafumo, Hydrogen and Fuel Cells – 3rd Edition (2018)