

7 <sup>th</sup> Semester	RCH7D001	Fuel Cells Fundamentals	L-T-P 3-0-0	3Credits
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**Module-I****9 hrs**

Fuel cell definition, Fuel cells versus batteries, type of fuel cell, basic fuel cell operation, fuel cell performance, advantages and disadvantages of fuel cell, overview of fuel cell system, fuel cell stack, thermal management subsystem, fuel delivery and processing subsystem, hydrogen storage, generation and delivery.

**Module-II****7 hrs**

Working principle and application: Phosphoric acid fuel cell (PAFC), polymer electrolyte membrane fuel cell (PEMFC), alkaline fuel cell (AFC), molten carbon fuel cell (MCFC), solid-oxide fuel cell (SOFC), performance characterization of fuel cell system.

**Module-III****9 hrs**

Reaction kinetics in fuel cell: Electrode kinetics, electrochemical reaction, heterogeneous electrochemical process, current rate, current amount and current density, activation energy in current transfer reaction, net rate of reaction calculation, potential and rate: Butler-Volmer equation, how to improve kinetic performance, catalyst electrode design.

**Module-IV****7 hrs**

Transport in fuel cell system: Ion transport in an electrolyte, electron transport, gas-phase mass transport, diffusive transport in electrode, convective transport in flow structures.

**Module-IV****4 hrs**

Environmental impact: Life cycle assessment, emission, climate change, greenhouse effect.

**Books:**

1. Ohayre R.P., Cha Suk-Won, Colella W. G., Prinz F. B., "Fuel Cell Fundamentals", John Wiley & Sons, Inc.
2. Larminie J., Dicks A., Fuel Cell System Explained", John Wiley & Sons
3. Mench M. M., "Fuel Cell Engines", John Wiley & Sons, Inc.
4. Zhao, T.S.; Kreuer, K.D., "Advances in fuel cells", Elsevier, 2007.
5. Linden, D., "Handbook of Batteries and Fuel Cells", McGraw-Hill.

**Web Learning Resources:**

1. Fuel Cell Technology by Prof. S. Basu, Department of Chemical Engineering, IIT Delhi (<https://nptel.ac.in/courses/103/102/103102015/#>)