

**ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

No. Acd./120 /IAPC-95

Dated: December 16, 2020

Head, Department of Hydro & Renewable Energy

The IAPC in its 95th meeting held on 09.12.2020 and 11.12.2020 vide Item No. 95.2.5 considered the proposal of Department of Hydro and Renewable Energy to introduce new Institute Elective Course i.e., IAH-306: Hydrogen Energy and Fuel Cells for B.Tech. students.

The IAPC approved the proposal with minor modifications. Duly modified syllabus is attached as **Appendix-A**.


Assistant Registrar (Curriculum)

Encl: as above

Copy to (through e mail):-

1. All faculty
2. All Heads of Departments/ Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Channel I/ Academic webpage of iitr.ac.in

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Hydro and Renewable Energy

1. **Subject Code:** IAH-306 **Course Title:** Hydrogen Energy and Fuel Cells
2. **Contact Hours:** **L:** 3 **T:** 0 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 3 6. **Semester:** Both 7. **Subject Area:** OEC
8. **Pre-requisite:** Nil
9. **Objective:** To provide basic knowledge about hydrogen energy and its usage primarily in fuel cells.

10. Details of the Course

S.No.	Contents	Contact hours
1.	General introduction about energy demand, various renewable energy sources, India energy scenario, need for alternate fuels, trends in energy use patterns, energy and development linkage	3
2.	Hydrogen production process, Thermal- steam reformation, thermo-chemical, water splitting, gasification, pyrolysis, nuclear thermos catalytic and partial oxidation methods	4
3.	Electrochemical- Electrolysis, photo-electrochemical, Biological- anaerobic digestion, Dark fermentation and photo fermentation	5
4.	Hydrogen storage and distribution, general storage methods, compressed storage-composite cylinders, glass micro sphere storage- zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, distribution techniques	5
5.	Hydrogen utilization-fuel cells, Introduction, types of fuel cells, advantages and drawbacks, applications, integration with other renewable energy sources, Thermodynamics of fuel cells: Reversible cell potential, Effect of operating conditions on reversible cell potential, Energy conversion efficiency	8
6.	Electrochemistry of fuel cells: Electrode potential and cell polarization, Review of electrochemical kinetics, Activation kinetics, polarization for charge transfer reaction	6
7.	Fuel cell charge transport: voltage loss due to charge transport, charge transfer resistance, Mass transport: diffusive transport, convective transport	6
8.	Scale-up issues in fuel cells-contact resistance management, flow field design, case study	5
Total		42

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	S.A. Sherif, D. Yogi Goswami, Elias K. Stefanakos, Aldo Steinfeld, "Handbook of Hydrogen Energy", 1 st Edition, CRC press	2014
2.	Ryan O'Hayre, Suk-Won Cha, Whitney Colella, Fritz B. Prinz, "Fuel Cell Fundamentals", (3 rd edition), Wiley	2016
3.	Ashok Pandey, Jo-Shu Chang, Patrick Hallenbeck, Christian Larroche, "Biohydrogen", 1 st Edition, Elsevier	2013
4.	Ram B Gupta, "Hydrogen Fuel: Production, Transport, and Storage", 1 st Edition, CRC Press	2008
5.	Supramaniam Srinivasan, "Fuel Cells: From Fundamentals to Applications", 1 st Edition, Springer	2006
6.	Allen J. Bard, Larry R. Faulkner, "Electrochemical Methods: Fundamentals and Applications", 2 nd Edition, Wiley	2000