

Department of Sustainable Energy Engineering
Indian Institute of Technology Kanpur

Proposal for Revision of a Course

1. Course Number: SEE612
2. Course title: Electrochemical Energy Systems: Materials, Design, and Manufacturing
3. Per Week Lectures: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours[0-2]: 0 (A), Credits (3*L+2*T+P+A): 9. Duration of Course: Full Semester
4. Proposing Department/IDP: SEE
Other Departments/IDPs which may be interested in the proposed course: CHE, MSE, ME CHEM
Other faculty members interested in teaching the proposed course: Sudarshan Narayanan, Soumyabrata Roy, Raju Gupta
5. Proposing Instructor(s): Lalit Pant
6. Course Description:

A) Objectives: The objective of this course is to familiarize students with the engineering principles involved in designing, manufacturing, and deploying electrochemical energy systems. The course emphasizes materials processing, component and system design, manufacturing technologies, quality control, reliability, and sustainability, while highlighting the practical trade-offs that govern commercial electrochemical devices.

B) Contents:

	Topic	Detailed Contents	No. of Lectures
1	Introduction/ Overview	- Course overview. - Role and brief history of electrochemical energy systems	1
2	Electrochemistry overview	- Revision of Electrochemistry & electrochemical systems. - Basics of electrochemical cell and redox reactions - OCV, kinetics, transport, etc.	2
3	Basic manufacturing and processing methods	- Slurry/ink-based electrode manufacturing methods: slurry making, rheology, pre-processing (ball-mill/ultrasonication, etc.) - Coating methods: tape casting, doctor blade, slot-die, spray coating, other advanced methods - Post-processing, transfer, and assembly - Electrolyte polymer processing	5
4	Fuel cells and electrolyzers	- Introduction, operation, types - Basic overview, triple phase boundary, role of different layers - Polarization curve, losses, efficiency - Fuel, water, and heat management. System-level management - Manufacturing of PEMFC, AEMFC, and SOFC - Manufacturing of PEMWE, AEMWE, SOWE	10
5	Batteries	- Introduction, basic structure, capacity, MTSE, cycling - Primary and secondary batteries, Gibbs phase rule, phase diagrams. 2-phase and 3-phase systems	10

		• Example systems: Zn-carbon, alkaline batteries, Ni-MH, Lead-acid, etc. • Li batteries: Design and manufacturing • Emerging battery chemistries, design, and manufacturing	
6	Supercapacitors	• Introduction and working principle • Types, materials, and manufacturing	3
7	Other electrochemical systems and applications	• CO₂ reduction, photoelectrochemical, NRR • Electrochemical sensing systems	4
8	Material aspects for electrochemical systems	• Role of critical minerals. Short overview on availability, mining, extraction, refining, and recycling • Carbon and recycling regulations, mandates • Overview of electrochemical material design	4

C) Pre-requisites, if any: None

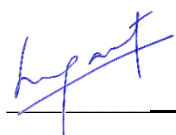
D) Short summary for inclusion in the Courses of Study Booklet:

This course provides an overview of electrochemical energy technologies, including batteries, fuel cells, electrolyzers, and supercapacitors, from a systems perspective. Emphasis is placed on materials selection, manufacturing processes, design considerations, and emerging technologies. Students gain familiarity with practical engineering aspects involved in developing electrochemical energy devices.

7. Recommended books:

- i. J. Bard and L. R. Faulkner, *Electrochemical methods: fundamentals and applications*, 2nd ed. New York: Wiley, 2001.
- ii. J. Newman and K. E. Thomas-Alyea, *Electrochemical Systems*, 3rd ed. New York, USA: Wiley, 2004.
- iii. R. O'Hayre, S. W. Cha, W. Colella, and F. B. Prinz, *Fuel Cell Fundamentals*, 3rd ed. New York, USA: Wiley, 2016.
- iv. R. Huggins. *Energy Storage*. 2nd ed. Springer International Publishing, 2016.

Dated: 02/07/2026

Proposer: 

Dated: _____ DUGC/DPGC Convener: _____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated: _____