SHARDA UNIVERSITY
Beyond Boundaries

NAAC A+ ACCREDITED

SHARDA SCHOOL OF
BASIC SCIENCES
& RESEARCH

COURSE

Rechargeable Battery Science and Technology (VAS105)

VALUE ADDED
COURSE BROCHURE-30 HRS
2022-23

ABOUT THE UNIVERSITY

Sharda University envisions to serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship. It has 14,000+ students from 95+ countries, 29 states, and Union Territories, providing cultural diversity and global exposure to students. It has 26000+ alumni who are today leaders in their realms. Sharda University is NAAC A+ University with Overall NIRF Rank of 87. Teaching Learning Center at Sharda University is to equip the faculty members with the expertise, skills and knowledge they need for capacity building of students. Teaching as a profession requires highly specialized skills and knowledge to impact significantly on student learning and therefore teachers must refine their conceptual and pedagogical skills.

ABOUT THE DEPARTMENT

The Department of Physics is dedicated to the development of global, multicultural, and multi-faceted scientists, teachers, administrators, and engineers capable of working across borders and boundaries.

Department of Physics, a department equipped with world-class labs, classrooms and eminent professors, offers four year B.Sc. (Hons./Hons. with research) programme in Physics, four-year B.Sc. (Hons. /Hons. with research) in Physics with minor in Computational Physics /Renewable Energy, two years M.Sc. programme in Physics, and an active Ph.D. programme in which a number of research students are currently enrolled.

The department has 19 faculty members who, apart from world class teaching, undertake cutting edge research on various active fields in physics eg: Nano Science, Solar cell technology, Actuators, Super capacitors, Ultrasonics, Cosmic rays, Photonics, Liquid crystals, and Multiferroics. It also has Physics laboratories of global standard to support teaching and research. Apart from regular engineering Physics labs, Nuclear physics lab, Optics lab, Electronics lab, and centre for Solar Cells and Renewable Energy (CSRE) are also essential part of the teaching learning/research.

World level Centre for Solar cells and Renewable Energy (CSRE) is a common platform for providing hands on training on synthesis, characterization and application of nanomaterials. CSRE is equipped with most important characterization tools like impedance spectroscopy, Keithley source major unit, FTIR, UV/Vis absorption spectroscopy. Using materials (stated above) and specialized equipments we are able to develop electrochemical devices like Solar Cells- Dye sensitized solar cell (DSSC), Perovskite solar cell (PSC), Quantum dot sensitized solar cell (QDSSC), Super Capacitors, Electrochemical Double Layer Capacitor (EDLC), Sensors, Fuel Cells.

ABOUT COURSE

Course: Rechargeable Battery Science and Technology

Overview of various battery types: Lead acid batteries, Ni-Cd, Ni-MH, Li-ion batteries, Li-air batteries, conventional and all-solid-state lithium-ion batteries; fundamental ideas and definitions of rechargeable batteries; components (materials aspect) of batteries: electrodes, separators, binder, electrolyte, additives, ion insertion/de-insertion, electrode-electrolyte interphase formation, degradation, thermodynamics and kinetics and other interfacial phenomena of electrochemical cell; methods of characterising batteries, such as charge/discharge cycles, overpotential, battery capacity, state of health, impedance, rechargeable (Li-ion) battery development and safety concerns (thermal runaway, short-circuiting, fire/explosion hazard); battery requirements and design considerations

RESOURCE PERSON

Dr. Shalu

Education:
Dr. Shalu has completed a B.Sc. and M.Sc. in Physics from the University of Delhi, followed by a doctorate degree from Banaras Hindu University. Dr. Shalu has completed two postdoctoral fellowships: the D.S. Kothari postdoctoral fellowship from the University of Delhi and the National Postdoctoral Fellowship from the National Physical Laboratory, New Delhi. Her Ph.D and postdoctoral research focused on studying new electrolyte materials and electrode systems to improve the efficiency and effectiveness of rechargeable batteries.

Dr. Shalu has made important advancements in the field of rechargeable batteries throughout her academic career. She has produced 28 research papers (the majority in Q1 journals) and 2 book chapters in reputable scientific journals, showcasing her skills in fields like battery design, materials characterization, electrochemical analysis, and performance optimisation. She has an h-index of 19 and total citations of 1389.

School: SSBSR **Programme: M.Sc (PG).** **Branch: Physics**	**Batch : 2022 - 2023** **Current Academic Year: 2024-2025** **Semester :**

1. Course Code	VAS103	
2. Course Title	Rechargeable Battery Science and Technology	
3. Credits		
4. Contact Hours (L-T-P)	30 Hours	
Course Type	Value added course	
5. Course Objective	The course "Rechargeable Battery Science and Technology" aims to provide a comprehensive understanding of the principles, materials, and technologies underpinning rechargeable battery systems. Students will explore the chemistry, physics, and engineering aspects of various battery types, learn about the latest advancements in battery technology, and analyze performance metrics, safety issues, and environmental impacts. The course is designed to equip students with the knowledge and skills necessary to contribute to the development of innovative battery solutions and sustainable energy storage applications.	
6. Course Outcomes	The student will be able to CO1: Gain the knowledge of different battery types and the composition of their constituent parts. CO2: Understand the fundamentals of battery material kinetics and thermodynamics. CO3: Apply the method to characterize the battery CO4: Hand on experience of operation of some of these instruments related to material fabrication and characterization of battery related materials CO5: Analyze the rechargeable battery development (Li-ion battery), safety issues and design	
7. Course Description	"Rechargeable Battery Science and Technology" is a comprehensive course designed to explore the principles, materials, and technologies underpinning modern rechargeable batteries. Through a blend of theoretical foundations and practical applications, students will delve into the chemistry, design, and engineering of lithium-ion, lead-acid, nickel-metal hydride, and emerging battery technologies. The curriculum emphasizes advancements in battery performance, safety, and sustainability, preparing participants for innovation in energy storage solutions.	
8. Outline syllabus		CO Mapping
Unit 1	**Overview of different batteries:**	
A	Types of Rechargeable Batteries: Exploring Li-ion, NiMH, and Lead-Acid Variants	CO1
B	Single-Use Batteries Unveiled: Alkaline and Lithium Comparisons	
C	Emerging Battery Technologies: From Solid-State to Flow Batteries	
Unit 2	**Basic Concepts, Fundamental and Definitions**	CO2,CO3 CO4,CO5
A	Introduction to Rechargeable Batteries	
B	Fundamental Principles of Rechargeability	
C	Key Definitions in Rechargeable Battery Technology	
Unit 3	**Physical Process (Thermodynamics and Kinetics) Related to Battery Materials**	
A	Ion insertion/de-insertion, electrode-electrolyte interphase formation	CO1,CO2 CO3,CO4 CO5
B	Degradation, thermodynamics: electrochemical Equilibrium, electrochemical potential	
C	Applications to different material systems, kinetics and other interfacial phenomena	
Unit 4	**Characterization Methods of Battery**	
A	Charge/discharge cycles, open circuit voltage measurement	CO1,CO2 CO3,CO4 CO5
B	overpotential, battery capacity, state of charge	
C	State of health, electrochemical impedance spectroscopy	
Unit 5	**Rechargeable Battery Architecture and Design Guideline**	
A	Rechargeable battery (Li-ion) development and safety issues (thermal runaway, short-circuiting, fire/explosion hazard)	CO1,CO2 CO3,CO4 CO5
B	Battery requirements and design considerations; overview of application of rechargeable (Li-ion) battery:	
C	Principles of operation including cell design example packaging; pack/module design.'	
Mode of Examination	Quiz/Viva	