University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK4DSECHE201**				
Course Title	**CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY- II**				
Type of Course	**DSE**				
Semester	4				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. A strong understanding of fundamental chemistry principles is essential. 2. A solid grounding in environmental science provides the context necessary to understand the interconnectedness of environmental chemistry with broader environmental issues and to effectively design and implement pollution control strategies. 3. UK3DSECHE201 (preferable)				
Course Summary	This course provides a comprehensive understanding of environmental chemistry, pollution control, electronics, solar energy, and green chemistry principles for clean energy applications. Students will engage in hands-on lab sessions to apply theoretical knowledge in water quality analysis and environmental monitoring practices.				

Detailed Syllabus:

Module	Unit	Content **CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY- II**	Hrs **75**
I	**BASIC ELECTRONICS AND SEMICONDUCTOR MATERIALS**		**11**
	1	Introduction to Electronics: Concept of electron, valence and conduction bands, Conductors, semiconductors, and insulators, Free electron theory and electrical conductivity.	2
	2	Semiconductor Chemistry: Intrinsic and extrinsic semiconductors, Effect of doping on conductivity (n-type and p-type), Formation of p-n junctions, depletion region.	3
	3	Semiconductor Devices: Working principles of diodes and Zener diodes, Transistors (basic idea, NPN/PNP types), Zener as voltage regulator.	3
	4	Optoelectronic Devices: Working and applications of LED and photodiodes, Chemistry and physics of solar cells Characteristics: I-V curve, efficiency, Fill Factor.	3

II	**SOLAR ENERGY AND PHOTOVOLTAIC PRINCIPLES**		11
	5	Fundamentals of Solar Energy, Solar spectrum, greenhouse effect Terrestrial vs extraterrestrial radiation, Direct and diffused solar radiation, atmospheric filtering.	3
	6	Solar Photovoltaics and Light-Matter Interaction, Absorption of light in semiconductors, Bandgap and photon energy (E = hv), Generation of electron-hole pairs, Semiconductor band alignment and junction behavior in PV cells.	4
	7	Solar Cell Structure and Parameters; Working of a solar cell-Parameters: open-circuit voltage (Voc), short-circuit current (Isc), efficiency, Optical coatings, anti-reflective layers, Introduction to modules and arrays.	4
III	**PV SYSTEM DESIGN AND ENERGY STORAGE**		**11**
	8	Types of PV Systems, Standalone vs grid-connected PV systems, Practical examples: rooftop solar, solar pumps.	2
	9	Balance of System Components, Charge controllers, inverters, mounting structures, Cabling and wiring considerations, Safety precautions in PV installations.	3
	10	Energy Storage Systems, Electrochemistry of batteries -Types: Lead-acid, Lithium-ion (Chemistry, Advantages and Disadvantages), Depth of discharge (DoD), charge/discharge cycles.	3
	11	Design Principles and Maximum Power Point Tracking (MPPT), Load estimation and system sizing, PV panel and battery sizing, Maximum Power Point Tracking (MPPT) – concept and importance.	3
IV	**RENEWABLE ENERGY TECHNOLOGIES AND SUSTAINABILITY**		**12**
	12	Overview of Renewable Energy Sources Wind, hydro, geothermal, and biomass: basic chemistry and mechanisms, Comparison with solar – energy output and environmental effects.	3
	13	Hybrid Renewable Systems. Solar-wind and solar-biomass systems Examples and benefits of hybrid configurations.	2
	14	Advanced PV Materials: Perovskite solar cells – structure and stability Organic photovoltaics (OPV) – polymer chemistry, Quantum dots – nanoscale semiconductor behaviour.	3
	15	Smart Grids and Energy Policy: Basics of smart grids and renewable integration, Intermittency challenges, role of storage.	2
	16	Environmental & Policy Aspects: Sustainability, carbon footprint reduction, National solar mission, PM-KUSUM, net metering, Role of renewable energy in climate action.	2
V	**OPEN ENDED MODULE: LAB COURSE**		**30**
	1	Measurement of Solar Radiation using a Pyranometer or Solar Mobile App.	
	2	Study of I-V Characteristics of a Solar Cell.	
	3	Estimation of Efficiency of a Small Solar Panel.	

	4	pH and Conductivity Measurement of Water.	
	5	Construction of a Simple Electrochemical Cell.	
	6	Comparison of Battery Types (Lead-Acid vs Li-ion) Using Models or Case Studies.	
	7	Demonstration of LED and Photodiode Functionality.	
	8	Simulation of Solar PV System Design using Free Online Software (e.g., PVsyst, PV Watts).	
	Any four Experiments should be done		

References

1. Bhargava, N. N., Kulshreshtha, D. C., & Gupta, S. C. (2009). *Basic electronics and linear circuits (2nd ed.).* Tata McGraw-Hill.
2. Mehta, V. K., & Mehta, R. (2012). *Principles of electronics (11th ed.).* S. Chand Publishing.
3. Sukhatme, S. P., & Nayak, J. K. (2008). *Solar energy: Principles of thermal collection and storage (3rd ed.)*. Tata McGraw-Hill.
4. Khan, B. H. (2017). *Non-conventional energy resources (3rd ed.).* McGraw Hill Education.
5. Solanki, C. S. (2015). *Solar photovoltaics: Fundamentals, technologies and applications (3rd ed.).* PHI Learning Pvt. Ltd.
6. Kothari, D. P., Singal, K. C., & Ranjan, R. (2011). *Renewable energy sources and emerging technologies (2nd ed.).* PHI Learning Pvt. Ltd.
7. Rao, S., & Parulekar, B. B. (2010). *Energy technology: Non-conventional, renewable and conventional (4th ed.).* Khanna Publishers.
8. De, A. K. (2006). *Environmental chemistry (6th ed.).* New Age International Publishers.
9. Chawla, S. (2003). *A textbook of engineering chemistry (3rd ed.).* Dhanpat Rai Publishing.
10. Gopalan, R., Venkappayya, D., & Nagarajan, S. (2009). *Applied chemistry (2nd ed.).* Vikas Publishing House.
11. Mike Lancaster, *Green Chemistry: An Introductory Text*, Royal Society of Chemistry, 2002.
12. James E. Girard, Jones & Bartlett Learning, *Principles of Environmental Chemistry*, 2017.
13. Patrick Brezonik and William Arnold, *Water Chemistry*, Oxford University Press, 2011.
14. C. S. Rao, *Environmental Pollution Control Engineering*, Wiley, 2005.
15. Metcalf & Eddy, *Wastewater Engineering: Treatment and Reuse*, McGraw-Hill Education, 2013.
16. Paul T. Anastas and John C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, 2000.
17. John R. Balfour, *Introduction to Photovoltaics*, CRC Press, 2019.
18. Martin A. Green, *Solar Cells: Operating Principles, Technology, and System Applications*, Wiley, 2015.
19. Thomas L. Floyd and David M. Buchla, *Electronics Fundamentals: Circuits, Devices & Applications*, Pearson, 2019.
20. Donald A. Neamen, *Semiconductor Physics and Devices: Basic Principles*, McGraw-Hill Education, 2011.
21. Streetman and Sanjay Banerjee, *Solid State Electronic Devices* Ben G., Pearson, 2019.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate understanding of chemical and biochemical principles dictating fundamental environmental processes in the atmosphere, hydrosphere, and lithosphere	An	PSO - 1,3
CO-2	Outline the fundamental principles of Green Chemistry for Clean Energy	An	PSO - 1,3
CO-3	Develop skills in analysis of water sample	E	PSO - 1,3
CO-4	Utilize fundamental chemical principles to scrutinize chemical reactions implicated in diverse environmental challenges (air, water, and soil).	C	PSO - 1,3
CO-5	Gain the skills to measure solar and electrical parameters, evaluate basic energy devices, compare battery types, and use software to design simple solar systems.	C	PSO - 1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY- II

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO - 1,3	An	F, C	L	
2	CO-2	PSO - 1,3	An	F, C	L	
3	CO-3	PSO - 1,3	E	F, C	L	
4	CO-4	PSO - 1,3	C	F, C	L	
5	CO-5	PSO - 1,2,3,5	C	F, C, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	2	-	3	-	-	3	2	-	-	-	-	-	-
CO 2	3	-	2	-	-	2	3	-	-	-	-	-	-
CO 3	3	-	3	-	-	3	2	-	-	-	-	-	-
CO 4	3	-	3	-	-	3	3	-	-	-	-	-	-
CO 5	2	3	2	-	3	3	3	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		