



University of Kerala

Discipline	CHEMISTRY				
Course Code	UK3DSECHE201				
Course Title	CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY-I				
Type of Course	DSE				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	<ol style="list-style-type: none"> Students should possess critical thinking skills to evaluate different energy resources objectively and analyze their advantages, disadvantages, and impacts. Proficiency in using technology and understanding basic engineering principles will be helpful, especially when studying energy production technologies and their efficiency. 				
Course Summary	This course aims to thoroughly understand diverse energy resources, their characteristics, and associated advantages and disadvantages, facilitating informed decision-making in energy production and consumption. By exploring innovative technologies and critically evaluating energy strategies, students develop skills to address real-world environmental challenges and promote sustainable energy practices in various sectors.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY-I	
I	NON - SUSTAINABLE AND NON- RENEWABLE ENERGY SYSTEMS		9
	1	Non-sustainable and non-renewable energy systems. Classification of non-sustainable energy sources, significance of fossil fuels and nuclear energy.	2
	2	Fossil fuels and its importance; Coal, petroleum, Natural gas; mitigating environmental impacts, and promoting energy security and resilience	3
	3	Basics of nuclear energy, nuclear forces, isotopes, and radioactivity, Type of radiations and their properties	1
	4	Nuclear fission and fusion reactions, nuclear power plant, nuclear fuel cycle, nuclear safety and regulations	3
II	CONVENTIONAL ENERGY SOURCES AND ENVIRONMENTAL CONSEQUENCES		9



	5	Environmental pollution associated with energy generation from non-renewable sources and its consumption.	1
	6	Fossil fuels and air pollution. Greenhouse effect, Global warming, Carbon foot print- measures to reduce carbon foot print, Concept of carbon neutrality.	3
	7	Radioactive waste management, nuclear accidents – (two specific incidents-Fukushima and Chernob) and their environmental impacts, safety concerns related to nuclear energy production.	3
	8	Introduction to sustainable energy: Global energy challenges and need for sustainability and renewability.	2
III	BASIC CONCEPTS OF ENERGY RESOURCES		9
	9	Introduction to Renewable Energy- Definition. Renewable Energy sources switching, Difference between Renewable & Non-renewable sources, Main sources – solar, wind, tidal, biomass, geothermal, Applications	2
	10	Brief descriptions of solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy Hydrogen as a source of renewable energy- Introduction to hydrogen economy. Fuel cell – hydrogen- oxygen fuel cell.	3
	11	Green energy and zero energy concept. Renewable energy sources, Energy conservation principle, Measurement of Industrial energy efficiency, Transportation efficiency and alternative fuels	2
	12	Energy storage technologies. Future trends in energy storage systems, Environmental impact of energy extraction, production, and consumption.	1
	13	Environmental impact and Policy regulation, Environmental and social impacts.	1
IV	ENERGY ASSESSMENT AND EVALUATION		18
	14	Introduction to Energy Audit, Assessment, and Survey-Definition and scope of energy audits, Importance of energy management in laboratories and chemical industries, Role of energy assessment in sustainable development, Basic components of an energy survey: data collection, energy flow analysis, consumption trends	6
	15	Types of Energy Audits and Related Practices; Walk-through Audit: Initial assessment, quick survey, spotting obvious inefficiencies Preliminary Energy Audit: Intermediate level data analysis, identification of major energy-saving opportunities Detailed Energy Audit: Comprehensive analysis with monitoring instruments, ROI calculation, in-depth diagnostics Retro-commissioning: Re-optimization of existing building systems Industrial Energy Assessment: Evaluation of energy use in chemical processes and industrial equipment Renewable Energy Assessment: Feasibility and impact of solar, wind, and bioenergy alternatives	6



		Recommended Practices: Use of energy performance indicators, benchmarking, adherence to Bureau of Energy Efficiency (BEE) guidelines	
	16	<p>Conducting the energy audit Step-by-Step Audit Procedure: Planning and pre-audit data collection; On-site inspection and instrumentation; Energy flow analysis and benchmarking; Identifying energy conservation opportunities (ECOs); Use of Computer Simulation Tools: Introduction to energy modeling software (e.g., RET Screen, Energy Plus, e-QUEST); Simulating building/lab/industrial energy systems; Input requirements and interpretation of outputs; Predictive energy savings and scenario comparison Developing the Audit Report: Executive summary, methodology, findings, recommendations, financial analysis; Use of graphs, Sankey diagrams, and tables; Report writing best practices and formatting; Communication of findings to stakeholders</p>	6
V	OPEN ENDED MODULE: Learning through problem-solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams, etc		15
	1.	Assign topics to help students understand the types, uses, and properties of various energy resources.	
	2.	Encourage students to explore the characteristics, benefits, and limitations of different energy sources.	
	3.	Guide students to compare different energy sources based on cost, efficiency, and environmental impact.	
	4.	Promote student-LED projects on innovative and emerging technologies in sustainable energy.	
	5.	Analyze the environmental, social, and economic impacts of different energy sources.	
	6.	<p>Faculty-Initiated Methods Include activities like field visits, expert talks, or online learning modules as suggested by faculty, related to syllabus modules.</p>	
	7.	Engage students in evaluating the practicality and implications of different energy strategies.	
	8.	<p>Policy and Behaviour Analysis Discuss the role of energy policies, technology, and behaviour in moving toward sustainable energy.</p>	
	9.	<p>Group Activities and Discussions Assess participation in group discussions, presentations, and collaborative work.</p>	
10.	<p>Creative Solutions: Encourage students to develop creative, real-world solutions to problems related to conventional energy use</p>		

References



1. G. Boyle, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 2019.
2. R. K. Rajput, *Energy Technology: Non-Conventional, Renewable and Conventional*, Laxmi Publications.
3. G. D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers.
4. C. S. Solanki, *Solar Energy: Fundamentals, Design, Modelling and Applications*, PHI Learning Pvt. Ltd.
5. D. P. Kothari, K. C. Singal, and R. Ranjan, *Renewable Energy Sources and Emerging Technologies*, PHI Learning Pvt. Ltd.
6. S. C. Bhatia, *Environmental Pollution and Control in Chemical Process Industries*, Khanna Book Publishing.
7. A. K. De, *Environmental Chemistry*, New Age International Publishers.
8. P. C. Trivedi, *Renewable and Non-Renewable Energy Sources*, Pointer Publishers.
9. L. A. Kumar and G. Ganesan, *Energy Audit and Management: Concept, Methodologies, Procedures, and Case Studies*, CRC Press, 2023.
10. Y. P. Abbi and S. Jain, *Handbook on Energy Audit and Environment Management*, TERI Press.
11. C. S. Solanki, *Renewable Energy Technologies: A Practical Guide for Beginners*, PHI Learning Pvt. Ltd.
12. S. P. Sukhatme, *Solar Energy: Principles of Thermal Collection and Storage*, Tata McGraw-Hill Education.
13. S. S. Chandel, *Solar Photovoltaic Systems: Principles and Applications*, Alpha Science International.
14. B. S. Rajanikanth, *Fuel Cells: Principles and Applications*, Universities Press, Hyderabad.
15. S. Srinivasan, *Fuel Cells: From Fundamentals to Applications*, Springer.
16. P. Morris and R. Therivel, *Environmental Impact Assessment: Theory and Practice*, Cambridge University Press, 2020.
17. A. Hasanbeigi, L. Price, E. Lin, and H. Lu, *Energy Auditing and Energy Management Handbook*, Academic Press, 2021.
18. A. Thumann, W. J. Younger, and T. Niehus, *Handbook of Energy Audits*, Fairmont Press, 2022.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the classification, significance, and scientific principles of non-sustainable and non-renewable energy systems, including fossil fuels and nuclear energy, with respect to their environmental implications and energy challenges.	An	1,2,3
CO-2	Analyze the environmental consequences of conventional energy sources by examining pollution, greenhouse gas emissions,	An	1,2,3



	carbon footprint, and the risks of nuclear energy, including accidents and waste management, to understand the need for sustainable alternatives.		
CO-3	Evaluate various renewable energy sources and emerging green energy technologies based on their principles, applications, efficiency, and environmental impact to promote sustainable energy solutions.	E	1,2,3,4
CO-4	Create a comprehensive energy audit plan by integrating data analysis, simulation tools, and sustainability principles to identify and recommend effective energy conservation strategies in industrial and laboratory settings	C	1,2,3,4
CO-5	Demonstrate the ability to critically evaluate, compare, and propose creative, sustainable energy solutions by engaging in collaborative activities, real-world problem-solving, and experiential learning, while analyzing the environmental, economic, and policy dimensions of energy systems.	C	1,2,3,4,5

An-Analyse, E-Evaluate, C-Create

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

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	CO-1	PSO-1,2,3 PO-1,2	An	C	L	
2	CO-2	PSO-1,2,3 PO-1,2	An	C	L	
3	CO-3	PSO-1,2,3,4 PO-1,2	E	P	L	
4	CO-4	PSO-1,2,3,4 PO-1,2,7	C	P	L	
5	CO-5	PSO-1,2,3,4,5 PO-1,2	E, C	F, C, P, M	L/T	

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



Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2	3	-	-	3	3	-	-	-	-	-	-
CO 2	3	2	3	-	-	3	3	-	-	-	-	-	-
CO 3	3	2	3	2	-	3	3	-	-	-	-	-	-
CO 4	2	3	2	2	-	2	3	-	-	-	-	2	-
CO 5	2	3	2	3	2	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		✓	✓	

