Department of Chemistry

College of Education

University of Salahaddin

Subject: Sustainable Chemistry

Course Book: (Year 4)

Lecturer's name: Essa Ismaeil Ahmed

Academic Year: 2024/2025

1st Semester

Course Book

1. Course name	**Sustainable chemistry**
2. Lecturer in charge	**Essa Ismaeil Ahmed**
3. Department/ College	**Chemistry/College of Education**
4. Contact	**e-mail : essa.ahmed@su.edu.krd** **Tel: (07504880190)** **(07803751092)**
5. Time (in hours) per week	**Theory: 2**
6. Office hours	**6 hours**
7. Course code	**.....**
8. Teacher's academic profile	▪ **BSc in chemistry (2002)** **The University of Salahaddin - Erbil- Iraq** ▪ **MSc in Industrial chemistry/petroleum (2008)** **The University of Salahaddin - Erbil- Iraq** ▪ **PhD in petroleum and lubricant chemistry (2015)** **The University of Leicester- Leicester-UK**
9. Keywords	**Sustainable chemistry, green solvents and solubility, molten salts, Ionic liquids (ILs), and deep eutectic solvents (DESs), biocatalysis, renewable energy, biodegradable plastics, life cycle assessment…etc.**

10. Course overview:

Sustainable chemistry is a module which concerned about delivering the fundamental knowledge and skills related to sustainability, which are necessary for chemists graduating from the chemistry department at the college of education to know. The course covers an introduction to the importance of sustainable chemistry which is an approach to chemical research, development, and manufacturing that aims to minimize environmental impact and maximize efficiency. The course designed to start with a brief introduction to sustainable chemistry, then addressing the main approaches scientist try to apply in their carrier concerning green solvents and solubility such as molten salts, Ionic liquids (ILs), and dee eutectic solvents), Biocatalysis, Renewable energy, Biodegradable plastics, Life cycle assessment

The main object of a sustainable chemistry module is to educate and inspire students to become agents of positive change in the field of chemistry. By providing a comprehensive understanding of the principles, practices, and applications of sustainable chemistry, the module aims to:

Promote environmental awareness: Raise awareness of the environmental challenges facing our planet and the role of chemistry in addressing them.

Foster critical thinking: Encourage students to think critically about the environmental impact of chemical processes and products.

Develop problem-solving skills: Equip students with the skills to identify and solve environmental problems related to chemistry.

Inspire innovation: Stimulate students to develop innovative and sustainable chemical solutions.

Cultivate a sense of responsibility: Foster a sense of responsibility for the environment and a commitment to sustainable practices.

12. Student's obligation

Attending all lectures are crucial for students to do because all messages which has been designed to be delivered to improve the knowledge and skills are interpreted in class times.

Additionally, it is recommended to practice the following tips:

Punctuality: arrive on time, pack up and leave on time.

Respect: speak respectfully, listen respectfully.

Responsibility: be prepared for classes—do the required activities and reading.

Academic Honesty: contribute original work—plagiarism is not acceptable.

Participate: acknowledge and welcome diversity – be prepared to receive and give feedback and do not be afraid to ask for help.

13. Forms of teaching

To engage our students in active learning, that reflect on what is advised in teaching undergraduate subjects, the following strategies are practiced;

Building appropriate relationships with students through learning their names, respecting and acknowledging diversity in the classroom and responding to questions in a supportive manner.

Using a range of teaching strategies to support different learning preferences and student diversity and build student independence.

Using teaching techniques that ensure that all students can contribute to and learn from classroom learning experiences.

Practicing feedback to show students how they can improve their learning, through classroom interactions.

Using a range of resources to support classroom activity, including but not limited to books, videos, handouts, white and black boards, online resources, room layout and other people. This accompanied by understanding the role of both online and face-to-face experiences in supporting student learning to explain the subject in more details.

14. Assessment scheme

The final degree (100%) will be based on the following assessments

Mid-term exam (25%)

Activities, homework's and quizzes (15%)

Reports (10)

Attendance: Attending all classes and laboratory sessions is of crucial student obligation and will be taken class period. One (1) unexcused absence will not count against your overall attendance grade. If you know you will be absent ahead of time, it is your responsibility to make arrangements in advance to cover the material you will miss. Attendance will be count with an extra 2 scores for whom attended 100%.

Final comprehensive theoretical exam counts (50%)

15. Student learning outcome:

A sustainable chemistry module could equip students with a comprehensive understanding of the principles, practices, and applications of green chemistry. Here are some key learning outcomes:

Knowledge and Understanding:

Define sustainable chemistry and its principles.

Explain the importance of sustainable chemistry in addressing environmental challenges.
Understand the concept of life cycle assessment and its role in evaluating the environmental impact of products.
Identify various green chemistry practices, such as green solvents, catalysis, and synthesis methods.
Recognize the potential benefits and challenges associated with implementing sustainable chemistry in industrial processes.
Discuss the role of renewable energy sources and sustainable materials in a green economy.
Skills and Abilities:
Analyse the environmental impact of chemical processes and products.
Evaluate the effectiveness of different green chemistry strategies.
Design sustainable chemical processes and products.
Critically assess the scientific literature on sustainable chemistry.
Communicate effectively on sustainable chemistry topics, both orally and in writing.
Collaborate with others to solve environmental problems related to chemistry.
Values and Attitudes:
Appreciate the importance of sustainable chemistry for a healthy planet and future generations.
Demonstrate a commitment to ethical and responsible chemical practices.
Develop a critical mindset towards the environmental impact of chemical industries.
Show a willingness to contribute to the development and implementation of sustainable chemistry solutions.
By achieving these learning outcomes, students will be well-prepared to play a significant role in advancing sustainable chemistry and contributing to a more environmentally friendly future.

16. Course Reading List and References;

1. Mohammad, A., Green Solvents I and II: Properties and Applications in Chemistry. 2012: Springer Netherlands.
2. Cavani, F., et al., Sustainable Industrial Chemistry: Principles, Tools and Industrial Examples. 2009: Wiley.
3. Benvenuto, M.A., et al., Sustainable Green Chemistry. 2017: De Gruyter.
4. Manahan, S.E., Fundamentals of Sustainable Chemical Science. 2009: CRC Press.
5. Ren, J., Y. Wang, and C. He, Towards Sustainable Chemical Processes: Applications of Sustainability Assessment and Analysis, Design and Optimization, and Hybridization and Modularization. 2020: Elsevier Science.

17. The Topics:	Lecturer name
Part 1: Introduction to Sustainable Chemistry	Essa Ismaeil Ahmed, duration: (2 hrs) 08/09/2024 to 00/12/2024
Definition of sustainable chemistry Environmental challenges and the role of chemistry	
Principles of green chemistry The 12 principles of green chemistry Applications of green chemistry principles	
Life Cycle Assessment (LCA) Understanding life cycle assessment	

Conducting LCA studies and case studies of LCA	
Part 2: Green Chemical Processes	
Green solvents and their applications Ionic liquids, supercritical fluids, and deep eutectic solvents	
Midterm Exam	
Biocatalysis Homogeneous and heterogeneous catalysis Biocatalysis and its applications	
Green synthesis methods Microwave-assisted synthesis and ultrasound-assisted synthesis Flow chemistry (a modern approach to chemical synthesis).	
Part 3: Sustainable Chemical Products	
Sustainable materials Biodegradable polymers and plastics Renewable materials (cellulose, lignin, chitin) Sustainable building materials	
Sustainable Energy Renewable energy sources (solar, wind, hydro) Energy storage and efficiency	
Sustainable pharmaceuticals and agrochemicals Green synthesis of pharmaceuticals and agrochemicals Reduction of environmental impact	
Part 4: Case Studies and Applications	
Case Studies in sustainable chemistry Examples of successful green chemistry initiatives Challenges and opportunities in sustainable chemistry	
Future Perspectives of sustainable chemistry Emerging trends and technologies The role of education and research	
Final Exam	
18. Practical Topics	

19. Examinations:

1. **Compositional:**

- Define sustainable chemistry and list its key principles.
- Explain the concept of atom economy and why it's important in sustainable chemistry.
- How does sustainable chemistry approach the use of solvents differently from traditional chemistry?
- Describe the role of catalysis in sustainable chemical processes.
- Compare and contrast renewable and non-renewable feedstocks in chemical manufacturing.
- How does the principle of "design for degradation" contribute to sustainability in chemistry?
- Explain the concept of E-factor in green chemistry and how it's used to assess process

efficiency.

2. True or false type of exams:

- Sustainable chemistry primarily focuses on improving economic benefits without considering environmental impacts. False (It balances economic benefits with environmental and health considerations.)

3. Multiple choices:

- Which of the following is an example of a green solvent?

a. Water
b. Hexane
c. Dichloromethane
d. Benzene
Answer: a. Water

20. Extra notes:

21. Peer review **پێداچوونەوەی هاوەڵ**