Green Chemistry (Special Topics)

Department of Chemistry and Biochemistry
College of Natural Sciences and Mathematics
CHEM 4980 (future CHEM 4200); Section: 020; CRN: 61805

Instructor: Dr. Mark Mason
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Lecture: Tuesday and Thursday, 5:30- 6:45 p.m.; Memorial Field House, Room 2240

Office Hours: Tuesday and Thursday, 3:00-5:00 pm

Credit Hours: 3

Course Description:

Advanced topics in green chemistry, including industrial applications, atom economy, safer solvent substitutions, alternatives assessment, green metrics (PMI, E-factor), basic life cycle analysis, and an introduction to chemical toxicology.

Course Overview:

Green chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products, including fuels, plastics, polymers, synthetic fibers, pharmaceuticals, food additives, fragrances, pesticides, herbicides, detergents and cleaning supplies. This course will introduce the principles and fundamental concepts of green chemistry, and provide examples of commercial applications of green chemistry. The course will be especially pertinent for students studying chemistry, medicinal chemistry, chemical engineering, and environmental sciences.

Student Learning Outcomes

Upon completion of this course, students will be able to:

1. Apply the principles of green chemistry to chemical-related problems and waste reduction.
2. Apply the principles of green chemistry to improve chemical manufacturing processes.
3. Calculate atom economy, process mass intensity, and E-factor.
4. Analyze toxicology data, materials properties, and regulatory requirements to choose safer chemicals for product formulations and process chemistry.
5. Understand the fundamentals of chemical alternatives assessment.

Prerequisites: Organic Chemistry II (CHEM 2420 or equivalent)

University Policies: The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.

Academic Accommodations: The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations/adjustments in this course please contact the Student Disability Services Office.

Academic Dishonesty: The University Policy on Academic Dishonesty will be strictly enforced. See: http://www.dl.utoledo.edu/current_students/academic_dishonesty.htm.

Textbooks: Course material will be taken from the text by Lancaster, supplemented with material from texts by Anastas and Warner, Baird and Cann, and Manahan. Additional examples will be taken from scientific articles and reviews.

Recommended Textbook

Lancaster, M. *Green Chemistry: An Introductory Text*, Second Edition; RSC Publishing; 2010. ISBN: 978-1-84755-873-2

Supplementary Texts

Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press, Oxford; 1998. ISBN: 0-19-850234-6

Baird, C.; Cann, M. *Environmental Chemistry*, Fifth Edition; W. H. Freeman and Company, New York; 2012. ISBN-13: 978-1-4292-7704-4. (Toxicology, Chapters 13-15)

Manahan, S. E. *Environmental Chemistry*, Eighth Edition; CRC Press, 2005. ISBN: 1-56670-633-5. (Toxicology, Chapters 22-23)

Grading: Final grades will be based on two exams (100 points each), five quizzes (10 points each), and a comprehensive final exam (150 points). The following final grading scale (out of a possible 400 points) will be applied:

A	340 points	C+	253
A–	320	C	240
B+	300	C–	227
B	280	D+	213
B–	267	D	200

Exam and quiz dates are provided below:

Exam 1	Tuesday, September 29
Exam 2	Tuesday, November 17
Final Exam	Tuesday, December 15 (5:00-7:00 pm)
Quizzes	Tuesday, September 8
	Tuesday, September 22
	Thursday, October 22
	Tuesday, November 10
	Tuesday, December 8

Midterm grades will be assigned based on student performance on the first exam and the first two quizzes.

Homework: Problem sets will be distributed periodically. These will not be collected or graded. Answer keys will be posted online.

Tentative Course Schedule

Week	Date	Topics	Notes
1	August 25 & 27	Introduction, Atom Economy, Principles of Green Chemistry	
2	September 1 & 3	Alternative Solvents/Energy Efficiency	
3	September 8 & 10	Catalysis, Abiotic Depletion of Elements	**Quiz 1**, Sept. 8
4	September 15 & 17	Renewable Feedstocks	
5	September 22 & 24	Climate Change (Prof. Jorgensen) Biodegradation	**Quiz 2**, Sept. 22
6	September 29	**Exam 1**	No lecture on October 1. Attend lecture by Paul Anastas on September 30
7	October 8	Toxicology, Designing Safer Chemicals	No class on October 6. Fall Break.
8	October 13 & 15	Metrics: E-Factor and PMI	No lecture on October 13.
9	October 20 & 22	Commercial Examples of PMI Life Cycle Assessment	**Quiz 3**, Oct. 22
10	October 27 & 29	Triple Bottom Line, Supply Chain Issues, Business Considerations	
11	November 3 & 5	Risk vs. Hazard Assessment, Chemical Alternatives Assessment	Attend Michigan Green Chemistry Conference on Nov. 4. (optional)
12	November 10 & 12	Environmental Laws, Policies, and Regulations	**Quiz 4**, Nov. 10
13	November 17 and 19	Inherently Safer Design	**Exam 2** on November 17.
14	November 24	Emerging Green Technologies	No class on Nov. 26. Thanksgiving.
15	December 1 & 3	Presidential Green Chemistry Award Winners	
16	December 8 & 10	Graduate Student Presentations	**Quiz 5**, Dec. 8
17	December 15	**Final Exam**, 5:00 – 7:00 pm	Cumulative