

**INTER-AMERICAN UNIVERSITY OF PUERTO RICO**  
**CAMPUS \_\_\_\_\_**  
**DEPARTMENT OF \_\_\_\_\_**  
**CHEMISTRY PROGRAM**

**SYLLABUS**

**I. Overview**

Course Title	:	Green Chemistry
Code and Course	:	CHEM 3370
Credits	:	3 credits
Academic Term	:	
Professor	:	
Place and hours of Office	:	
Office Phone	:	
Email	:	

**II. Description**

Introductory study of the basic chemical concepts and methods focused on process design and product synthesis that impacts the environment in a benign way. Includes the discussion and analysis of principles and the historical development of green chemistry, evaluating advantages and disadvantages. Analysis of examples of the application of green chemistry, at the academic and industrial levels by evaluating its economic and environmental impact. Prerequisites: CHEM 2222.

**II. Terminal Objectives**

Upon successful completion of the course, the student will be able to:

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

**IV. Content**

<b>Topics</b>	<b>Thematic Content</b>
1. Principles and Concepts of Green Chemistry	Definition of Green Chemistry, Theoretical Foundations of the Discipline, Sustainable Development and Green Chemistry, Green Engineering, The Twelve Principles of Green Chemistry, Atom Economics, Reactions of Economy and Non-Economy of Atoms, Toxicity Reduction
2. Waste: Production, Problems and Prevention	Problems caused by waste, Sources of waste in the Chemical Industry, Cost of Waste, Techniques of Waste minimization, On-site waste treatment, Degradation designs, Polymer recycling

<b>Topics</b>	<b>Thematic Content</b>
3. Environmental Performance: Green Process <b>Measures and Control</b>	Importance of Measures, Introduction to product life cycle assessment, Green Process Metrics, Environmental Management Systems (EMS), Eco-labels, Integrated Pollution Prevention and Control (IPPC) legislation, Chemical Registration, Evaluation and Authorization (REACH)
4. Catalysis and Green Chemistry	Introduction to Catalysis, Heterogeneous Catalysis, Homogeneous Catalysis, Phase Transfer Catalysts, Biocatalysts, Photocatalysis
5. Organic Solvents: Environmentally Benign Solutions	Organic Solvents and Volatile Organic Compounds, Solvent-Free Systems, Supercritical Fluids, Water as a Solvent, Ionic Liquids, Fluorous Solvents, Green Solvent Comparison
6. Renewable Sources	Biomass, Energy, Renewable Raw Material Chemical Reagents, Alternative Economies, Biorefineries
7. Emerging Green Technologies and Alternative Energy Sources	Designs for energy efficiency, Photochemical reactions, Chemistry using Microwaves, Sonochemistry, Electrochemical synthesis
8. Industrial Case Study	Studies of the following cases: Methyl Methacrylate, Manufacture of Acetic Acid, EPDM Gums, Vitamin C, Manufacture of leathers, green inks, polyethylene, Eco friendly pesticides
9. Green future	Society and Sustainability, Barriers and Promoters, the role of legislation, Strategies to supply Green Chemical Reagents, Green Energy.

## V. Activities

Quizzes  
 Assignments  
 Videos  
 Participation in discussion forums  
 Discussion of Scientific Articles  
 Case Study

## VI. Evaluation

The course evaluation consists of:

<b>Evaluation Criteria</b>	<b>Points</b>	<b>% of final grade</b>
Quizzes	100	30
Assignments/ Critical Essays	100	20
Mid-exam	100	20
Final examination	100	30
<b>Total</b>	<b>400</b>	<b>100</b>

- The following assessment scale will be applied in the final grade.

100-85 A  
 84-75 B  
 74- 65 C  
 64-55 D  
 54-0 F

## VII. Special Notes

### 1. Auxiliary services or special needs

Any student who requires auxiliary services or special assistance must request them at the beginning of the course or as soon as he becomes aware that he needs them, through the corresponding registration, in the Orientation Office with \_\_\_\_\_.

### 2. Honesty, fraud, and plagiarism

Dishonesty, fraud, plagiarism, and any other inappropriate behavior in relation to academic work constitute major infractions sanctioned by the General Regulations of Students. Major infractions, as provided for in the General Regulations of Students, may result in the suspension of the University for a defined period of more than one year or the permanent expulsion from the University, among other sanctions.

### 3. Use of electronic devices

Cell phones and any other electronic devices that could disrupt teaching and learning processes or alter the environment conducive to academic excellence will be disabled. Pressing situations will be addressed, as appropriate. The use of electronic devices that allow access, storage or sending data during evaluations or exams is prohibited.

### 4. Compliance with the provisions of Title IX

The Federal Higher Education Act, as amended, prohibits discrimination based on sex in any academic, educational, extracurricular, athletic, or any other program or employment, sponsored or controlled by an institution of higher education regardless of whether it is performed on or off the premises of the institution, if the institution receives federal funds.

As provided by applicable federal regulations, our academic unit has appointed a Title IX Assistant Coordinator to aid and guidance in connection with any alleged incident constituting sex or gender discrimination, sexual harassment, or sexual assault. You can contact the Assistant Coordinator \_\_\_\_\_, extension \_\_\_\_\_, or email \_\_\_\_\_.

The Normative Document entitled **Rules and Procedures for Dealing with Alleged Violations of the Provisions of Title IX** is the document that contains the institutional rules for channeling any complaint that is filed based on this type of allegation. This document is available on the portal of the Inter-American University of Puerto Rico ([www.inter.edu](http://www.inter.edu)).

## VIII. Educational Resources

### a. Textbook

Lancaster, M. *Green Chemistry: An Introductory text*, Third Edition; RSC Publishing; 2016.  
ISBN-13: 978-1782622949

## IX. Bibliography

- Kaliaguine, S., Dubois J-L., *Industrial Green Chemistry*, De Gruyter, 2020, ISBN-13 : 978-3110646849
- Anastas, P.T. Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press, Oxford; 2000, ISBN-13: 978-0198506980
- Clark, J.H.; Macquarrie, D. *Handbook of Green Chemistry and Technology*, Wiley-Blackwell; 1st edition, 2002, Print ISBN-13: 978-0632057153, Online ISBN-10: 9781405172486
- Pietro, T.; Perosa A.; Zecchini F, *Methods and Reagents for Green Chemistry: An Introduction*, Wiley, 2007. ISBN-13: 978-0471754008
- Sheldon, R.A; Arends, I.; Hanefeld, U. *Green Chemistry and Catalysis*, Wiley-VCH, 2007, Print ISBN-13: 978-3527307159, Online ISBN: 9783527611003
- Marteel-Parrish, A.; Abraham, M.A. *Green Chemistry and Engineering: A Pathway to Sustainability*, Wiley, 2014 ISBN-13: 978-0470413265
- Nandeshwarappam B.P, *A Green Chemistry Approach - Microwave Assisted Organic Synthesis*, LAP LAMBERT Academic Publishing, 2017, ISBN-13 : 978-3330063877
- Rashmi, S.; Vandana, S. *Green Chemistry for Environmental Remediation* John Wiley & Sons, 2012. Printed ISBN 978-0-470-94308-3 Electronic ISBN 978-1-118-28768-2
- Nelson, W.M, *Green Solvents for Chemistry: Perspectives and Practice*, Oxford University Press, 2003, ISBN 978-0-195-15736-9
- Matlack, A. *Introduction to Green Chemistry*, Second Edition, CRC Press, 2010, ISBN 9781420078114
- Suresh C. Ameta, S, C; Ameta R. *Green Chemistry: Fundamentals and Applications*, CRC Press, 2013. ISBN: 9781926895437

## Electronic resources

- American Chemical Society (ACS) Green Chemistry Institute  
{<https://www.acs.org/content/acs/en/greenchemistry.html>}
- Green Chemistry, United States Environmental Protection Agency (EPA) {  
<http://www.epa.gov/greenchemistry>}
- Berkeley Center for Green Chemistry, University of California, Berkeley  
<http://bcgc.berkeley.edu/>
- Beyond Benign, Green Chemistry Education  
<http://www.beyondbenign.org/>
- Green Chemistry Assistant, St. Olaf College  
<http://fusion.stolaf.edu/gca/>
- Green Chemistry, University of Oregon  
<http://greenchem.uoregon.edu/>
- Green Chemistry Education Network (GCEdNet), University of Oregon  
<http://cmetim.ning.com/>
- Green Chemistry Network  
<http://www.greenchemistrynetwork.org>
- Green Chemistry Research Exchange (GreenChemEx){<http://www.greenchemex.org/gcex/>}
  
- Interuniversity National Consortium "Chemistry for the Environment" (INCA)  
<http://www.incaweb.org/>
- The Institute for Green Science, Carnegie Mellon University (CMU)  
<http://www.chem.cmu.edu/groups/collins>

- iSUSTAIN Green Chemistry Index v2.0  
<https://www.isustain.com/>
- Greening Across the Chemistry Curriculum, University of Scranton  
<http://academic.scranton.edu/faculty/cannm1/dreyfusmodules.html>
- Green Chemistry, California Department of Toxic Substances Control  
<http://www.dtsc.ca.gov/pollutionprevention/greenchemistryinitiative/index.cfm>
- Green Chemistry, Michigan Department of Environmental Quality  
[http://www.michigan.gov/deq/0,1607,7-135-3585\\_49005---,00.html](http://www.michigan.gov/deq/0,1607,7-135-3585_49005---,00.html)
- Inventory Update Reporting and Chemical Data Reporting, United States Environmental Protection Agency (EPA)  
<http://www.epa.gov/iur/>
- Laws and Executive Orders, United States Environmental Protection Agency (EPA)  
<http://www.epa.gov/lawsregs/laws/>
- Toxic Release Inventory, United States Environmental Protection Agency (EPA)  
<http://www.epa.gov/tri/>
- Summary of the Toxic Substances Control Act of 1976, Laws and Regulations, United States Environmental Protection Agency (EPA) {  
<http://www2.epa.gov/laws-regulations/summary-toxic-substances-control-act>}
- Regulation, Evaluation, Authorization, and Restriction of Chemical Substances (REACH), European Commission {[http://ec.europa.eu/enterprise/sectors/chemicals/reach/index\\_en.htm](http://ec.europa.eu/enterprise/sectors/chemicals/reach/index_en.htm)}
- Green Chemistry Awards, American Chemical Society (ACS) Green Chemistry Institute  
{<https://www.acs.org/content/acs/en/funding-and-awards/awards/gci.html>}
- Presidential Green Chemistry Challenge, United States Environmental Protection Agency (EPA)  
{  
<https://www.epa.gov/greenchemistry/information-about-presidential-green-chemistry-challenge>}
- ICIS Green Chemicals Blog  
<http://www.icis.com/blogs/green-chemicals/>
- Green Chemistry Blog, RSC Publishing  
<http://blogs.rsc.org/gc/>
- *Environmental Science and Sustainable Development*. (n.a.). Retrieved from  
[http://www.geo.mtu.edu/~asmayer/rural\\_sustain/aguascalientes/extra/barajas\\_etal.docx](http://www.geo.mtu.edu/~asmayer/rural_sustain/aguascalientes/extra/barajas_etal.docx)
- GLOOBAL. (n.a.). *Environmental knowledge guide*. Retrieved from Environmental Knowledge Guide:  
<http://www.gloobal.net/iepala/gloobal/fichas/ficha.php?id=1547&entidad=Noticias&cabecera=medioambiente&opcion=documento>
- Trade Union Institute of Labour, Environment and Health (ISTAS. (n.a.). *ISTAS*. Retrieved from ISTAS: <http://www.istas.net/web/index.asp?idpagina=3463>

**Revised November 2018, Actualized August 2021, Translated August 2021**