

# Introduction to Green Chemistry (CHMD89H) – Winter 2011

## University of Toronto at Scarborough

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Welcome to the first ever offering of CHMD89! This course will introduce you to the growing field of green chemistry – an interdisciplinary approach to chemistry that strives to develop environmentally benign chemical reactions and processes. The course will begin by introducing the twelve principles of green chemistry followed by the use of green chemistry metrics for quantifying ‘greenness.’ In this context, we will move on to explore major areas of green chemistry research including alternative solvents, catalysis and renewable feedstocks. Examples from industry and from the current literature will be used to reinforce the material and highlight recent advancements. The topics covered will be multidisciplinary in nature and will draw on aspects of organic, inorganic and polymer chemistry. Prerequisites for this course include CHMB31 and one of either CHMC41 or CHMC42; CHMC31 is strongly recommended.

Please take a few minutes to read through this document. It contains important information that will help ensure your success in this course.

### ***Instructor:***

Dr. Effie Sauer

SW650

Email: [esauer@utsc.utoronto.ca](mailto:esauer@utsc.utoronto.ca)

Office Hours: Mondays and Wednesdays, 1:30-2:30 pm

### ***Lecture Schedule:***

Tuesdays 5-6 pm in MW 262

Thursdays 1-3 pm in MW 110 (NOTE: most weeks we’ll only meet from 1-2 pm)

### ***Website:***

CHMD89 maintains a Blackboard web space which archives a variety of course-related information including: class announcements, assigned readings, grades, discussion board posts, contact information and links to outside resources. In addition, class emails will regularly be sent via Blackboard. ***In order for you to receive these emails, you must have a valid “utoronto.ca” email account registered with ROSI.***

### ***Method of Evaluation:***

Your grade in this course will be determined by your participation in class discussions, two assignments (each with an accompanying oral presentation) and an end-of-term test. The breakdown is shown here with more detailed descriptions of each item on the following page.

|                     |      |
|---------------------|------|
| Class Participation | 15%  |
| Assignment 1        | 20%  |
| Assignment 2        | 45%  |
| End of Term Test    | 20%  |
| Total               | 100% |

### ***Class Participation:***

A significant portion of your grade will come from class participation. By this, I mean making a *meaningful* contribution to class discussions – both during lecture and, on occasion, through the discussion board on Blackboard. Since class discussions are unlikely to have been a major part of your previous chemistry courses, I want to make sure that you understand what is expected. Below is a sample rubric of how I will grade your in-class participation. A similar rubric will be used for any discussions that take place online.

|                                   | <b>Excellent</b>   | <b>Needs Some Improvement</b>   | <b>Unsatisfactory</b>  |
|-----------------------------------|--|---|--|
| <b>Listening</b>                  | Actively and respectfully listens to peers and instructor  | Sometimes displays lack of interest in comments of others   | Projects lack of interest or disrespect for others   |
| <b>Preparation</b>                | Arrives fully prepared having thoroughly read and thought about the assigned readings                    | Sometimes arrives unprepared or with only superficial preparation   | Exhibits little evidence of having read or thought about the assigned readings                 |
| <b>Quality of Contributions</b>   | Comments are relevant and reflect a deep understanding of the material and the remarks of other students | Comments are sometimes irrelevant, suggesting a lack of preparation, or lack of attention to previous remarks by students | Comments reflect little understanding of either the assigned readings or the remarks of others |
| <b>Impact on Seminar</b>          | Comments frequently help move the conversation forward   | Comments sometimes advance the conversation, but other times do little to move it forward                                 | Comments do not advance the conversation or are actively harmful to it                         |
| <b>Frequency of Participation</b> | Actively participates at appropriate times   | Sometimes participates but at other times is “tuned out”  | Seldom participates and is generally not engaged   |

### ***Assignment 1:***

The first assignment for this course will be a critical review of a recent paper in green chemistry. You will each select your own primary article; however, it must be approved by me in advance. Using the principles of green chemistry and the metrics discussed in class, you will critique your selected paper in the context of what advancements are made by the research and how it improves upon the previously reported methods from both a green chemistry perspective, and, more generally. The grade for this assignment will be made up of three components:

- 5 pts - Proposal (0.5 page, primary article selection plus articles for comparison)
- 10 pts - Critical Review (3-5 pages)
- 5 pts - Presentation (10 minutes)

### ***Assignment 2:***

The second assignment for this course will be similar in format to the first assignment; however, rather than reviewing a single paper, you will write a critical review of a current topic in green chemistry. As part of this assignment, you will also be expected to formulate your own ideas for future research directions in this area. The grade for this assignment will be made up of four components:

- 5 pts - Topic Selection and Bibliography
- 10 pts - Detailed Outline (2-3 pages)
- 20 pts - Critical Review (10-15 pages)
- 10 pts - Presentation (15 minutes)

### ***End of Term Test:***

There will be a 2-hour, open-book test written during the last class of the semester. It will cover material from the entire course, including student presentations.

**Lecture Schedule (tentative):**

| <b>Date</b>  | <b>Lecture Topic</b>                            | <b>Due Dates</b>          |
|--------------|---|---------------------------|
| Lecture1     | introduction                                    |                           |
| Lecture2     | 12 principles of green chemistry                |                           |
| Lecture3     | metrics part 1                                  |                           |
| Lecture4     | metrics part 2                                  |                           |
| Lecture5     | the solvent problem                             |                           |
| Lecture6     | water as a solvent                              |                           |
| Lecture7     | glycerol as a solvent                           | Proposal for Assignment 1 |
| Lecture8     | specialty solvents                              |                           |
| Lecture9     | catalysis - overview                            |                           |
| Lecture10    | heterogeneous catalysis                         |                           |
| Lecture11    | ----- student presentations -----               | Assignment 1              |
| Lecture12    | ----- student presentations -----               |                           |
| Reading Week |   |                           |
| Lecture13    | homogeneous catalysis                           |                           |
| Lecture14    | specialty systems for catalytic reactions       | Proposal for Assignment 2 |
| Lecture15    | renewable feedstocks - biofuels                 |                           |
| Lecture16    | renewable feedstocks - commodity/fine chemicals |                           |
| Lecture17    | energy efficient processes                      | Outline for Assignment 2  |
| Lecture18    | alternative reagents                            |                           |
| Lecture19    | designing for degradation                       |                           |
| Lecture20    | case studies/special topics                     |                           |
| Lecture21    | ----- student presentations -----               | Assignment 2              |
| Lecture22    | ----- student presentations -----               |                           |
| Lecture23    | ----- student presentations -----               |                           |
| Lecture24    | end of term test (in class)                     | Test                      |

**Texts:**

There is no required text for this course; however, there are several recommended texts from which I will be assigning readings throughout the semester. These are all on reserve in the library for 3-hour short term loans. In addition, articles from the primary literature will be assigned as reading on a regular basis.

- 1) Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice*; Oxford University Press: New York, 2000.
- 2) Lancaster, M. *Green Chemistry: An Introductory Text*; RSC: Cambridge, 2002. **(Note: this text is also available online through the UTSC library website)**
- 3) Matlack, A. S. *Introduction to Green Chemistry*, 2nd ed; Taylor & Francis: Boca Raton, FL, 2010.
- 4) Tundo, P.; Perosa, A.; Zecchini, F. *Methods and Reagents for Green Chemistry: an Introduction*; Wiley: Hoboken, 2007.
- 5) Rothenberg, G. *Catalysis: Concepts and Green Applications*; Wiley: Weinheim, 2008.

***Accessibility:***

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the AccessAbility Services Office as soon as possible. I will work with you and AccessAbility Services to ensure you can achieve your learning goals in this course. Enquiries are confidential. The UTSC AccessAbility Services staff (located in S302) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416) 287-7560 or [ability@utsc.utoronto.ca](mailto:ability@utsc.utoronto.ca).

***Academic Integrity:***

Academic integrity is one of the cornerstones of the University of Toronto. It is critically important both to maintain our community which honours the values of honesty, trust, respect, fairness and responsibility and to protect you, the students within this community, and the value of the degree towards which you are all working so diligently.

According to Section B of the University of Toronto's Code of Behaviour on Academic Matters <http://www.governingcouncil.utoronto.ca/policies/behaveac.htm> which all students are expected to know and respect, it is an offence for students to:

- To use someone else's ideas or words in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e. to commit plagiarism.
- To include false, misleading or concocted citations in their work.
- To obtain unauthorized assistance on any assignment.
- To provide unauthorized assistance to another student. This includes showing another student completed work.
- To submit their own work for credit in more than one course without the permission of the instructor.
- To falsify or alter any documentation required by the University. This includes, but is not limited to, doctor's notes.
- To use or possess an unauthorized aid in any test or exam.

There are other offences covered under the Code, but these are by far the most common. Please respect these rules and the values which they protect. Offences against academic integrity will be dealt with according to the procedures outlined in the Code of Behaviour on Academic Matters.

***Turnitin.com:***

Please note that this course will be using turnitin.com for all papers and presentation. Students will be required to submit their course work to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.