University of Toronto - St. George Campus
Chemistry Department

CHM 417/1106 Fall 2017
Lab Instrumentation

Course Description

CHM 417/1106, "Lab Instrumentation," is intended for senior undergraduate students and junior graduate students. While such students often have a strong background in the principles of chemistry, physics, and biology, they often lack experience with the practical skills that are necessary to build or fix the customized instrumentation that is pervasive in the modern research lab. The course is intended to address this gap – we will discuss the basics of building and using optics- and electronics-based instrumentation for laboratory research, as well as discussing the implementation of custom software to control experiments in the lab. This course will be an ***introduction*** to these topics – if you have had formal courses in optics, electronics, or programming/data acquisition, or if you already have experience with these topics from your own time working in the laboratory, you should not take this course. The goal for this course is for you to learn basic principles about building custom analysis instruments, which you may then build upon in your own work in the research lab.

In the last third of the course, graduate student and undergraduate student courses will be split. These split sessions will be used to further focus on instrumentation used in graduate laboratories at UofT and elsewhere. All students will give presentations about some aspect of instrumentation during the last third of the course. For graduate students, the presentations will be individual presentations on instrumentation used in their laboratory, while undergraduate students will participate in small group presentations.

Objective

The objective of this course is to teach you the basics needed to design and build simple optics- and electronics-based instrumentation, including simple computer-programming interfaces. As a test case, in a series of optional hands-on laboratory exercises, you will be able to design, build, and operate an epifluorescence detector appropriate for use with chromatography experiments. Presentations made by groups (for undergraduate students) and individuals (for graduate students) will enable students to delve more deeply into selected topics centered around laboratory and real-world instrumentation.

Instructor and Office Hours

The instructor is Rebecca Jockusch. Please feel free to call her "Rebecca." Office hours will be held every Tuesday from 3:00-5:00 in her office in Lash Miller, LM253.

The instructor can also be reached by email at rebecca.jockusch@utoronto.ca, but there is no guarantee that every email will be answered.

Topics and Schedule

A schedule will be posted on the course website detailing meeting times, places, and tentative topics for each class period. Lectures will be in LM155. The undergraduate course, CHM417, meets Tuesdays from 1:00-3:00 PM in for the entire semester. Graduate students enrolled in CHM1106 will attend the same lectures during the first part of the course. For the second part of the course (beginning with November 14), the CHM1106 (graduate course) meeting time will change to Thursdays, 6-8 pm.

The shared CHM417/CHM1106 lectures will have introductory information about electronics (voltage and current, resistors, capacitors, inductors, diodes, transistors, op-amps) in September , optics (light sources, wavelength selectors, detectors, lenses, mirrors, prisms, polarizing optics, microscopy) in October and an introduction to programming for instrumental control (in Python or LabVIEW) in November.

In the last third of the course, CHM417 (undergraduate) students will delve more deeply into instrumentation and methods in fluorescence spectroscopy and microscopy. Each undergraduate student will make a short presentation as part of a small (~3 person) group presentation focused on some aspect of instrumentation. Groups and topics for these presentations will be assigned during the first part of the course. These presentations represent an important mark for the presenting students, and we will discuss the requirements in detail in the near future.

In the last third of the course, graduate students who are enrolled in CHM1106 will give lectures describing instruments used in their labs. These presentations represent an important mark for the presenting students, and we will sign up for presentation slots and discuss the requirements in detail in the near future. *Undergraduate students* may earn **extra credit** by attending the graduate student presentations and submitting questions after the presentation.

Important Sessional Dates:

September 12: first day of CHM417/CHM1106
November 6: last day to drop F section code courses from academic record and GPA
November 6-10: fall break (no classes)
December 5: last day of CHM417

Tests

Test 1: Tuesday October 17, 1-3 pm (in class period but in IN204)
Test 2: Thursday November 16, 6-8 pm **(note the evening time slot**: HA 410)

There is no final exam in this course.

Tests are designed to include questions that will require you to think rather than simply plug values into memorized equations. Occasionally, this results in questions that are ambiguously worded or that have multiple partly-correct answers. As a result, when marking exams, partial credit and bonus points

are liberally awarded. So, as you answer questions on tests and exams in this course, if you find one that is especially tricky, don't panic! Simply give the best possible answer and talk with the instructor about the question after the test. Good test-taking strategy suggests that you should not waste time obsessing about tricky questions; simply give your best answer and move on to the others. Re-marks will be considered for test papers that have not left the instructor's office.

Labs

A series of five labs will be held in LM206 on **Thursday evenings, 6-8 pm**. There will be no formal lab reports; however, the labs will useful for understanding the lecture content, and several questions on the tests may be taken directly from the lab experiments.

Outside-of-Class Labs	
Thursday, September 21, LM 206	Lab 1
Thursday, October 5, LM 206	Lab 2
Thursday, October 19, LM 206	Lab 3
Thursday, October 26, LM 206	Lab 4
Thursday, November 2, LM 206	Lab 5

Participation in these labs is voluntary; however, please note that **there will be no makeups and/or alternate times**, and if you do not participate in these activities, your course mark may suffer. If you have unavoidable scheduling conflicts, you should consider not taking this course.

Reference Materials

There is no formal required text for this course – the content that you will be responsible for will be presented in lectures, labs, and problem-sets. However, there are several references that may be useful for independent preparation, including:

Texts

Principles of Instrumental Analysis by Skoog, Holler, and Nieman
The Art of Electronics by Horowitz and Hill
Optics by Hecht
Building Scientific Apparatus by Moore, Davis, and Coplan

On-line resources:

Hyperphysics is an excellent resource for many, many physical concepts:
http://hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html
A user-friendly online circuit emulator can be found at:
http://www.falstad.com/circuit/
A website designed to teach about beginning circuitry is:
http://www.allaboutcircuits.com/

Website

Our website is hosted by the U of T Blackboard server. Students are expected to regularly check the course website. To access the website, go to http://portal.utoronto.ca/ and log in with your UTOR ID and password. On the right side of the introduction page, you should see the title of this course listed as a link. I will regularly post lecture slides, announcements, and other information on the website.

Problem Sets and Old Tests

As the course progresses, problem sets and answer keys will be posted on the website. The problem sets will not be collected or graded; however, it is highly recommended that you complete them and make sure that you understand the relevant concepts. In addition, copies of old midterms will be posted for practice.

Marking Scheme

The marking scheme is detailed below. The details of the presentation assignment will be discussed in class, and pdfs detailing the assignment and assessment criteria will be available on the course website.

Undergraduate Students	**Graduate Students**	**Date/timing**
Test 1 (30%)	Test 1 (30%)	Tuesday October 17, 1-3 pm (IN 204)
Test 2 (30%)	Test 2 (30%)	Thursday November 16, 6-8 pm **(note the evening time slot**; HA410)
Group Presentation (30%)	Individual Presentation (30%)	These will be made during the last third of course. Sign-ups will determine in class presentation schedule.
Participation (10%)	Participation (10%)	Throughout course

Extra Credit: Undergraduate students may earn up to 3% extra credit (1% per session) by attending CHM1106 graduate student lectures and turning in a question about *each* of the graduate student lectures that day. The question you turn in may be a question that you ask after/during the lecture, but not a question that was asked by someone else.

Late Assignments and Absences

Absences and missed or late assignments are discouraged, but are understood to be unavoidable in some cases. In general, there will be no "make up" or "late assignments" in this course. In very rare cases a late assignment may be considered; such cases must be negotiated with the instructor, and

appropriate late penalties (e.g., 4% per day) will be applied. Supporting documentation such as a UofT medical or death certificate may be required.

Academic Integrity

The university treats cases of cheating and plagiarism very seriously. Refer to the *Code of Behaviour on Academic Matters* for details:
http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf

Final Thoughts

You are advanced students in our department, and as such, it is anticipated that most students should be able to pass this course (i.e., a "D-" for undergrads or a "B-" for grad. students), and that many students will make high marks. Note that this is ***not*** a guarantee, and assumes sufficient time and effort devoted to learning the material.