



## Chemistry 221

# Instrumental Analysis



Spring 2012

**LECTURE:**

- MWF 12:50 - 1:40 p.m.
- B203 Angell

**INSTRUCTOR:**

- Joel Goldberg
- 438 College Street, Room 204
- (802) 656-1273
- [Joel.Goldberg@uvm.edu](mailto:Joel.Goldberg@uvm.edu)
- <http://www.uvm.edu/~jgoldber/>

**DESCRIPTION:**

This course presents a survey of instrumental methods of chemical analysis. We will focus on understanding the fundamental principles underlying instrumental methods and their realization in modern instrumentation for chemical analysis. We will focus on the following broad methodological areas:

- Electrochemistry,
- Chromatography,
- Optical Spectroscopy, and
- Mass Spectrometry.

This is *not* a "how-to" course; you will not learn how to operate analytical instruments nor will we cover specific analytical "recipes;" these change (sometimes quite quickly) with time as the discipline grows, so our focus on principles and concepts of implementation should provide greater insight both into how current instruments work as well as the basis for your understanding how they will work a decade from now.

Lastly, we will pay attention to the chemical systems to which these methods are applicable and how best to obtain the chemical information desired using the most appropriate instrumental methods.

**LEARNING OBJECTIVES:**

You should develop an understanding of the analytical capabilities of a number of instrumental methods and be able to suggest suitable instrumental methods for particular analytical problems. In order to choose the best instrumental method for addressing an analytical problem, we will consider:

- the property or quantity of the chemical system to be measured,
- the physical and chemical principles upon which the measurement is based,
- generation of a signal by a suitable detector (transducer) and the processing of the signal to convert it to a form appropriate for a readout device, and
- the strengths and limitations of each particular instrumental method or approach.

In order to make these kinds of assessments, you will need to understand:

- the chemical and/or physical principles exploited during the measurement
- how the instrument actually makes the measurement, and
- some of the techniques used to improve analytical figures of merit (such as accuracy, precision and sensitivity).

**OFFICE HOURS:**

During the first week of the semester, based on your schedules and on my availability, I will schedule office hours for the semester - these will be posted on the website for the course and will be announced in class, as well. I am available at other times as well (see me to make an appointment) and, of course, you are welcome to stop by my office at your convenience, but if I am busy we will have to reschedule for another time. Also, I am *virtually* available via [email](mailto:joel.goldberg@uvm.edu) for your questions; I check my email regularly every day (even on weekends), so you should be able to get an email reply to a question within 12 hours of your posting it to me (barring any unforeseen technical difficulties!). Please put "CHEM 221:" as a prefix on the subject line in order to ensure my prompt attention.

**TEXT:**

*Principles of Instrumental Analysis - 6th Edition* by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).

NOTE: This is not an inexpensive book (a kind way of saying that it is expensive!), but it is one that we will use for all assigned readings and problems. It is an excellent reference book as well, that will serve any practicing chemist or scientist who uses modern chemical instrumentation. Do not skimp and buy an earlier edition or the softcover international edition - they are not the same book!

**GRADING:**

There will be three "hour" exams and one comprehensive Final Exam. The "hour" exams are *tentatively scheduled* for February 15th, March 21st, and April 18th (all Wednesdays). These exams will be administered at 7:00 p.m. on those dates and, although you will be allowed as much time as you would like, they should take no more than two hours to complete. The Final Exam is scheduled for Monday, May 7th at 1:30 pm in B203 Angell.

Your grade for the course will be determined as follows:

Exam I:	200 points
Exam II:	200 points
Exam III:	200 points
Final Exam:	400 points

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**TOTAL:** 1000 points

**LECTURE:**

A tentative [lecture schedule](#) is available with links to detailed lecture/reading/problem lists for each unit that we cover. It is important to realize that it is not possible to learn all that you need to know about Instrumental Analysis from just the text, lectures, supplemental readings, or problem sets. Rather, attention must be paid to *all* of these areas as the material covered in each is designed to be complementary. I think that you will find that the problems in the problem sets (and exams!) will be easier to solve if you've attended the lectures and done the assigned readings.

I encourage you to come to lecture having already read the assigned material as I would prefer to spend as much of our class time *discussing* the

material, answering your questions about the material and asking *you* questions about the material. Obviously, our time in class will only be meaningful if you've already read the assigned readings for that particular unit.

Your attendance in class is, of course, expected - if there is a class that you know you will not be able to attend, please let me know ahead of time so that we can make sure you don't miss anything.

The assigned readings and problems for the material we are covering are listed on the web page for the course ([www.uvm.edu/~jgoldber/courses/chem221](http://www.uvm.edu/~jgoldber/courses/chem221)). Additionally, you will find direct links on that site to lecture slides for each class. It is my intention to have the lecture slides for each class uploaded and available on the web at least 24 hours *prior* to each class, so that it should be possible to print out a copy of them for you to use as a reference during class.

**PROBLEM SETS:**

Problem sets will not be collected and are not "due" at any particular time -- it is in your best interests, however, to work the problem sets contemporaneously with the lecture material. Detailed solutions to the problems sets will be made available online at the [course website](#). Problems just like or very similar to those on the problem sets have a habit of finding their way onto exams, so it would be prudent of you to ensure that you can work the relevant problem set problems before you take one of the exams.

**THE WEB:**

The website ([www.uvm.edu/~jgoldber/courses/chem221](http://www.uvm.edu/~jgoldber/courses/chem221)) for this course is an integral tool for this class -- you **must** have web and email access in order to obtain all of the assignments and materials for this course. All materials relevant to this course will be made available online at the course website. All reading and problem set assignments and solutions will be made available **ONLY** on the course website (i.e., I will not hand out hardcopies during the semester -- you will need to go online to the website to get them). All PowerPoint lecture slides will be made available online as will [old exams](#) (from Spring 2011) and solutions to [this year's exams](#). If you do not currently have access to the web, please see me as soon as possible so that I can assist you in getting online so that you can access all of the materials available for this course!

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[Joel.Goldberg@uvm.edu](mailto:Joel.Goldberg@uvm.edu)

E-MAIL

**Chemistry 221**  
**Instrumental Analysis**  
**Course Schedule**

**Spring 2012**

Ok, realize that this is only a *tentative* schedule and can change at a moment's notice (with the update indicated here, of course!).

<i>Approximate Dates</i>	<i>Topics</i>	<i>Assignments</i>	<i>Exams</i>
January <a href="#">18</a> , <a href="#">20</a> , <a href="#">23</a> , <a href="#">25</a> , <a href="#">27</a>	<i><a href="#">Introduction: Signals and Noise</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	-
January <a href="#">30</a> February <a href="#">1</a> , <a href="#">3</a> , <a href="#">6</a>	<i><a href="#">Electrochemistry</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	-
February <a href="#">8</a> , <a href="#">10</a> , <a href="#">13</a>	<i><a href="#">Optical Spectroscopy I:</a> <a href="#">Intro/Background</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	<i><a href="#">Exam #1</a> <a href="#">7:00 pm</a> <a href="#">Wednesday</a> <a href="#">February 15th</a></i>
February <a href="#">13</a> , <a href="#">17</a> , <a href="#">22</a> , <a href="#">24</a> , <a href="#">27</a> , <a href="#">29</a>	<i><a href="#">Optical Spectroscopy II:</a> <a href="#">Instrumentation</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	-
February <a href="#">29</a> March <a href="#">2</a> , <a href="#">16</a>	<i><a href="#">Optical Spectroscopy III:</a> <a href="#">IR Molecular Absorption</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	<i><a href="#">Exam #2</a> <a href="#">7:00 pm</a> <a href="#">Wednesday</a> <a href="#">March 21st</a></i>
March <a href="#">16</a> , <a href="#">19</a> , <a href="#">23</a> , <a href="#">26</a> , <a href="#">28</a> , <a href="#">30</a>	<i><a href="#">Optical Spectroscopy IV:</a> <a href="#">Atomic Absorption and Emission</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	-
March <a href="#">30</a> April <a href="#">2</a> , <a href="#">4</a> , <a href="#">6</a> , <a href="#">9</a> , <a href="#">11</a> , <a href="#">13</a>	<i><a href="#">Optical Spectroscopy V:</a> <a href="#">Molecular Luminescence and Raman</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	-
April <a href="#">16</a> , <a href="#">20</a> , <a href="#">23</a> , <a href="#">25</a> , <a href="#">27</a>	<i><a href="#">Mass Spectrometry</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	<i><a href="#">Exam #3</a> <a href="#">7:00 pm</a> <a href="#">Wednesday</a> <a href="#">April 18th</a></i>
April <a href="#">27</a> , <a href="#">30</a> May <a href="#">2</a>	<i><a href="#">NMR Spectroscopy</a></i>	<a href="#">Readings</a> <a href="#">Problems</a>	-
			<i><a href="#">Final Exam</a> <a href="#">1:30 pm</a> <a href="#">Monday</a> <a href="#">May 7th</a></i>

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[Joel.Goldberg@uvm.edu](mailto:Joel.Goldberg@uvm.edu)

E-MAIL