Instrumental Analysis (Chem 5640)

Instructor: Dr. Leo Chen

Class Times/Location: 1:00 PM - 1:50 PM MWF/ESLC 053
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Office Hours: open office

Course Text: Principles of Instrumental Analysis (6th Edition) by Skoog, Holler and Crouch, published by Thomson Brooks/Cole. Note: Supplementary course material, literature references along with class handouts, will be provided in class or on the web and will be announced in-class. Students may also find the following supplemental text useful: “Undergraduate Instrumental Analysis” (7th Ed.) by Robinson and Frame.

Course Learning Objective: This course will focus on the theory and application of instrumental methods in quantitative analysis, separation and identification of chemical and biological substances. Satisfactory completion of this course will afford students a working knowledge of analytical instrumentation typically employed in chemistry, biochemistry and biology research laboratories. It will also provide the student with an appreciation of the relative strengths and limitations of different instrumental based analysis methods, as well as current state of the art analytic instrumentation.

Specific Course Learning Objectives Include:

* Demonstrate knowledge of sampling methods for all states of matter.
* Integrate a fundamental understanding of the underlining physics principles as they relate to specific instrumentation used for atomic, molecular, vibrational, mass spectrometry, and magnetic resonance spectrometry and chromatography.
* Assess sources of error in chemical and instrumental analysis and account for errors in data analysis.
* Recognize interferences in chemical and instrumental analysis.
* Apply and assess concepts of availability and evaluation of analytical standards and formulate standardization methodology.
* Understand and be able to apply the theory and operational principles of analytical instruments.
* Distinguish between qualitative and quantitative measurements and be able to effectively compare and critically select methods for analytic analyses.

Very important note: This course emphasizes teaching analytic methods and instruments that are currently used in the laboratories to address real questions, so that the students can benefit from the class to their feature careers. Reading the textbook is an essential component of the class. This will enable the class to have more time to cover the practical aspects of different analytic methods and instrumentation. Students should read ahead and be prepared to ask/answer questions during class on the material as it is covered. In addition to class lectures based upon material in the textbook, we will cover materials in more detail and discuss recent advances in instrumentation beyond what is covered in the textbook. In these cases, supplementary
course material will be provided to the student either as handouts or as web links.

**Exams:** Three one hour exams will be held at normal class times as indicated on the attached class schedule. Exams will comprise material and problems similar to those discussed during class lecture, textbook example problems and problems assigned at the end of each chapter of the text. In class examinations will generally concentrate on new material covered since the last exam. The final examination will be comprehensive and cover material from the entire semester. The final examination is currently scheduled for Monday, April 27 from 11:30 AM - 1:20 PM.

**Take Home Problems:** Typically one or more take home problems will be assigned or handed out each week relating to material being covered in class. These problems will be graded and your % average for all of the problems will count as part (100 points maximum) towards your final class grade.

**Missed Exam Policy:** Missed exams which have a well documented and acceptable cause can be made up by a student, at the discretion of the instructor, by taking an appropriate make up exam to be schedule at a mutually agreeable time. Excusable absences include: (1) illness when verified by a note from the Student Health Center or your doctor; (2) a family emergency which will require a note from your academic advisor and (3) any regularly scheduled university activities (e.g., sports teams) only with prior approval and a note from the person in charge of the activity stating explicitly the reasons for the absence. Students should notify the instructor in advance, if possible, prior to missing any exam. Students missing an exam will have one week to notify the instructor that they have a valid excuse and to produce the necessary documentation.

**Grading:** Grades will be assigned according to the results from three in class exams, in-class quizzes and the final examination using the following point distributions:

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<thead>
<tr>
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<th>Points</th>
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<tbody>
<tr>
<td>Take Home Problems</td>
<td>100</td>
</tr>
<tr>
<td>Exam I</td>
<td>100</td>
</tr>
<tr>
<td>Exam II</td>
<td>100</td>
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<tr>
<td>Exam III</td>
<td>100</td>
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<tr>
<td>Final Exam (Comprehensive)</td>
<td>100</td>
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</tbody>
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**Total** 500 Points

**Grading Scale (percentage of 500 points)**

A: 100-90%  B: 89-80%  C: 79-70%  D: 69-60%  F: below 60%

The grade designations + and - will also be used for final letter grades for the class.

**Note:** Grade cutoffs may change to lower percentages (but not higher) depending upon the exact class exam averages. Also, the attached class schedule is tentative. I will
attempt to follow it as closely as possible with respect to lecture topics and exam material. However, any changes as to the exact material to be covered in lecture and on each exam will be announced in class. It is therefore important for you to attend class regularly.

**Course Withdrawal:** Students may withdraw from Chemistry 5640 as outlined in the current on-line edition of the Utah State University General Catalog (web link: [http://catalog.usu.edu/content.php?catoid=7&navoid=1259 - Dropping Courses]).

**Additional Provisions:** The administration of Chemistry 5640 will adhere strictly to the USU Academic Policies outlined in the current on-line edition of the Utah State University General Catalog. The complete code of Policies and Procedures for Students can also be viewed online at: [http://www.usu.edu/studentservices/studentcode/](http://www.usu.edu/studentservices/studentcode/).

**Spring Holidays:** Because of the two spring semester Monday holidays (Martin Luther King, Jr. Day, January 20 and President’s Day, February 17), students will attend their Monday schedule of classes on Tuesday, February 18.

**Final Note:**

*In accordance with the Americans with Disabilities Act, reasonable accommodation will be provided for all persons with disabilities in order to ensure equal participation in Chemistry 3000. A student who requires an accommodation must contact the Instructor. The disability must be documented by the Disability Resource Center. In cooperation with the Disability Resource Center, reasonable accommodation will be provided for students with Disabilities. Course material may be requested in alternate formats through the Disability Resource Center (phone number 797-2444).*

**New Course Evaluation System**

**Categories for Primary Course Learning Objectives:**

I. **Basic Cognitive Background**
   - Gaining factual knowledge (terminology, classifications, methods, trends)
   - Learning fundamental principles, generalizations, or theories

II. **Application of Learning**
   - Learning to apply course materials (to improve rational thinking, problem solving and decisions)
   - Developing specific skills, competencies and points of view needed by professionals in the field most closely related to this course
Instrumental Analysis (Chem 5640) Tentative Course Content Outline

I. Orientation

II. Introduction (1 lecture), Charter 1

III. Basics of Spectroscopy
   a. Introduction to Spectroscopic Methods (1 lecture) Chapter 6
   b. Components of Optical Systems (1 lecture) Chapter 7

IV. Molecular Spectroscopy – UV-Vis
   a. Introduction to UV-Vis molecular spectroscopy (2 lectures) Chapter 13
   b. Applications of UV-Vis spectroscopy (1 lecture) Chapter 14

V. Molecular Spectroscopy – Fluorescence
   a. Fluorescence, phosphorescence and chemiluminescence (2 lectures) Chapter 15
   b. Applications of Fluorescence spectroscopy (4 lectures)

End of Material for First Exam

VI. Molecular Spectroscopy – Vibrational excitation
   a. IR absorption spectroscopy (2 lectures) Chapter 16
   b. Applications of Infrared Spectrometry (1 lectures) Chapter 17
   c. Raman Spectroscopy (2 lectures) Chapter 18
   d. Application of Raman Spectroscopy (4 lectures)

VII. Molecular Spectroscopy – Nuclear transitions
   a. NMR (3 lectures) Chapter 19

VIII. Atomic Spectroscopy
   a. An Introduction to Optical Atomic Spectroscopy (1 lectures) Chapter 8
   b. Atomic absorption spectroscopy (1 lecture) Chapter 9
   c. Atomic Emission Spectroscopy (1 lecture) Chapter 10

End of Material for Second Exam

IX. Additional Instrumental Methods for Structural Analysis
   a. Mass Spectrometry (3 lecture) Chapter 20
   b. Mass Spectrometry in biological applications (3 lectures)

X. Separation Science
   a. Fundamentals of chromatographic separations (1 lectures) Chapter 26
   b. Gas chromatography (1 lectures) Chapter 27
   c. High performance liquid chromatography (1 lectures) Chapter 28

XI. Particle/protein size determination (1 lecture) Chapter 34

End of Material for Third Exam

Final Exam (Comprehensive) - Monday, April 27 from 11:30 AM - 1:20 PM