

# Course Syllabus for Instrumental Analysis (Chem 5640) Spring 2018

**Instructor:** Associate Professor Kimberly Hageman

Class Times/Location: 12:30 PM - 1:20 PM MWF, ESLC 053

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**Office Hours:** T 3:30-4:30 PM & F 4-5 PM

**Note:** office hours are subject to change; changes will be announced in class

**Course Text:** Principles of Instrumental Analysis (7th Edition) by Skoog, Holler and Crouch, published by Cengage Learning. **Note:** Supplementary course material, 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 texts useful: "Principles of Electronic Instrumentation" (3rd Ed.) by Diefenderfer and Holton and "Undergraduate Instrumental Analysis" by Robinson, Frame and Frame (7th Ed.).

**Overall Course Learning Objective:** This course concerns the theory and practice of instrumental methods for the separation, identification and quantitative analysis of chemical substances. Satisfactory completion of this course will afford students a working knowledge of analytical instrumentation typically employed in chemical/biochemical research and industry laboratories. It will also provide the student with an appreciation of the relative strengths and limitations of different instrumental based analysis methods.

## Specific Course Learning Objectives:

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

**Important note: Reading the textbook is an essential** component of the class. 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 may cover material in more detail or 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 in-class 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 lectures, 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. It will be based upon the nationally administered American Chemical Society Instrumental Analysis exam. The class results from the ACS standard exam will also be used anonymously as part of the Department of Chemistry's assessment process (see this web link for more information on university assessment: <http://www.usu.edu/aaa/>). The final examination for the course is currently scheduled for Monday, April 30 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 will count as part (100 points maximum) of your final class grade. Weekly problem sets will be worth 10 points each and the 10 best scores will be used to determine your overall points. Typically, 12 problems sets are assigned.

**Missed Exam Policy:** Missed exams with a well-documented and acceptable cause can be made up by a student, at the discretion of the instructor. Make-up exams will be scheduled 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 documented by a note from your academic advisor and (3) 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 reason for the absence. Students are expected to notify the instructor in advance of missing an exam; students are required to produce the necessary documentation within one week after missing the exam.

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

Take Home Problems 100 points  
Exam I 100 points  
Exam II 100 points  
Exam III 100 points  
Final Exam (Comprehensive) 100 points  
**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.

\*\* Grade cutoffs **may** change to lower percentages (but **not** higher) depending upon the exact class exam averages.

**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 for Spring 2017 academic calendar with deadlines: <http://www.usu.edu/registrar/>).

**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://studentconduct.usu.edu/studentcode/index>.

**Spring Holidays:** Because of the two spring semester Monday holidays (Martin Luther King, Jr. Day, January 15 and President's Day, February 19), students will attend their Monday schedule of classes on Tuesday, February 21.

**Note about Disabilities:**

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 5640. 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).

**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

**Note about course schedule:** The attached course 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 all classes.

## **Instrumental Analysis (Chem 5640) Tentative Course Content Outline**

### **I. Measurement Principles and Electronics**

- a. Introduction to the analytical process (2 lecture) Chapter 1
- b. Basic electronics (1 lectures) Chapter 2, 3, 4
- c. Signals and noise (2 lectures) Chapter 5

### **II. Basics of Spectroscopy**

- a. Introduction to Spectroscopic Methods (2 lecture) Chapter 6
- b. Components of Optical Systems (2 lecture) Chapter 7

### **III. Atomic Spectroscopy**

- a. An Introduction to Optical Atomic Spectroscopy (2 lectures) Chapter 8
- b. Atomic absorption spectroscopy (2 lecture) Chapter 9
- c. Atomic Emission Spectroscopy (2 lecture) Chapter 10

## **End of Material for First Exam (tentatively scheduled for Wednesday February 21)**

### **IV. Molecular Spectroscopy – Electronic transitions**

- a. Introduction to UV-Vis molecular spectroscopy (2 lectures) Chapter 13
- b. Applications of UV-Vis spectroscopy (2 lecture) Chapter 14
- c. Fluorescence, phosphorescence and chemiluminescence (2 lectures) Chapter 15

### **V. Molecular Spectroscopy – Vibrational excitation**

- a. IR absorption spectroscopy (2 lectures) Chapter 16
- b. Applications of Infrared Spectrometry (2 lectures) Chapter 17

### **VI. Molecular Spectroscopy – Nuclear transitions**

- a. NMR (3 lectures) Chapter 19

## **End of Material for Second Exam (tentatively scheduled for Friday March 30)**

### **VII. Additional Instrumental Methods for Organic Structural Analysis**

- a. Mass Spectrometry (3 lecture) Chapter 20

### **VIII. Separation Science**

- a. Fundamentals of chromatographic separations (3 lectures) Chapter 26
- b. Gas chromatography (2 lectures) Chapter 27
- c. High performance liquid chromatography (2 lectures) Chapter 28

## **End of Material for Third Exam (tentatively scheduled for Wednesday April 25)**

## **Final Exam (Comprehensive) – Monday April 30, 11:30am – 1:20pm**