

## Syllabus for Chem 314, Instrumental Analysis Spring Semester 2023

Instrumental Analysis, 4 credit hours; Prerequisite: Phys 112, Chem 212, Chem 214, and either Chem 222 or Chem 224 and 226 or permission of the instructor.

Instructor: Dr. Paul Chiarelli, Flanner Hall 102, phone 508-3106, E-mail: mchiare@luc.edu. Office hours, Monday, Tuesday, and Thursday 10 -11:30 AM **or by appointment.**

Classes are held MWF from 12:35 to 1:25 PM in FH 105 Labs are held MW from 1:40 to 5:30 PM in FH 314/315.

**Course Description:** Chem 314, Instrumental Analysis, is a writing intensive, capstone course for students in BS or BA Chemistry Track. Students enrolled in this course will become familiar with modern methods of chemical analysis. Students will learn to analyze and write/present their results and analysis in a clear and concise manner. Specific learning outcomes associated with this course are listed (but not limited to) as follows:

- 1) Students will develop an understanding of the function of basic components of chemical instrumentation.
- 2) Students will be able to interpret recorded data with standard statistical methods including noise analysis.
- 3) Students will understand how different methods of chemical separation are used for the analysis of different compound classes.
- 4) Students will learn how optical spectroscopy is used to identify specific structural features of molecules.
- 5) Students will learn fundamental aspects of electrochemical analysis involving voltammetry, amperometry, and potentiometry.
- 6) Students will become familiar with how mass spectrometry is used to determine molecular weights, empirical formulas, and primary structural features of different molecules.
- 7) Students will learn how to write their experimental results in a manner consistent with chemical literature practices.
- 8) Students will learn how to use electronic resources for searching the chemical literature.

**Textbook:** "Fundamentals of Analytical Chemistry" (10th edition), by D.A. Skoog, D.M. West, F.J. Holler, and S.R. Crouch. Print ISBN: 9780357450390, 0357450396 eText ISBN: 9780357450437, 0357450434.

**Other Materials for lecture and lab:** You will need an inexpensive calculator having logarithmic (base 10 and base e), exponential, and trigonometric functions. Be sure you are familiar with your calculator and that it is in user-ready condition for quizzes and exams. **Calculators cannot be shared during exams and the covers must be removed while taking the exam.** You will need a laptop computer with Microsoft Excel for use in the laboratory. You will need a composition book for lab.

## TENTATIVE CLASS SCHEDULE

<b>Date</b>	<b>Day</b>	<b>Topic</b>	<b>Chapter</b>
Jan 16	Monday	MLK day, no class	
Jan 18	Wednesday	Introduction/Review of Fundamental Concepts	
Jan 20	Friday	Statistics, Random and Systematic Error in Measurements	5
Jan 23	Monday	Statistical Tests in Chemical Analysis	5
Jan 25	Wednesday	Statistical Tests Continued	
Jan 27	Friday	Statistical Tests Continued	
Jan 30	Monday	Sampling and Calibration Methods	6
Feb 1	Wednesday	Quantification Methods	8
Feb 3	Friday	Exam 1: Chapters 5,6,8	
Feb 6	Monday	Introduction to Chromatography	29
Feb 8	Wednesday	Gas Chromatography	30
Feb 10	Friday	High Performance Liquid Chromatography	31
Feb 13	Monday	Ion Exchange and Ion Chromatography	31
Feb 15	Wednesday	Size Exclusion, Chiral, and Affinity Chromatography	31
Feb 17	Friday	Chromatography Detectors; FID, ECD, and Thermal Conductivity	31,32
Feb 20	Monday	Detectors continued, NPD, Photoionization, light scattering	31,32
Feb 22	Wednesday	Exam 2: Chromatography and detectors	30,31,32
Feb 24	Friday	Electrochemistry: Basic Concept Review	16,17
Feb 27	Monday	Potentiometry, Reference Electrodes	19

Mar 1	Wednesday	Potentiometry	19
Mar 3	Friday	Electrogravimetry and Coulombic methods of Analyses.	20
March 6-10		Spring Break	
Mar 13	Monday	Amperometric Analyses	20
Mar 15	Wednesday	Exam 3: Electrochemistry	16,17,19,20
Mar 17	Friday	Introduction to Voltammetry Reference Electrodes	21
Mar 20	Monday	Stripping Voltammetry	21
Mar 22	Wednesday	Cyclic Voltammetry	21
Mar 24	Friday	Introduction to Spectroscopic Methods Electromagnetic Spectrum	22
Mar 27	Monday	Instrumental Components for Absorption and Emission Spectroscopy	22
Mar 29	Wednesday	Molecular basis of Fluorescence and Phosphorescence	25
Mar 31	Friday	Instrumental components and instruments	22, 25
Apr 3	Monday	Instrumental components and instruments Continued	22,25
Apr 5	Wednesday	Exam 4: Voltammetry, UV Absorption, and Emission Spectroscopy	21,22,25
April 8	Friday	Easter Break, No Class	
Apr 10	Monday	Easter Break, No Class	
Apr 12	Wednesday	Introduction to Infrared Spectroscopy	22,23
Apr 14	Friday	Light Sources for IR Spectroscopy	
Apr 17	Monday	Detectors for IR Spectroscopy	
Apr 19	Wednesday	Fourier Transform IR Spectroscopy	23
April 21	Friday	Introduction to Mass Spectrometry	27

April 24	Monday	Quadrupole Mass analyzers
Apr 26	Wednesday	Time-of-Flight mass analyzers, ion traps
Apr 28	Friday	Ionization methods, Electron Ionization, Electrospray, DESI, and MALDI

### Final Exam

The University sets the schedule for all final exams. The final will be held on:

**Friday, May 5, 9-11 AM**

in Flanner Hall 105. You will have exactly 2 hours to complete the exam. Additional time will not be granted, even if you arrive late. There will be no make-up final exams given under any circumstance, and the exam will not be given early, either.

Instructors may not reschedule final exams for a class for another day and/or time during the final exam period. There can be no divergence from the posted schedule of dates for final exams. Individual students who have four (4) final examinations scheduled for the same date may request to have one of those exams rescheduled. If a student reports having four final examinations scheduled for the same date, should be directed to e-mail a petition to Adam Patricoski, Assistant Dean for Student Academic Affairs, CAS Dean's Office ([apatricoski@luc.edu](mailto:apatricoski@luc.edu)).

**Laboratory Assignments:** Students are expected to arrive with a working knowledge of the content of the assigned lab and be ready to begin promptly in order to complete the various tasks associated with the laboratory assignment. Students are expected to read the material made available on Sakai and in class prior to the lab and are encouraged to read web-based materials on various subjects as well. Students who do not prepare adequately for lab will lose points on their lab reports. Students will work together in groups of two to ensure that each student has "hands-on" experience with each instrument. Groups will follow different schedules (for the most part) over the course of the semester to ensure that everyone gets experience with a wide variety of instrumentation. Because several instrumental techniques are being covered simultaneously in the laboratory, the lecture and the lab will not run in synch. **Time will be carved out of the lecture schedule to discuss basic concepts and procedures associated with each laboratory. We will also discuss how lab assignments should be written.** The first scheduled lab period will be used for these purposes as well.

Working in groups is not easy. We expect you to make an honest effort to evaluate your own contribution and that of your partners to the group. At week three, you will be given an opportunity to choose different lab partners. If an individual performs so poorly within a group that they are not "desirable" they will be expected to complete the entire lab on their own.

**Grading:** The total grade for the course is based on four exams (including the final) and your writing assignments. Each exam is worth 11% of your grade (total 44%). The final is worth 16 % of your grade. The final is not cumulative. Your lab writing assignments will constitute the other 40% of your grade. In order to do well on the exams, you need to take good notes in class, read the material in the textbook, and do the assigned problems at the end of each chapter. I do not give multiple-choice exams. You will complete seven laboratory assignments (outlined in the table below). Your writing assignments will consist of six, four-page lab summaries (each is 5% of your total grade) and one nine-page report

(10% of your total grade). I will correct and return the first four 4-page summaries, so you can resubmit them for a better grade. Your nine-page report will be concerned with the analysis of peptides and proteins using ion trap mass spectrometry. The instructor will provide you with a protein (5-10,000 amu molecular weight) to identify. I will correct these reports and return them to you within a week's time. Each of the four-page summaries are worth 5% of your grade. The nine-page paper will be worth 10% of your grade ( $6 \times 5\% + 10\% = 40\%$ ).

**I will correct and return the first four labs you hand in. First drafts must be handed in one week after the lab is completed. Second drafts are due one week after you receive my corrections on the first draft. You will lose 5 pts on your score for each day an assignment is late.**

The grading scale is as follows:

**A 100-93; A- 92-89; B+ 88-85; B 84-81; B- 80-77; C+ 76-73; C 72-69; C- 68-65; D 64-57; F <56.**

Week	<u>Tentative</u> Lab Schedule	
	Group 1	Group 2
Jan 16	No Lab, MLK day	
Jan 23	Introduction, Writing Summaries and Lab Reports, Statistics, Lab Procedures	
Jan 30	Ion Chromatography	UV-Vis Spectroscopy
Feb 6	UV-Vis Spectroscopy	Ion Chromatography
Feb 13	Ion Chromatography	UV-Vis Spectroscopy
Feb 20	HPLC-Fluorescence analysis of Vitamin B homologs	LC/MS-determination of protein MW
Feb 27	LC/MS-determination of protein MW	HPLC-Fluorescence analysis of Vitamin B homologs
March 6	Spring break	Spring break
March 13	HPLC-Fluorescence analysis of Vitamin B homologs	LC/MS determination of protein MW
March 20	Tandem MS of peptides	Cyclic Voltammetry
March 27	Cyclic Voltammetry	Tandem MS of peptides
April 3	Tandem MS of peptides	Cyclic Voltammetry
April 10	Atomic Absorption	GC/MS of halomethanes
Apr 17	No Lab, Easter Break	Atomic Absorption
Apr 24	Atomic absorption	GC/MS of halomethanes

### **Pass/Fail Conversion Deadlines and Audit Policy**

A student may request to convert a course into or out of the “Pass/No-Pass” or “Audit” status only within the first two weeks of the semester. For the Spring 2023 semester, students are able to convert a class to “Pass/No-Pass” or “Audit” through Monday, January 30th. Students must submit a request for Pass/No-Pass or Audit to their Academic Advisor.

### **Health, Safety, and Well-Being On-Campus**

Please be familiar with and adhere to all policies and protocols posted on the *Campus Info & Resources* site:

<https://www.luc.edu/healthsafetyandwellbeing/campusinforesources/>

### **Course Repeat Rule**

Effective with the Fall 2017 semester, students are allowed only THREE attempts to pass Chemistry courses with a C- or better grade. The three attempts include withdrawals (W). The Department advises that it is preferable to complete a course with a grade of C or C-, and to demonstrate growth in future coursework, than to withdraw from a course. After the second attempt, the student must secure approval for a third attempt. Students must come to the Chemistry Department, fill out a permission to register form or print it from the Department of Chemistry & Biochemistry website:

<https://www.luc.edu/chemistry/forms/> and personally meet and obtain a signature from either the Undergraduate Program Director, Assistant Chairperson, or Chairperson in Chemistry. A copy of this form is then taken to your Academic Advisor in Sullivan to secure final permission for the attempt.

### **Student Accommodations**

The Student Accessibility Center (SAC, formerly known as SSWD), Sullivan Center (773-508-3700), <http://www.luc.edu/sac>, has the mission “to support, service, and empower Loyola University Chicago students with disabilities” and to “Partner with faculty and staff to provide opportunities for collaboration, professional development, personal growth, and staff interaction, as they relate to students with disabilities.” Please direct all questions concerning accommodations of disabilities to the Student Accessibility Center. Academic accommodations afforded to students require documentation and review. The Student Accessibility Center will issue accommodation letters for registered students to present to their instructors: accommodations are not active until students present these letters to their instructors. If students’ accommodations involve attendance or deadlines, instructors and students will jointly complete and execute an Agreement Form articulating their terms. See <https://www.luc.edu/sac/faculty/facilitatingaccommodations/> for guidance about implementing various kinds of accommodations in a way that is appropriate to your class. The Student Accessibility Center stands ready to work with you.

### **Academic Integrity**

All students in this course are expected to have read and to abide by the demanding standard of personal honesty, drafted by the College of Arts & Sciences, which can be viewed at:

<https://www.luc.edu/cas/advising/academicintegritystatement/>

A basic mission of a university is to search for and to communicate the truth as it is honestly perceived. A genuine learning community cannot exist unless this demanding standard is a fundamental tenet of the intellectual life of the community. Students of Loyola University Chicago are expected to know, to respect, and to practice this standard of personal honesty.

Academic dishonesty can take several forms, including, but not limited to cheating, plagiarism, copying another student’s work, and submitting false documents.

Any instance of dishonesty (including those detailed on the website provided above or in this syllabus) will be reported to The Chair of The Department of Chemistry & Biochemistry who will decide what the next steps may be. Students caught cheating will receive a grade of zero for that assignment.

### **Loyola University Absence Policy for Students in Co-Curricular Activities (including ROTC):**

Students missing classes while representing Loyola University Chicago in an official capacity (e.g., intercollegiate athletics, debate team, model government organization) shall be allowed by the faculty member of record to make up any assignments and to receive notes or other written information distributed in the missed classes.

Students should discuss with faculty the potential consequences of missing lectures and the ways in which they can be remedied. Students must provide their instructors with proper documentation i.e., "[Athletic Competition & Travel Letter](#)" describing the reason for and date of the absence.

This documentation must be signed by an appropriate faculty or staff member and it must be provided to the professor in the first week of a semester. It is the responsibility of the student to make up any assignments. If the student misses an examination, the instructor is required to allow the student to take the examination at another time.

(<https://www.luc.edu/athleteadvising/attendance.shtml>)

Students who will miss class for an academic competition or conference must provide proper documentation to their instructor as early in the semester as possible.

### **Accommodations for Religious Reasons**

If you have observances of religious holidays that will cause you to miss class or otherwise effect your performance in the class you must alert the instructor **within 10 calendar days of the first class meeting of the semester** to request special accommodations, which will be handled on a case by case basis.

### **Spring 2023 Masking Requirement**

Students will be required to wear masks during the Spring 2023 semester in class and lab. it will remain a principle of this class section that, out of respect for the health of classmates and others in regular contact with members of our community, in this class we properly wear masks at all times (e.g., over nose and mouth).

### **Recording of Zoom class meetings**

In this class software **may** be used to record live class discussions. As a student in this class, your participation in live class discussions will be recorded. These recordings will be made available **only** to students enrolled in the class, to assist those who cannot attend the live session or to serve as a resource for those who would like to review content that was presented. All recordings will become unavailable to students in the class when the Sakai course is unpublished (i.e. shortly after the course ends, per the [Sakai administrative schedule](#)). *Students will be required to turn on their cameras at the start of class. Students who have a need to participate via audio only must reach out to me to request audio participation only without the video camera enabled.* The use of all video recordings will be in keeping with the University Privacy Statement shown below.

### **Privacy Statement**

Assuring privacy among faculty and students engaged in online and face-to-face instructional activities helps promote open and robust conversations and mitigates concerns that comments made within the context of the class will be shared beyond the classroom. As such, recordings of instructional activities occurring in online or face-to-face classes may be used solely for internal class purposes by the faculty member and students registered for the course, and only during the period in which the course is

offered. Students will be informed of such recordings by a statement in the syllabus for the course in which they will be recorded. Instructors who wish to make subsequent use of recordings that include student activity may do so only with informed written consent of the students involved or if all student activity is removed from the recording. Recordings including student activity that have been initiated by the instructor may be retained by the instructor only for individual use.