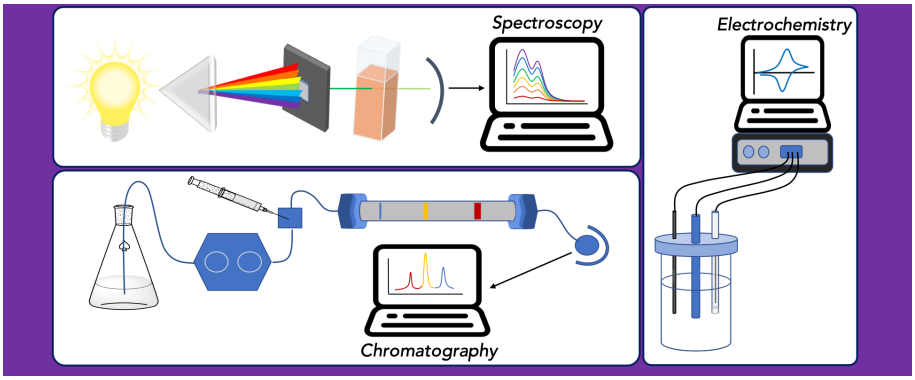
Course Syllabus
CHEMISTRY 446 – INSTRUMENTAL ANALYSIS

INSTRUCTOR: DR. RIHA
OFFICE: CBB448
EMAIL: sriha@uwsp.edu

LECTURE: M/W 10:00-10:50 AM
CBB105

LAB: M/W 11:00 AM -1:50 PM
CBB466 & 476



COURSE DESCRIPTION

What do Martian soils, bodily fluids of racehorses and Olympic athletes, commercial and military jet aircraft oil, and the Vinland Map have in common? They all depend on the use of instrumental techniques for analysis, verification, and authenticity. Instrumental analysis has become an important part of everyday life due to the rising concern for our environment and our well-being. Instrumental methods can be used to validate and enforce quality control in consumables, analyze new products for the pharmaceutical industry, detect hazardous materials, and analyze tissue samples critical for diagnosing diseases. This course is intended to provide you with the basic principles of chemical instrumentation through hands-on experimentation and discussion. Through a combination of lectures, laboratory experiments, and assignments, you will learn how to apply foundational knowledge of chemical instrumentation to designing and conducting experiments that address scientific questions. Specifically, we will address: 1) instrument components and design, 2) understanding and interpret instrumental data and 3) applications of instrumental analysis. As the senior capstone experience for chemistry majors and an integral part of the communication in the major, students will document, evaluate, and communicate experimental results of an inquiry-based experiment through written and oral presentations.

LEARNING OUTCOMES

At the end of this course, a successful student will be able to:

- APPLY foundational chemical instrument knowledge to operate chemical instrumentation and solve problems.
- ANALYZE data to optimize chemical instrumentation and methods.
- EVALUATE, document, and *communicate* experimental data according to accepted scientific standards
- DESIGN and construct experiments to address scientific questions using appropriate methods, techniques, and modern chemical instrumentation.

REQUIRED MATERIALS

- Course text: *Principles of Instrumental Analysis, 6th Ed.* Skoog, Hollar, Crouch
- Laboratory notebook: Permanently bound notebook(s), preferably quadrille ruled.
- Calculator: Any scientific calculator that can perform logarithms and exponentials.
- Safety goggles

COURSE COMPONENTS

Lecture is focused on the discussion of many different techniques in instrumental analysis and their application to modern society. The format will be a flipped classroom to promote more active learning. Video recordings and video quizzes will be used to introduce each instrumental method, while in-class activities will be geared at a deeper understanding of the technique and its application to real world challenges. To facilitate active discussion in class, students should come prepared by watching assigned videos to become familiar with the instrumental method prior to attending lecture.

Lab is the "hands-on" experience essential to learning chemistry and critical to your success in this course. It gives you the experience of putting the key concepts you covered in lecture into practice, teaches you experimental techniques, and helps you better learn how to problem solve. Students should come to lab prepared—reading the experimental procedure and preparing your notebook—as there will only be two lab periods allotted for each experiment. Knowing which experiments you will be working on in advance will help you stay on track. Finally, use lab time for experimental work only.

GRADING

The grade you receive for the course will be based on the following:

	Point breakdown	*Total Points*	*%*
Lecture		**500**	**50**
Exams	3 @ 100 pts each		
Video Quizzes	20 @ 5 pts each		
In-class Activities	10 Problem Sets @ 10 pts each		
Lab		**250**	**25**
Lab Reports	7 @ 30 pts each		
Lab Notebook	2 @ 20 pts each		
Research Project		**250**	**25**
Research Topic	5		
Proposal-1st Draft	30		
Peer Review	15		
Proposal Presentation	30		
Final Proposal	50		
Abstract	10		
Final Paper	60		
Oral/Poster Presentation	50		

Tentative grading scale cut-offs:

Grade	Point Range	Grade	Point Range	Grade	Point Range
A	1000 – 930	B-	800 – 829	D+	660 – 699
A-	900 – 929	C+	760 – 799	D	600 – 659
B+	860 – 899	C	730 – 759	F	0-629
B	830 – 859	C-	700 – 729		

ASSESSMENT DETAILS

Your progress in this course will be assessed through exams, assignments laboratory exercises, and an independent research project.

Video Quizzes serve as concept checks for lecture videos and assess your preparation for class discussions. These quizzes will be given on Canvas. **Exams** are designed for you to demonstrate what you have learned in lecture and lab. The exams will cover material discussed in lecture AND lab. Exam dates will NOT change.

In-class Activities are designed to help you learn and apply material covered in lecture videos, as well as aid in group discussions. Activities will include traditional problem sets, current literature applications, and case studies. These activities will be completed in-class and your grade will be dependent on participation and completeness.

Lab Reports will be submitted by each student. Details regarding what is to be included in each lab report can be found at the end of the procedure for each experiment. Lab reports must be typed and are due one week after completion of the lab.

Lab Notebooks should be used at all times in the lab to record data as it is collected. Notebooks will be checked at random several times during the semester and graded twice during these random checks. Failure to record data as it is collected will result in a score of zero during a notebook check.

Independent Research Projects allow students to explore their curiosity about a particular scientific question and demonstrate their ability to propose and design experiments to provide new knowledge about that research topic. During the semester, you will plan and execute an independent research project. The proposal, execution, and presentation will take place in several stages over the course of the semester. Details for each component are provided below.

INDEPENDENT RESEARCH PROJECT

Project proposal The project proposal will be spit up into multiple parts: 1) submission of research topic, 2) 1st draft of research proposal, 3) peer review, 4) oral presentation of research proposal, and 5) final draft of research proposal.

1) *Research Topic:* A description of approved research projects will be provided on Canvas. After reviewing each research project, you must submit your top project choices by **Wednesday, February 10th**. If you are conducting undergraduate research with a chemistry faculty, you may be able to incorporate that research as a part of your independent research project upon consulting me and your faculty research mentor first. If you have questions or concerns about any research project, or are not sure where to start, speak with me *prior* to the due date. You may also wish to discuss certain research topics with other chemistry faculty. Final approval of your research project will depend on instrument availability and the number of students each project can accommodate.
2) *1st Draft of Research Proposal:* Upon approval of your research project, a more detailed description of your research is required. The 1st draft of the research proposal is due **Friday, February 26th**, and should include the following:
    a. *Introduction* The introduction should provide a concise description of the proposed research and define the project objective. It should also clearly and convincingly demonstrate the significance of the research project and what new knowledge you hope to discover. This should be supported by literature citations.

b. *Experimental Approach* Clearly describe how your research will be conducted by answering the questions below. This should be written in paragraph form and avoid using first person voice.
    i. What are the objectives of the research project?
    ii. How will the sample(s) be collected, synthesized, or obtained?
    iii. How will the sample(s) be prepared for analysis?
    iv. Which instruments will be used for analysis?
    v. Is there precedence for the analysis? If so, provide references.
    vi. How will the data be validated?
    vii. How will the data be communicated?
        1. What format will the final paper be written in (journal article, technical report, or laboratory experiment)?
        2. If the final paper will be written in the form of a journal article, include the journal it will be submitted to along with any restrictions on number of words/figures.
c. *Timeline* Outline how you will use the time allotted in lab to complete your project.
d. *Budget* You must list any and all materials needed to complete the project and their approximate costs. You must meet with Brent Speetzen in the stockroom in order to obtain final approval of your budget.
e. *References* You must include appropriate references as noted above. Citations should be formatted according to the journal you are submitting to or using ACS standards. In-text citations and an annotated bibliography are required. Your proposal should include at least five (5) articles or other works directly related to your project.
f. *Curriculum Vitae/Resume* Provide an updated resume or vita with your proposal. It is highly advised that your meet with an academic & career advisor in the Academic & Career Advising Center to have your resume checked.

3) *Peer Review:* Each research proposal will be peer reviewed by me and one of your peers. You will be required to review another student's proposal. The reviews will be a 'double blind' peer review, with the name of the proposer and reviewer omitted. The peer review should be conducted in a confidential and professional manner, meaning you *should not discuss the proposal you are reviewing* with anyone except me, nor should you communicate with the person whose work you are reviewing. Peer reviews are due **Monday, March 8th**.
4) *Oral Presentation:* You will prepare a short talk, 10-15 minutes, about your research proposal. The audience for this presentation is your fellow students. The presentation should follow a similar format as the research proposal and include appropriate graphics to illustrate the main points in your project. Your score on this will be split: 15 points awarded for the presentation and 15 points awarded for providing feedback to other presenters. Presentations will be given during lecture on **March 29th**, **31st**, **April 5th, and 7th**.
5) *Final Draft:* The final draft of your proposal is due **Friday, March 19th**. It must address the comments of both of the reviewers (peer and instructor).

Project Execution You may begin obtaining your sample(s) once final approval of your research project has been given. Instruments will be available beginning the week of March 29th and you will have the

remaining weeks in the semester to complete your experimental work. All work must be completed and you must be checked out by your last scheduled lab period.

Final Project Report You will communicate the results of your project in two formats: 1) written report, and 2) oral/poster presentation.

1) *Written Report*: Each student will write a paper on their research project. The format of the paper must adhere to the requirements of the journal chosen in the research proposal, in the case of a journal article, or the requirements of a technical report or laboratory experiment as discussed. It is expected that in the introduction of the paper, a complete background of the instrumental methods chosen for this project, the theory of their operation, and why they were the best methods for this project are included. Readability, errors in content, use of footnotes, grammar, etc. will be assessed and affect the overall grade. You are strongly encouraged to have your peers review your work prior to submission. If time permits, I will, at your request, read and comment on the content of the paper prior to the final submission date. The paper is due **Friday, May 14th**.
2) *Poster/Oral Presentation*: Each student will give a presentation (oral or poster) on their independent research project on **Friday, May 7th** during the COLS virtual undergraduate research symposium. You must submit an *abstract* for your presentation by **Wednesday, April 21st**, to ensure it is submitted to the organizers of the symposium by the registration deadline. More details on how the abstracts and posters/oral presentations should be prepared will be given later in the semester.

HELP & RESOURCES

- **Canvas.** Course information, including the syllabus, lecture materials, lab experiments, due dates, study guides, and other supporting material will be posted on the course Canvas page. You can also find a running total of your points for the course.

- **Come see me.** I am dedicated to help you learn. You can e-mail me to set up an appointment. Don't ever feel like you are bothering me when you come see me—you are the reason I am here ☺!

- **Disability Services.** UWSP is committed to providing students with disabilities the academic accommodations and auxiliary aids necessary to ensure access to all university services, programs, and activities. Disability and Assistive Technology Center (DATC) is responsible for determining these accommodations. Visit the DATC website to find out more:
  http://www.uwsp.edu/disability/Pages/default.aspx

ADVICE FOR SUCCEEDING IN A FLIPPED CLASSROOM MODALITY

In the flipped classroom modality, students engage in the lecture material outside of class. In turn, traditional lecture time is used for active learning, (i.e., asking questions and group discussions), problem-based learning (i.e., homework sets), and collaborative learning (i.e., case studies) to enhance student understanding.

- **Take notes.** Just like in a normal lecture, taking notes while watching lecture videos or reading lecture content not only keeps you informed on what was covered but will also help you know what material is most likely to make it on an exam. In addition, you can use your notes to aid in classroom activities and discussions.

- **Ask questions.** No question is a dumb question. If you are struggling with material or are just curious about something after watching the lecture videos, don't hesitate to ask. Chances are there is someone else in the class with the same question.
- **Form (virtual) study groups.** Working with other students in the course is a great way to build off each other's strengths and see how to approach problems in different ways. You will be given the opportunity to work with others during class on problem sets and case studies. Extend this group work outside the classroom for exam preparation.
- **(Re)Work the suggested/assigned problems.** I cannot stress this point enough! Chemistry is not a course that can simply be memorized right before the exam. Chemistry is a complex subject and can seem, at times, very overwhelming. Working through suggested/assigned problems means writing complete solutions and including explanations for your solutions where appropriate. This approach will not only help you understand and retain the material better, it will also prepare you for questions that may appear on exams.
- **Read the topics carefully.** After covering the material in lecture, go back and read through the key topics. Look over the sample exercises to make sure you understand the key concepts. Then test your skills by trying some of the end of chapter exercises.
- **Don't fall behind.** The benefit to having lecture content online is it gives you the freedom to learn at your own pace, helping busy students. Keeping up with lecture content and following the lecture schedule will help you stay prepared for in-class activities and prevent you from falling behind. Binge watching chemistry videos is not the same as binge watching your favorite show on Netflix.

THE FINE PRINT

- **Instrument Use Policy (20% deduction if not followed).** After an experiment is completed, the instrument must be returned to its rest state (either turned off or placed in standby as necessary), and the laboratory area surrounding the instrument should be cleaned and returned to an orderly state. Failure to abide by this policy will result in a 20% deduction from your lab report per incident.

- **Late Work:** Meeting deadlines and staying on track with your work are not only useful life and career skills, but also help reduce stress. For this course, you are expected to complete assignments, reports, and research project components on schedule. If you have a personal situation that prevents you from completing your work on time, you will need to discuss this with me before the due date. Extensions are granted at my discretion.
  - **Late Assignments:** A 10% point deduction will be assessed each day the assignment is late.
  - **Late Reports:** Late lab reports will incur a 5-point penalty for each lab period it is late if an extension is not discussed in advance.
  - **Research Project:** Late work for any part of the research project will incur a 10% deduction for each day it is late.

- Attendance, Absences and Make-ups
  - Attendance at lecture is expected, and hopefully will be highly informative. However, certain circumstances may prohibit you from participating in-person. When these situations arise, you must notify me via email. We will make arrangements for virtual attendance or for on-line activity completion. Laboratory attendance and participation is mandatory. Missed labs may be made up only when a legitimate written (via email) excuse for the absence is provided. Assigned experiments are to be conducted during lab time unless prior arrangements are made with me. Failure to make up or complete all labs or failure to submit one or more reports will result in a maximum grade of a D for the course. COVID exceptions may apply.

- **Etiquette.** Be respectful of your fellow classmates!
  - Students in my classroom may have diverse racial, ethnic, cultural, and religious backgrounds, sexual orientations and gender identities. Each and every voice in the classroom brings with it a wealth of experiences, values, and beliefs. Please respect your fellow classmates and refrain from personal attacks or demeaning comments of any kind.

- Participation in class is highly encouraged but please be mindful of those around you. Dominating class discussions and restricting others' participation, disrupting others, making negative, offensive, and/or disrespectful comments will not be tolerated.
- Cell phones must be turned off and put away during class unless instructed otherwise.
- No iPods, radios, MP3 players or other recording and transmitting devices may be used during exams. Hats with bills must be turned backwards during an exam.
- It is your responsibility to check Canvas for the points you have earned in the class. If you find that an error has been made, you must inform me within *one week* of the posting grade for it to be considered.

- **Academic Misconduct.** As stated in the Student Academic Standards and Disciplinary Procedures:
  "The Board of Regents, administrators, faculty, academic staff and students of the University of Wisconsin System believe that academic honesty and integrity are fundamental to the mission of higher education and of the university of Wisconsin system. The university has a responsibility to promote academic honesty and integrity and to develop procedures to deal effectively with instances of academic dishonesty."

  Therefore, students caught cheating on quizzes/exams or in the laboratory are subject to a grade of F for the course and a report being placed in their judicial file. More information can be found at: http://www.uwsp.edu/dos/Pages/Academic-Misconduct.aspx

My Spring 2021 Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00		101 Virtual Lab		106 Lab CBB230	R, P, G
9:00	Class prep		Class prep		
10:00	446 Lecture CBB265		446 Lecture CBB265		
11:00	446 Lab CBB476	R, P, G	446 Lab CBB476	R, P, G	
12:00					
1:00					
2:00	R, P, G		R, P, G		Department Meeting
3:00					
4:00					

SCHEDULES

Tentative Lecture Schedule

- Please note that this is a *tentative* schedule and may be adjusted depending on the pace of the class. The exam dates, however, will not change.

Week	Date	Topic(s)	Chapter(s)	Events/Due Dates
1	25-Jan	Choosing an Analysis Method	1	
	27-Jan	EM Radiation and Spectroscopy	6	
2	1-Feb	Optical Instrument Components	7	
	3-Feb	UV-vis-NIR spectroscopy	13, 14	
3	8-Feb	Fluorescence Spectroscopy	15	
	10-Feb	IR Spectroscopy	16, 17	Research topic due **2/10**
4	15-Feb	Raman Spectroscopy	18	
	17-Feb	**Exam 1**		
5	22-Feb	AA Spectroscopy	8, 9	
	24-Feb	AA/AE Spectroscopy	9, 10	1st draft due **2/26**
6	1-Mar	AE Spectroscopy	10	
	3-Mar	Mass Spectrometry-Atomic	11	
7	8-Mar	Mass Spectrometry-Molecular	20	Peer review due **3/8**
	10-Mar	X-ray Spectrometry (XRF, EDS)	12	
8	15-Mar	X-ray Spectrometry (XRD)	12	
	17-Mar	**EXAM 2**		Final draft due **3/19**
	22-Mar	Spring Break		
	24-Mar			
9	29-Mar	Presentation - Research project		Presentation in lecture
	31-Mar	Presentation - Research project		
10	5-Apr	Presentation - Research project		Begin project
	7-Apr	Presentation - Research project		
11	12-Apr	Surface Analysis-Spectroscopy	21	
	14-Apr	Surface Analysis-Microscopy	22	
12	19-Apr	E-chem Basics and Potentiometry	23, 24	
	21-Apr	E-chem Methods	21, 25	Abstract due 4/21
13	26-Apr	E-chem Kinetics and Thermo	21, 25	
	28-Apr	Chromatography	26	
14	3-May	GC	27	
	5-May	LC	28	Present at COLS virtual URS 4/7
15	10-May	Thermoanalytical techniques	31	
	12-May	Review and catch-up		Final Paper due **5/8**
Exam Week	18-May	**EXAM 3 (2:45-4:45 PM)**		Commencement **5/22**

Lab Schedule

Week	Date	Lab Experiment - Group A schedule	Lab Experiment - Group B schedule
1	25-Jan	Check-in & esearch Project discussion	No lab
	27-Jan	Exp 1: Analysis of Analgesics by UV-spectroscopy	Check-in & Research Project discussion
2	1-Feb		Exp 1: Analysis of Analgesics by UV-spectroscopy
	3-Feb	Exp 2: Analysis of Quinine in Tonic Water by Fluorescence Spectroscopy	
3	8-Feb		Exp 2: Analysis of Quinine in Tonic Water by Fluorescence Spectroscopy
	10-Feb	Exp 3: Determination of Metals in Pet Food by ICP-OES	
4	15-Feb		Exp 3: Determination of Metals in Pet Food by ICP-OES
	17-Feb	Exp 4: Potentiometric Determination of Fluoride and Chloride	
5	22-Feb		Exp 4: Potentiometric Determination of Fluoride and Chloride
	24-Feb	Exp 5: Quantitative Determination of ions by Stripping Voltammetry	
6	1-Mar		Exp 5: Quantitative Determination of ions by Stripping Voltammetry
	3-Mar	Exp 6: Identification of Chloronated and Bromonated Compounds by GC-MS	
7	8-Mar		Exp 6: Identification of Chloronated and Bromonated Compounds by GC-MS
	10-Mar	Exp 7: Separation of Structurally Similar Compounds by HPLC	
8	15-Mar		Exp 7: Separation of Structurally Similar Compounds by HPLC
	17-Mar	No Lab	
	22-Mar	Spring Break	
	24-Mar		
9	29-Mar	Independent Research Project	Independent Research Project
	31-Mar		
10	5-Apr	Independent Research Project	Independent Research Project
	7-Apr		
11	12-Apr	Independent Research Project	Independent Research Project
	14-Apr		
12	19-Apr	Independent Research Project	Independent Research Project
	21-Apr		
13	26-Apr	Independent Research Project	Independent Research Project
	28-Apr		
14	3-May	Independent Research Project	Independent Research Project
	5-May		
15	10-May	Independent Research Project Check out	Independent Research Project Check out
	12-May		
Exam Week	18-May	**EXAM 3 (2:45-4:45 PM)** Commencement **5/22**	

*** All laboratory work must be complete *before* your check-out day. ***