NJIT New Jersey Institute of Technology

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF CHEMISTRY AND ENVIRONMENTAL SCIENCE

Chemistry: *Analytical Methods (CHEM 221)*

Fall 2023 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Chemistry & Environmental Science (CES) takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

CHEM 221 Course Description: The objective of this course is to teach the students the science of chemical measurements. Often, scientists and engineers are faced with the question, what is in a given sample, and how much? Chemical measurement or analytical chemistry is the systematic study of methods which can be used to answer these questions.

This course has been designed for students taking their first laboratory course in quantitative methods of chemical analysis. The topics covered fall under the general category of Analytical Chemistry. By the end of the semester, the students are expected to have acquired fundamental knowledge to prepare them to embark upon a rational approach to qualitative and quantitative analysis. After reviewing the large number of topics and experiments that could have been included here, we have selected a small set of diverse experiments that we believe will provide fundamental knowledge of various popular and powerful analytical techniques. These experiments include data evaluation, gravimetric, complexometric/volumetric/potentiometric titration, and UV-Vis molecular spectrophotometry.

It will be to the student's advantage to continue to read and reread the chapters in their textbooks on laboratory techniques throughout the semester. There are also some practical aspects of chemical analysis that are best learnt during the experiments. For example, you will learn that one should not use a graduated cylinder for accurate volumetric measurements, and that solids are best dissolved in a beaker covered with a watch glass. The laboratory professor or teaching assistant (TA) will usually explain and/or demonstrate these and many more techniques which have been used successfully over the years.

Students are encouraged to ask questions before it is too late and the mistakes have already been committed.

Number of Credits: 2

Prerequisites: CHEM 222

Course-Section and Instructors

Course- Section	Course Time	Location	Instructor
CHEM221-101	W 6:00 PM – 10:05 PM	Tiernan 208	Chunyan Liu Email: cliu1@njit.edu

0ffice Hours: Please send an email to schedule an appointment.

You are welcome to stay after class when the instructor is available.

E-Mail: All E-mail to me should start with CHEM 221 in the subject so that it can be filtered appropriately. Any e-mail pertaining to your academic standing (i.e., grades) must be sent from your NJIT account. Anonymous e-mail will not be read.

Lab manual is required. CHEM 221, Analytical Methods Laboratory Manual, available from NJIT Bookstore for $20.

Reference Textbook: *Quantitative Chemical Analysis*, 9th Ed., D.C. Harris, WH Freeman, NY, 2016, ISBN-10: 1-4641-3538-X

Secondary reference: Fundamentals of Analytical Chemistry, ninth edition, by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch, Brooks/Cole 2014, ISBN-10 0-495-55832-X.

Other required material:

- Hard-cover laboratory notebook
- Lab coat (available online)
- Safety goggles (available at the NJIT Bookstore or Home Depot)
- Disposable nitrile gloves (available online or at Home Depot)

Students are RESPONSIBLE of bringing their own PPE (Lab Coat, Goggles & Nitrile Gloves) to the lab.

POLICIES

All CES students must familiarize themselves with, and adhere to, all official university-wide student policies. CES takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Expt.1and 2	2 x 50 pts
Major experiments (7 total)	7 x 100 pts = 700
Pre-lab (9 total)	9 x 50pts = 450
Group oral presentations (including Q&A)	200 pts
Participation (13 classes)	13 x 10 pts = 130
Lab behavior and cleanliness (13 classes)	130 pts
Each Quiz (2 total)	2 x 50 pts = 100
TOTAL POINTS	**1810 pts**

Your final letter grade in this course will be based on the following tentative curve:

A	90-100	**C**	70-75
B+	86-89	**D**	60-69
B	80-85	**F**	<60
C+	76-79		

Turnitin penalties: All orange and red flags will be reviewed individually. Similarity scores of 30% or higher may results in a grade penalty and/or reporting to the Dean of Students office, depending on what leads to high score. The instructor will review all flagged Turnitin scores before the end of the semester.

- Do NOT copy and paste from any source, including the lab manual or your own lab report from this or a previous semester (if you are repeating).
- There is a Turnitin penalty section for each lab report which could be up to the full point total earned. Minor penalties could be applied, see the document in Canvas.
- The Dean of Students may apply harsher penalties than the instructor. The penalties they apply cannot be adjusted by the instructor.

Students work in groups of three or four and submit **individual reports**. Each group will do an oral presentation on one of the experiments at the end of the semester.

Attendance and laboratory notebook usage: Attendance to all laboratory sessions is **mandatory**. A missed laboratory session without an excused absence will result in a grade of zero (0) for that experiment. A second unexcused absence will result in a grade of zero (0) for the course. An excused absence must be obtained from the instructor before the relevant lab. An excused absence will only be granted for verifiable documented reasons of serious illness or family emergency. Students will be asked to sign the attendance sheet each week when arriving in lab.

Lateness to lab will NOT be tolerated (changes in directions/safety concerns may be given during the pre-laboratory lecture). The instructor reserves the right to dismiss you from the lab and you get a ZERO for the week. College policy states that students must notify faculty within the first three weeks of the semester if they anticipate missing any classes due to religious observance.

Students working in the same group must arrive in lab and begin the experiment at the same time. All students must remain in lab until the experiment is completed. Students working in the same group can perform the experiment together, work on calculations together, but each of them must be filling their own notebook.

See below for the guidelines to good laboratory notebook practices. The completeness and accuracy of the notebook will be checked by the instructor at the beginning of each lab, and its proper usage during the lab period will be checked before students leave.

Students are expected to **come to the lab on time and in full preparation for the scheduled experiment**, and to stay in the lab until the data collection is completed or points will be lost.

Safety and cleanliness: Wear your safety goggles at all times while in the laboratory. Clothing that covers your legs and shoulders is required. No shorts or skirts. Everyone will be required to wear lab coats and gloves during all experiments. Closed shoes must be always worn. Food or drinks are not allowed in the lab. **Turn off cell phones and do not use them in the lab**. Properly dispose of waste materials. Clean up your workspace at the end of each lab session and wash your hands prior to leaving the laboratory.

Laboratory reports All reports and presentations must be submitted **online in Canvas via Turnitin. Reports or presentations submitted by e-mail will NOT be accepted. No extra time is provided without a Dean of Students approved excuse and instructor communication.** If you miss a deadline by *a little bit* early in the semester, you need to ask to have the Canvas assignments reopened at the instructor's discretion. The format of the laboratory report can be found below.

Make-up Laboratory or Quizzes Policy: There will be **no make-up laboratories or quizzes** during the semester. If a student has a legitimate reason for missing an exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the laboratory and/or quiz, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the CES Department Office/Instructor that the laboratory period will be missed so that appropriate steps can be taken to make up the grade**.**

In addition, any medical excuse that can be taken into consideration (after receiving confirmation from NJIT Dean of Students office**) and the purpose of medical excuse is to grant you an extension on any missing class assignments or quizzes without penalty.**

Syllabus modification: Any modification of this syllabus will be distributed in class and via e-mail.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all lab times. Such devices must be stowed in bags during exams or quizzes.

ADDITIONAL RESOURCES

Chemistry Tutoring Center: Located in the Central King Building, Lower Level, Rm. G12. Hours of operation are Monday – Friday 10:00 am - 6:00 pm. For further information please click here.

Accommodation of Disabilities: **O**ffice of **A**ccessibility **R**esources and **S**ervices (***formerly known as Disability Support Services***) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director at the Office of Accessibility Resources and Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall Room 260. A Letter of Accommodation Eligibility from the Office of Accessibility Resources Services office authorizing your accommodations will be required.

For further information regarding self-identification, the submission of medical documentation and additional support services provided please visit the Accessibility Resources and Services (OARS) website at:

http://www5.njit.edu/studentsuccess/disability-support -services/

Course Outline

Week	Date	Topic
1	9/6	Check in/Safety Lecture (Safety quiz)
2	9/13	(expt. 1) Techniques in Preparing Solutions
3	9/20	(expt. 2) Volumetric Glassware, Statistics, and Spreadsheet Exercise
4	9/27	(expt. 3) Determination of sulfate as barium sulfate
5	10/4	(expt. 3) Determination of sulfate as barium sulfate
6	10/11	(expt. 4 Percentage of Na_2CO_3 in a sample
7	10/18	(expt. 4) Percentage of Na_2CO_3 in a sample
8	10/25	(expt. 5) Determination of hardness of water
9	11/1	(expt. 6) Potentiometric titration of an acid mixture
10	11/8	(expt. 7) Determination of trace iron using UV-Visible spectrophotometry
11	11/15	(expt. 8) Spectrophotometry of a two-component mixture
12	11/22	Friday Classes Meet
13	11/29	(expt. 8) Spectrophotometry of a two-component mixture
14	12/6	Group oral presentations (2^{nd} quiz)

Laboratory report format and guidelines:

Laboratory reports are an important part of science education. Students in chemistry and biology will be expected to write professional laboratory report. Therefore, in this course you will be introduced to several of the major components of writing a laboratory report. It is my hope that this course will give you an advantage in upper-level courses.

The format

Clarity of expression, correct grammar, spelling and paragraphing are expected. The lab report will consist of the following and must be in the order below: All components will be in paragraph form and must be double typed double spaced in Times New Roman 11-point font with 1" margins. Do

not list anything. Data and results must be put in tables. Schemes and figures must be prepared using a proper software such as Biovia (free), ChemSketch (free), ChemDoodle (free), or ChemDraw. They can also be neatly written down in ink. See Laboratory Manual for further details.

Tables
You must use tables. They must be numbered using Roman Numerals: (I, II, III----etc) Figures & Graphs should be numbered using alpha numerals (1, 2, 3------etc).

Introduction: Objective and Theory
The introduction must contain a discussion of the basic principles the lab is illustrating. This must be in your own words and not a paraphrase of the published experiment in your lab manual. You must cite statements of fact not ordinarily known using the following method: [#] at the end of the sentence containing the information. Do not include extraneous facts that do not pertain directly to the objective of the lab. Any equations used should be included along with a discussion of how they will be used. Be sure to identify all variables in every equation you discuss.

Procedures and observations
Writing a procedure for a chemical experiment involves using a formal and stylized writing approach. The experimental section will consist of a short paragraph that includes a sentence that refers the reader to some source for the procedure. Details from the published procedure and any experimental hints or tips that may aid the reader in understanding and repeating the experiment should be included. All reagents used must be reported in as the quantity you actually used (in parentheses, followed by the number of moles). All products used must be reported in as the quantity you actually used (in parentheses, followed by the number of moles) and % yield.

Results
The results section should contain tables, graphs and illustrations.

- Tables should be numbered using ROMAN NUMERALS. (Table I, Table II, Table III...)
- Graphs and illustrations should be numbered using ALPHANUMERICS (Figure1, Figure 2, Figure 3...)
- Label the x and y axes of your graphs with an informative label and include the units. For instance, for a titration the x axis would be “Volume NaOH (mL)” while the y axis might be “Voltage (mv)”.
- Do not just connect the dots. At this level most graphs can be fit to the best straight line (y = mx +b) using linear regression. In MSExcel you can use TRENDLINE.
- All tables, graphs and illustrations should have an informative title: “Table I – Experimental Melting Points”
- All raw data that is used to perform calculations must be put in a table.

Calculations
Show all equations you used to calculate your result. For instance, if you are calculating percent error you must first include the equation for percent error as follows:

% error ={ [|*ExpVal* – *AccptVal*|] / *AccptVal* }100

- This can be typed (good time to learn how to use the equation writer in MSWord) or neatly handwritten in ink.
- Follow with the actual calculation (can be neatly handwritten in ink) using correct significant figures

and units.

- If your lab requires repetitive calculations, you only need to include one of these calculations in your report.
- Percent yield calculations: Refer to General Chemistry 1 notes on limiting reactant, theoretical yield and percent yield calculations. Show all steps for full credit.

Discussion (400 and 1200 words)
This is an important part of your laboratory report. In this section you will do the following:

- Restate your final results: "The molecular mass of copper sulfate was found to be -------"
- If possible, compare your results to expected or literature values.
- Explain the meaning of your results:
    - Did you achieve your goal? Why or why not.
    - Did your results match literature values? Report literature value and % error.
    - If your value was too high, explain why. Be specific.
    - If your value was too low, explain why. Be specific.
    - Discuss how this laboratory relates to chemistry. Explain what principles and concepts it illustrates.

Conclusion
Provide a global conclusion regarding your experimental results. This section should be 100 – 250 words.

Questions
There are questions related to each experiment in the lab manual. You must answer all questions in the lab report. Type the question itself in bold then answer using complete sentences using regular font. If the question requires a calculation use the rules found under the CALCULATION SECTION above.

Remote and converged Teaching

The shift to remote and converged teaching due to the COVID-19 pandemic has required that both instructors and students make changes to their normal working protocols for courses. Students are asked to practice extra care and attention in regard to academic honesty, with the understanding that all cases of plagiarism, cheating, multiple submission, and unauthorized collaboration are subject to penalty. Students must properly cite and attribute all sources used for papers and assignments. Students may not collaborate on exams or assignments, directly or through virtual consultation, unless the instructor gives specific permission to do so. Posting an exam, assignment, or answers to them on an online forum (before, during, or after the due date), in addition to consulting posted materials, constitutes a violation of the university's Honesty policy. Likewise, unauthorized use of live assistance websites, including seeking "expert" help for specific questions during an exam, can be construed as a violation of the honesty policy. All students should be familiar with the **NJIT Academic Integrity Code**.