

ANALYTICAL CHEMISTRY (21:160: 223)

Fall 2021 Syllabus

Course Meeting Days/Times:

Lecture: Tuesday, Friday 1:00PM - 2:20 PM

Location: SMT 220

*** This course is designed to be synchronous; students are required to attend lectures as scheduled.**

Instructor: Dr. Xinbo Lau

Email: xinbo.lau@rutgers.edu

Office location: Olson 204

Office Hour: Wednesday 2:00PM-3:30PM

Thursday 2:00PM-3:30PM

Required Materials:

Textbook: "Exploring Chemical Analysis", 5th Edition, by Daniel C. Harris, published by Freeman, NY, 2009. ISBN-13: 978-1-4292-7503-3

Learning Outcomes/Goals:

On completion of this course, students should

- understand the principles behind quantitative and qualitative analysis of chemical samples.
- know how to design experiments to separate chemical components from mixtures.
- understand the operating principles of analytical instrumentation, including high performance liquid chromatography, UV-visible spectroscopy, atomic absorption spectroscopy, gas-chromatography/ mass spectrometry, and electrochemical devices.
- know how to use equilibrium chemistry to explain titration experiments.

Tentative Grading

Exams*	400 points
Quizzes*	200 points
Homework*	100 points
Final Exam (Cumulative)*	<u>300 points</u>
TOTAL	1000 POSSIBLE POINTS

* There will be 3 in-class exams (400 points, 40%) offered throughout the semester, each exam is worth 20%, 200 points out of 1000 points. The lowest exam will be dropped.

* 4 quizzes will be offered, which take up 200 points, which is 20% of your total grade. Each quiz will be 50 points, which is 5%.

* There will be assigned Homework, which takes up 100 points, worth 10% of your total grade. There will be a few questions assigned from the textbook as homework after each chapter is done.

All the assignments are done through Canvas by uploading files. Your submission needs to include YOUR handwritten answers for those assigned questions. Late submission won't be accepted. Keeping track of the due dates of all the assignments is student's responsibility.

Any technical issues (WIFI connection, malfunction of laptop, power problem, etc.) will be student's responsibility.

* Final exam will be hosted during final exam period, which is scheduled by the university on **Friday 12/17/21**, from **11:45AM to 2:45PM, SMT 220**, which is cumulative (from CH 1 to CH 23). Final exam is mandatory. Final exam will take up 300 points, which is 30%.

Final Grades will be based on the following scale:

- A = 85.00-100
- B+ = 80.00-84.99
- B = 70.00-79.99
- C+ = 65.00-69.99
- C = 55.00-64.99
- D = 50.00-54.99
- F = 0-49.99

Important Dates:

Please find the detailed information by using the following link:

<https://registrar.newark.rutgers.edu/office-registrar-fall-academic-calendar>

9/1/21	1 st day of class
9/6/21	Labor Day Observed - University Closed - NO CLASSES
9/8/21	Wednesday will follow a Monday Class Schedule
9/1/21 - 9/9/21	add/drop
9/8/21	Last day to drop
9/10/21 - 10/25/21	Receive a "W" Grade You can click here and read more about "How Dropping and/or Withdrawing from Courses Affects Financial Aid".

11/29/21	Monday will follow a Wednesday Class Schedule
11/24/21 – 11/28/21	Thanksgiving Recess
12/13/21	Regular Classes End
12/14/21 – 12/15 /21	Reading Day

Course Policies:

- ACADEMIC INTEGRITY POLICY FOR RUTGERS UNIVERSITY can be found at:
<http://academicintegrity.rutgers.edu/academic-integrity-policy/>
- **You cannot use programmable (graphing) calculators during the exam**
- **NOTE!! There is no bathroom or money-in-the-meter breaks during midterm exams or final UNLESS you speak to me before you take your exam to arrange for a break**
- **There will be assigned seating. Arrive early in order to find your assigned seat.**
- **You must bring a picture ID with you.**
- **No one will be permitted to enter after 30 minutes have elapsed and no one will be permitted to leave until at least 30 minutes have elapsed.**
- **All cell phones must be turned off and put away; no smart watches, headphones or any other electronic devices are allowed. You will receive a ZERO automatically if you are found using any electronic devices during the exams.**

Policy on special accommodations:

Rutgers University Newark (RU-N) is committed to the creation of an inclusive and safe learning environment for all students. RU-N has identified the following resources to further the mission of access and support:

- **Students with Disabilities:** Rutgers University welcomes students with disabilities into all of the University's educational programs. The Office of Disability Services (ODS) is responsible for the determination of appropriate accommodations for students who encounter barriers due to disability. In order to receive consideration for reasonable accommodations, a student with a disability must contact ODS, register, have an initial appointment, and provide documentation. Once a student has completed the ODS process (registration, initial appointment, and documentation submitted) and reasonable accommodations are determined to be necessary and appropriate, a Letter of Accommodation (LOA) will be provided to the student. The student must give the LOA to each course instructor, followed by a discussion with the instructor. This should be completed as early in the semester as possible as

accommodations are not retroactive. More information can be found at ods.rutgers.edu. Contact ODS: (973) 353-5375 or ods@newark.rutgers.edu.

- **Religious Holiday Policy and Accommodations:** Students are advised to provide timely notification to instructors about necessary absences for religious observances and are responsible for making up the work or exams according to an agreed-upon schedule. The Division of Student Affairs is available to verify absences for religious observance, as needed: (973) 353-5063 or DeanofStudents@newark.rutgers.edu.
- **Counseling Services:** Counseling Center Room 101, Blumenthal Hall, (973) 353-5805 or <http://counseling.newark.rutgers.edu/>.
- **Students with Temporary Conditions/Injuries:** Students experiencing a temporary condition or injury that is adversely affecting their ability to fully participate in their courses should submit a request for assistance at: <https://temporaryconditions.rutgers.edu>.
- **Students Who are Pregnant:** The Office of Title IX and ADA Compliance is available to assist students with any concerns or potential accommodations related to pregnancy: (973) 353-1906 or TitleIX@newark.rutgers.edu.
- **Gender or Sex-Based Discrimination or Harassment:** Students experiencing any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking, should know that help and support are available. To report an incident, contact the Office of Title IX and ADA Compliance: (973) 353-1906 or TitleIX@newark.rutgers.edu. To submit an incident report: tinyurl.com/RUNReportingForm. To speak with a staff member who is confidential and does **NOT** have a reporting responsibility, contact the Office for Violence Prevention and Victim Assistance: (973) 353-1918 or run.vpva@rutgers.edu.

☐ Learning Resources:

- Rutgers Learning Center (tutoring services)
Room 140, Bradley Hall
(973) 353-5608
<https://sasn.rutgers.edu/student-support/tutoring-academic-support/learning-center>
- Writing Center (tutoring and writing workshops)
Room 126, Conklin Hall
(973) 353-5847
nwc@rutgers.edu
<https://sasn.rutgers.edu/student-support/tutoring-academic-support/writing-center>

Responsible behavior and commitment:

1. **Absences:** Per the University's Course Attendance policy (10.2.7), students are responsible for communicating with their instructors regarding absences. The Division of Student Affairs is available to verify extended absences: (973) 353-5063 or DeanofStudents@newark.rutgers.edu.

2. Regular attendance is the minimum demonstration of responsibility and commitment on your part. Therefore, **you are responsible to pick up handouts and returned exams/quizzes etc. on time.** You will have one week since the exam is returned to check any grading errors, please contact the instructor for corrections. After one week, the exam score is finalized and recorded as it is.

3. **In case of inclement weather, students should find out on their own whether the University will be closed.**

Scheduled exams will NOT be cancelled if the University does not cancel class.

4. All students must have a valid Rutgers e-mail account. **Class-related information will be sent only to students Rutgers e-mails. Students are responsible for checking their Rutgers e-mails so that important class-related information will not be missed.**

5. **□ Academic Integrity (The following statement is recommended for inclusion on all syllabi.):**

As an academic community dedicated to the creation, dissemination, and application of knowledge, Rutgers University is committed to fostering an intellectual and ethical environment based on the principles of academic integrity. Academic integrity is essential to the success of the University's educational and research missions, and violations of academic integrity constitute serious offenses against the entire academic community. The entire Academic Integrity Policy can be found here: <http://academicintegrity.rutgers.edu/academic-integrity-policy/>

Tentative lecture outline

Tentative lecture outline, the exact topics covered on any given day may vary

Week	Date	Chap	Topic
1	9/1-9/3	0 & 1& 2	The Analytical Process & Chemical Measurements & Tools of the Trade
2	9/6-9/10	2 & 3	Tools of the Trade & Math Toolkit QUIZ 1 (Friday (09/10/21))
3	9/13-9/17	3	Math Toolkit
4	9/20-9/24	4	Math Toolkit & Statistics
	09/21 (Tue)		EXAM 1
5	9/27-10/1	4 & 5	Statistics
6	10/4-10/8	5	Quality Assurance (QA) & Calibration Methods QUIZ 2 (Friday (10/8/21))
7	10/11-10/15	5 & 6 & 7	Quality Assurance (QA) & Calibration Methods & Good Titrations & Combustion Analysis &

8	10/19-10/22	8 & 9	Introducing Acids & Bases & Buffers
	10/19 (Tue)		EXAM 2
9	10/25-10/29	10	Acid-Base Titrations
10	11/1-11/5	11	Polyprotic Acids & Bases QUIZ 3 (Friday (11/5/21))
11	11/08-11/12	11 & 14	Polyprotic Acids & Bases & Electrode Potentials
12	11/15-11/19	15 & 16	Electrode Measurements & Redox Titrations
	11/16(Tue)		EXAM 3
13	11/22-11/26	16 & 17	Redox Titrations & Instrumental Methods in Electrochemistry
	11/24-11/28		Thanksgiving Recess
	11/29		Follow Wednesday Schedule
14	11/29-12/3	18 & 19 & 20	Let There be Light & Spectrophotometry & Atomic Spectroscopy QUIZ 4 (Friday(12/03/21))
15	12/6-12/13	21& 22& 23	Principles of Chromatography & Mass Spectrometry & Gas & Liquid Chromatography & Chromatographic Methods and Capillary Electrophoresis
	12/17(Fri)		Final Exam (CH1 to CH 23): from 11:45 AM to 2:45 PM

The instructor reserves the right to change the syllabus at any time. All changes will be announced in class and a new syllabus will be electronically available on blackboard. If you are enrolled in this class past the add/drop day you are subject to all rules in this syllabus.

Purposes and Approach of this course

The analytical chemist works to find out how much of a certain analyte in a sample. How do I find this out, what tools do I use, how can I do this efficiently, how am I assured that the results are both accurate and precise? In this course, you will study some of the important ideas and techniques for both quantitative and qualitative measurements in an analytical chemistry. By the end of this semester, you should have an improved understanding of:

- a). The distinction between quantitative and qualitative measurements
- b). Statistical techniques for evaluating and interpreting your data
- c). The sources of error in chemical and instrumental analysis.
- d). Basic concepts of stoichiometry
- e). Various titration basics and calculations
- f). Interferences in chemical and instrumental analysis
- g). Concept of instrument calibration
- h). Principles of quantitative and qualitative measurements using optical methods
- i). Principles of gas and liquid chromatography
- j). Concept of an electrochemical methods for quantitative and qualitative measurements
- k). Concept of standard addition techniques

Tentative Homework assignments

Chap. 0- The Analytical Process--skim this chapter, but READ IT and find the answers for these problems.

Problems: 1-4

Chap. 1- Chemical Measurements--units, conversions, concentrations, preparing solutions, K_{eq} . Read this chapter.

Problems: 7, 8, 9, 10, 11, 15, 20, 29, 30

Learning goals: Units, unit conversions, significant figures (and use of them in calculations).

Chap. 2 - Tools of the Trade -- lab notebook, analytical balance, burets, volumetric flasks, pipets, syringes, drying, calibration of glassware, sample preparation. Skim this chapter.

Problems: 9,10, 12

Chap. 3 - Math Toolkit – Read carefully, **VERY IMPORTANT!!!**

Learning goals: Experimental errors: Types of errors, significant figures, gross errors, determinate errors, indeterminate errors, propagation of uncertainty and calculations.

Problems: 1, 4, 10, 14, 16, 19, 20, 21

Chap. 4 - Statistics - **VERY IMPORTANT!!!**

Learning Goals: Gaussian distribution, average deviation, standard deviation, etc. True value, average value (mean), median, analyte, confidence intervals, Student's t test, s(pool), Q-test (rejecting data), Grubb's test (for outlier, rejecting data, finding the "best" straight line, construction of calibration curve.

Problems: 4, 7, 9, 13, 15, 19

Chap. 5- Quality Assurance(QA) & Calibration Methods

Learning Goals: Basics of quality assurance, validation of an analytical procedure, standard addition technique, internal standards

Problems: 11, 15, 17, 20, 21, 22

Chap. 6- Good Titrations (Read through to be able to answer the following questions)

Problems: 1, 2, 3, 6, 15,16, 21, 25

Chap. 7- Gravimetric & Combustion Analysis

Skim this chapter

Chap. 8- Introducing Acids & Bases

Problems: 1, 5, 10, 11, 15, 17, 24, 28

Chap. 9- Buffers (read through to be able to answer the following problems.

Problems: 1, 2, 6, 9, 10, 16

Chap. 10- Acid-Base Titrations (read very carefully)

Problems: 4, 5, 6,8, 14, 15, 20, 23

Chap. 11- Polyprotic Acids & Bases (read through)

Problems: 3, 9, 15, 19, 25, 28

Chap. 14- Electrode Potentials (read very carefully)

Problems: 4, 10, 13, 19, 23, 24, 25

Chap. 15- Electrode Measurements (read very carefully)

Problems: 4, 11, 12, 14, 18, 19

Chap. 16- Redox Titrations (read very carefully)

Problems: 2, 6, 15

Chap. 17- Instrumental Methods in Electrochemistry

Problems: 5, 23

Chap. 18- Let There be Light (Skim to able to answer the following questions)

Problems: 4, 7, 22, 26, 30.

Chap. 19- Spectrophotometry; Instruments and Applications (read through to be able to answer the following questions)

Problems: 1, 3, 9, 16

Chap. 20- Atomic Spectroscopy

Problems: 1, 2, 8, 11

Chap. 21- Principles of Chromatography & Mass Spectrometry

Problems: 1, 2, 6, 9, 17

Chap. 22- Gas & Liquid Chromatography

Problems: 1, 3, 9, 18

Chap. 23- Chromatographic Methods and Capillary Electrophoresis

(Skim this chapter to understand various chromatographic methods and their applications.)