

Instrumental Analysis
Course Number 50:160:326 (CHEM 326)
RUTGERS, CAMDEN

SPRING 2024

I. LOGISTICS

Instructor: Dr. Kumi, george.kumi@rutgers.edu (email)

Class Location: Fine Arts Building 225 (FA 225)

Class Meeting Times: Monday, Wednesday & Friday at 10:20 AM-11:15 AM.

Instructor Office Hours: Friday 11.20 – 11.50 AM, 1.45 – 2.45 PM or by appointment

II. COURSE DESCRIPTION AND OBJECTIVES

Course Pre-requisites: ORGANIC CHEMISTRY II (50:160:336), ORGANIC CHEMISTRY LABORATORY II (50:160:340)

Course Co-requisite: INSTRUMENTAL ANALYSIS LABORATORY (50:160:330)

If for any reason, you do not meet (i.e., have not taken or are not taking) the stated course pre- and co-requisite courses, please notify the course instructor within the first week of classes.

Course description. This course focuses on teaching modern instrumental methods routinely used in chemical analyses. The objective is to provide students with an understanding of the fundamental theory and the practical implementation related to these techniques. Specifically, this course will cover several standard spectroscopic (UV-Vis, Fluorescence, IR, NMR, XRF) and chromatographic (HPLC, GC) methods. Mass Spectrometry will also be briefly covered.

Student Outcomes for this Course. As a result of participating (and passing) this course, a student will be able to:

- Explain the underlying theory and practical implementation of several¹ commonly-used instrument-based chemical analyses
- Identify appropriate instrumental methods for relatively simple and specific chemical analyses
- Determine (both with and without the use of a spreadsheet program) the value and uncertainty associated with any reported measurement (via a statistical analysis); spreadsheet program proficiency is thus an implicit outcome of this course
- Describe, both generally and specifically, the process of obtaining a concentration calibration curve given a set of standards for an instrumental method of a student's choosing.

Course website. A Canvas-hosted course website has been created for this course. All students must have a Rutgers email address (RU NetID) in order to access the course material and information on Canvas. Go to <https://canvas.rutgers.edu> and sign in. This Instrumental Analysis course (Spring 2024) should be listed as one of your courses (under the ‘Courses’ selection) if you have a Rutgers NetID and are enrolled in this course. It is important to check this course site on a regular basis for class announcements, *e.g.*, new assignments, updated lecture schedules.

Required Course Material:

1. **Required Course Text.** *Principles of Instrumental Analysis, 7th ed., by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch (ISBN: 9781305577213).* This text has immensely more

¹ See methods listed in course description

material than can be covered in a single semester. Yet, because of its comprehensiveness, it can be a valuable reference and resource for you throughout your scientific career. Please note it is required text for this course; all students will need to have this text and read (numerous times!) the sections of the text covered by this course.

2. **A simple scientific calculator** (e.g., a TI-30X) **with basic functions** (e.g., cosine, sine, log)

III. COURSE TOPICS/CONCEPTS (listed the order these topics are covered in the course)²

Introduction to Instrumental Analysis

The basic underpinnings of all instruments, calibration methods, and how to select an analytical method

Signals and Noise

The signal-to-noise ratio, sources of noise in an instrumental analyses, signal-to-noise ratio enhancement methods

Introduction to spectroscopic methods

General properties (e.g., 'wave-like' and 'particle-like' nature) of electromagnetic radiation (EMR), the interaction of EMR with matter (i.e., absorption, emission, scattering, transmission), components of optical instruments (e.g., sources, wavelength, sample holders, radiation transducers)

Molecular Spectroscopy

UV-Vis Absorption, Fluorescence, Infrared Absorption, Nuclear Magnetic Resonance (NMR), and Mass Spectrometry

Chromatography

High Performance Liquid Chromatography (HPLC) and Gas Chromatography

Atomic Spectroscopy

X-ray Fluorescence Spectroscopy

IV. COURSE ASSESSMENTS AND ASSESSMENT POLICIES

Assignments. Over the course of the semester, there will be numerous assignments (~10). These assignments must be completed by their designated due dates, which will be explicitly shown on the assignment and made known to you on the course Canvas website. Unless there is a documented extenuating situation that prevents an assignment from being submitted on time, the grade for that assignment is zero. With appropriate documentation, the grade for a late assignment is a student's average assignment grade for the entire course.

Assignments can be handwritten or typed (or a combination of both), and all assignment must be submitted online via the Canvas course website by the submission deadline. All submitted documents should be a *single document in pdf format* (e.g., not a series of images or files); no other file types will be accepted/allowed for such submissions. In general, online submissions will be due by the beginning of class. Together, these assignments will count toward 165 out of the 700 points used to assign course grades (i.e., ~23 % of the course grade). They are an important aspect to doing well in this class – do not take them lightly! For each assignment, specific instructions will be provided on how to carry out and submit that assignment.

For the assigned problems sets, how you arrived at your final answer is more important than the answer itself. Any submitted assignment that does not explicitly show how calculated results were obtained will be deemed incorrect. In fact, if there is any ambiguity as to how you arrived at an answer for a

² A more detailed, tentative timetable is available in the Course Essentials module of the Canvas course website

specific problem, that problem will be assigned a score of zero. So, be sure to always explain the reason for any answer (even if a question does not appear to explicitly ask for this reasoning). To reinforce the idea that your reasoning behind any presented answer or solution is the most important aspect of your response to a question, the answer to some numerical questions will be provided in certain assignments. The assigned problem sets represent a subset of the problems available to you in your text, and it is strongly recommended that you further your understanding by tackling unassigned problems and perusing the listed additional resources in the chapters covered in this course.

Quizzes. Quizzes (~4 of them) will also be used to assess how well students are attaining the course student learning outcomes (see above). Unless there is a documented extenuating situation that prevents a quiz from being completed on time, the grade for that quiz is zero. With appropriate documentation, the grade for a late quiz is a student’s average quiz grade for the entire course. Together, these quizzes will count toward 150 out of the 700 points used to assign course grades (*i.e.*, ~14 % of the course grade).

Discussions. To enhance student-to-student interaction in this course, course discussion questions will be posted on a course discussion board at various times (~3) during the semester. For these questions, all students will have to respond to a question posted by the instructor by a specified deadline, and then these posts will be made available to the entire class. Each student must subsequently comment on a post by another course participant. A general grading rubric for such assessments can be found in the ‘Course Essentials’ module on the course Canvas website.

Exam and Grading Policy. Course grades will be assigned using the grading distribution specified in the Grading Scheme insert. Grades will be based on these criteria alone. No extra credit will be available on an individual basis.

There will be 2 exams, each worth 100 points, and a comprehensive final exam, which is worth 200 points. No make-up exams will be given without the submission of supporting documents (e.g., a doctor’s note, police report) for an extenuating circumstance. Notification about a missed exam should be done as soon as is possible (any delays may factor into how accommodations are provided). *Any make-up exam must occur within a week of the missed exam; be sure to provide times that you will be available to take a make-up exam when notifying me, the course instructor.* Whenever possible, notification about missing an exam should be received before the date of the scheduled exam and with appropriate documentation.

Grading Scheme		
<u>Assessment</u>	<u>Course pts</u>	<u>Course %</u>
2 Exams (100 pts each)	200 pts	~29
1 Final	200 pts	~29
Quizzes	100 pts	~14
Discussions	35 pts	~5
Assignments	<u>165 pts</u>	<u>~23</u>
Total	700 pts	100

Course Grade	% of 700 points
A	100 – 90
B+	89 – 87
B	86 – 80
C+	79 – 77
C	76 – 70
D	69 – 60
F	< 60

Re-grading Policy. In the event that you find or suspect an error in the grading of report or quiz you have the option of returning this material to the course instructor for a re-grade. Requests for re-grading must be submitted within a week after the graded material *is made available*. When requesting a re-grade, please attach a note describing the issue

to the graded test. Note that quizzes/reports submitted for re-grading are subject to a *full* re-grading to ensure there are no other grading errors on that assessment.

Late assessment advice. Please notify me as soon as possible whenever you are struggling to keep up with the assigned course work. Missing deadlines can be stressful, and my goal will be to help you develop a plan to mitigate (if not eliminate) your major struggles. Also, please contact me ahead of time if you believe you will not be able to complete an assignment on time to see if we can make other arrangements that will be fair to all in the course.

V. COURSE CONDUCT

Course Attendance. As per current Rutgers University stipulations/guidelines, this is an *in-person instructional mode* course (i.e., there is no ‘remote learning option’ for this course). In accordance with university policy, student attendance is *required* at every scheduled course meeting, i.e., attendance is mandatory.

Course Absences. Use the Student Self-Reporting Absence system (<https://sims.rutgers.edu/ssra/>) to notify the instructor about an absence and also email the course instructor directly; note that these are two separate but required actions. Also, please note that reporting an absence does not automatically excuse that absence. It simply notifies the instructor and institution about your absence. It is up to the instructor to determine how to accommodate or deal with this absence in accordance with the stated course policy described in the syllabus. Excuses considered ‘non-extenuating’ (e.g., I overslept, I forgot about class today, I had to work, traffic was a little slow) will not result in an excused absence. Also note that it is University policy to excuse **without penalty** students who are absent because of **religious observances**. If possible, notify the instructor of such absences or any other known future absences during the first week of the semester.

While no course points will be *given* for attendance, course points (for up to 10% of the total course points) may be deducted for unexcused absences (and for being late to) class sessions. The institution of such measures will be based on the overall class conduct; if all course participants attend sessions regularly and are on time (i.e., no more than one unexcused absence and one incidence of tardiness per student over the course of the semester), no course points will be deducted for absences and tardiness for all participants. Course participants will be informed prior to the commencement of any measures to address absences, tardiness, and early exiting.

Also, note that by registering for this course you are stating that you are available to take the course Final Exam week at the end of the semester. Please do not make plans (travel or otherwise) that may prevent you from being able to take the Final Exam during its scheduled time.

The Final Exam for this course is scheduled (by the Registrar’s Office) to take place on Wednesday May 8, 2024.

Calculators. Going along with the general philosophy that ‘I hear and I forget, I see and I remember, I do and I understand’, we will engage in many examples during our course meetings. These examples will require that you have a calculator, and therefore it is your responsibility to have a calculator readily available at each and every session. There are no stipulations on the type of calculator except for the fact that it must be able to perform simple arithmetic (addition, subtraction, multiplication, division) and basic logarithmic calculations. Any student who does not have a suitable calculator available will be deemed ‘unready’ to participate in the session course activities and may be asked to leave the session.

The University's Code of Student Conduct. It is the responsibility of each and every student to have read the *Rutgers University Code of Student Conduct*, as it specifies the obligations of any individual enrolled as a student. If you have not read it, it is suggested that you do. The standards of classroom behavior for this course are dictated by this code of conduct. Accordingly, students may not interfere with classroom procedures by distracting or disruptive actions (*e.g.*, talking while the instructor is talking, making distracting noises, coming late to class, allowing a cell phone to ring). Any students who engage in such prohibited acts *can* and may be penalized (*e.g.*, asked to leave the class session for the remainder of the class period). In addition, *every student is prohibited from engaging in violations of academic integrity*. Note that every instructor is ethically bound to follow certain procedures once a student is caught, or suspected of, breaching of academic integrity (see *Rutgers University Academic Integrity Policy*).

Audio/Visual Recordings. Neither audio nor video recordings of lectures are allowed without the explicit consent of the instructor. Also, listening to any audio or video recordings during class meetings is not allowed.

Course material copyrights. Any course materials (including quizzes) are protected by copyright. You may not and may not allow others to reproduce or distribute these course materials publicly (whether or not a fee is charged) without the copyright holder's (*i.e.*, the course instructor's) express written consent.

VI. OTHER PERTINENT COURSE INFORMATION

Rutgers University has several support services and resources that exist to facilitate *your academic success* and well-being. Details of these services and resources can be found at <https://studentaffairs.camden.rutgers.edu/student-resource-list>, and you are **highly encouraged** to visit the aforementioned website *at the beginning of the semester* so that you know what services are available to you (in case you need them at some point during the semester). A few of these services are listed below.

Accommodations for Students with Disabilities. Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: <https://ods.rutgers.edu/students/documentation-guidelines>. If the documentation supports your request for reasonable accommodations, your campus's Disability Services Office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form at <https://webapps.rutgers.edu/student-ods/forms/registration>. Please note that this is a process (*i.e.*, it takes time to review requests) and that instructors cannot make any accommodations until instructed to do so by a Letter of Accommodations. Therefore, if you need (or even *think* you might need) accommodations, please start the process as early as you can. The Rutgers-Camden disability office website can be found at <https://success.camden.rutgers.edu/disability-services>.

Division of Student Academic Success Services. The Division of Student Academic Success (DSAS) at Rutgers-Camden (<https://success.camden.rutgers.edu>) assists students through a variety of support and services including free tutoring, supplemental instruction, and academic coaching. It will be beneficial to contact DSAS to learn more about these services and to determine if you will be able to use any of their services to enhance your learning abilities and success in this and other courses. In

particular, the Center for Learning and Student Success (<https://class.camden.rutgers.edu>) provides Learning Specialists who can help you build a learning plan based on your strengths and needs. Tutors, study groups and more services are available you at no additional cost (i.e., you have already paid for these services to be available). In addition, if English is not your first language and this causes you concern about the course, the Center for Learning and Student Success (CLASS) may be able to assist. To learn more about CLASS or to schedule an appointment, visit the CLASS website (<https://class.camden.rutgers.edu>).

Rutgers-Camden Dean of Students Office. The Dean of Students Office (<http://deanofstudents.camden.rutgers.edu/>) provides support, care, and advocacy to ensure students can thrive both academically and personally. One of the goals of this office is to limit student stress by providing resources to mitigate areas of student concern. For some students, personal, emotional, psychological, academic, or other challenges (*inside* or *outside* the classroom) may hinder their ability to succeed both in and outside of the classroom. The Dean of Students Office serves as your initial contact if you need assistance with these challenges. Thus, this office is a vital resource whenever you are unsure of how to proceed on *any* matter you feel is impairing your ability to thrive academically and personally.

Pronouns. This course affirms people of all gender expressions and gender identities. If you have a preferred gender pronoun, feel free to correct me when I am communicating with you. If you have any questions or concerns, please do not hesitate to contact me. In addition, on the Canvas course site, the Rutgers Shout-Out tool allows you to type the phonetic spelling of your name and record the pronunciation of your name in a shared audio recording for your professor and fellow students.

Title IX and the Violence Prevention & Victim Assistance Office. The office for Violence Prevention and Victim Assistance (VPVA) provides support to students who have experienced sexual violence, domestic/dating violence, stalking or any form of sex or gender discrimination. For more information about VPVA or to schedule a time to speak with an advocate visit the VPVA website (<https://vpva.camden.rutgers.edu>). To report an incident or speak with the Title IX coordinator, please visit the Title IX website (<https://respect.camden.rutgers.edu>). If you choose to disclose to me, thank you for trusting me. However, please note that I am obligated to report any disclosure to our title IX coordinator to ensure you receive the appropriate support and university response.

Time Management. This is a challenging undergraduate Chemistry course. Like most challenging Chemistry courses, this course generally requires a relatively large amount of time and preparation. Though I will do everything in my power to guide and help you, what you ultimately get out of the course is a reflection of the effort that YOU put into the course. Please remember that your grade is based on how well you demonstrate knowledge of course material - not attendance, effort, how polite you are, etc.

To adequately prepare and learn the concepts being imparted in this course, the general consensus is that for **every 1 hour of class time you will need 3 hours of study/reading**. We will meet for roughly 3 hours each week, **so you need to be able to have at least 9 hours** (inter-dispersed throughout the week) to study for this course alone. Please make necessary adjustments in your study habits, course load, time management and work/class schedule – at the start of the semester – so that you will be geared to succeed.