Syllabus

CHEM 4421 Instrumental Analysis— Spring 2022
Department of Chemistry and Biochemistry, Angelo State University

Instructor:

Name	:	Dr. Shanmugapriya Dharmarajan
Office	:	CAV 204A
Office hours	:	M 10:00 am to 12:00 pm, T 12:30 to 01:30 pm, W 12:30 to 02:30 pm
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Phone	:	325-486-6626

Course Description:

Credit	:	4 hours credit (Lecture and lab)
Pre-requisite	:	Passing grade in CHEM 3421
Website	:	Blackboard

Meeting Time and Location:

Course delivery	:	Face-to-face (Accommodation can be provided if needed)
Lecture times	:	TR 08:00 – 09:15 AM [in CAV 211]
Lab times	:	R 02:00 AM – 04:50 PM [in CAV 215 and CAV 206]

Course Material:

Texts	:	Quantitative Chemical Analysis, 10th ed., Daniel C. Harris (Macmillan Achieve eBook recommended)
Online homework	:	Macmillan Achieve (You can buy the access code to Macmillan Achieve from the ASU Bookstore or using a link posted on Blackboard)
Lab materials	:	Lab manual (pdf) will be posted on Blackboard
Lab notebook	:	The Laboratory Notebook (carbonless, spiral) is required
Technology requirement	:	Top Hat, Bb Collaborate, and Respondus Lockdown Browser Monitor
Other materials	:	Safety goggles, scientific calculator

Course Objectives:

Instrumental analysis is the cornerstone of most of the work performed in the physical and life sciences. From determining the composition of soil on Mars to the changes of neurotransmitters in single nerve cells, from determining the ages of rocks in billions of years to monitoring the progress of a catalytic reaction on the femtosecond timescale, you will find instrumental methods in the center of the action. This course is designed to open the door of understanding of instrumental methods to you. The list of instrumental methods may seem endless, the complexity of the machines mind-boggling and the wealth of information produced overwhelming. HOWEVER, instrumental methods are designed around an amazingly small number of basic principles so that with a reasonable effort you can have insight into every area of scientific endeavor. A good understanding of instrumental methods will

prepare you for graduate school or medical school and is one of the best skills that you can have if you are seeking employment as a B.S. chemist. This course will give a broad overview of the principles of chemical analysis using instrumental methods. Emphasis will be placed on the theory, operation, and application of these methods. Broad topics include signal and noise, optical, electroanalytical and separations methods. Specific instruments & methods include, but are not limited to, UV/Vis, FTIR, AA/AE, HPLC, GCMS, coulometry and cyclic voltammetry.

Learning Objectives:

Essential Learning Outcomes*:* Number-letter notations in parentheses refer to Chemistry Department Student Learning Objectives which are available at the Chemistry Department website.

Learning to apply course material*:* Students coming out of the course should be able to decide what technique should be used for a critical application. They should be able to justify their choice and identify crucial method conditions for the application. Students should be able to apply the general principles of instrumental methods to understand and evaluate unfamiliar or new instrumental techniques.

Developing specific skills and competencies: Students should know key skills needed to produce reliable data and make good decisions regarding that data. This requires the ability to optimize instrument performance, process and analyze data, meaningfully interpret data (requires awareness of method limitations), and understand at a technical level how instruments work.

Important Goals:

Gaining factual knowledge (terminology, classifications, methods, trends)**:** Students will be able to identify and name the major instrumental methods. Students will be able to classify methods according to the type of method (spectroscopic, chromatographic, electrochemical, etc.), type of analyte, information required and the concentration range (major component, minor component, trace, etc.)

Learning fundamental principles, generalizations, or theories: Students will be able to describe the basic principles involved in the major instrumental methods and explain how these principles enable a method to obtain the desired information. Students will be able to use quantitative figures of merit to evaluate the suitability of a method for a given application.

Developing skill in expressing oneself orally or in writing*:* Students will be able record experimental data and results in a way it can be read and understood by anyone having a basic knowledge of analytical chemistry and that will permit the experiment to be duplicated. Students will be able to summarize experimental results in concise reports that meet requirements of the task at hand and the intended recipient of the report.

Evaluation:

Student learning outcomes will be evaluated by test questions and by the grading of lab notebook, reports and other assignments.

A = 900 to 1000 points; B = 800 to 899 points; C = 700 to 799 points; D = 600 to 699 points; F = below 600 points

Item	Points
Assignment/Homework	200 points
Quizzes (3 X 50)	150 points
Lab reports	200 points
Exams (3 X 100 points)	300 points
Final exam	150 points
Classroom participation	50 points (Bonus)
Total	**1000 points**

Student Responsibilities:

Attendance: You are expected to attend the in-person lectures and labs. You will get points for participating in the lecture quizzes through TopHat. You cannot make-up the missed TopHat points. The student is responsible for making-up any other work missed under the following conditions:

- Unavoidable emergency absences (illness, death in the immediate family, etc.): You must contact the instructor before the absence with a valid, and verifiable excuse.
- Planned absences (university related): You must get the instructor's approval to make-up the missed work prior to the absence. The reason for the absence should be the participation in university sponsored events.

Homework, Assignments and Quizzes: There will be an Achieve online homework for each chapter and their points may vary. The due dates and number of attempts will be mentioned before each assignment. For some chapters ungraded adaptive learning assignments may also be given.

There will be a total of 4 paper-based in-class 30-min quizzes. Each worth 50 points. The quiz grades will be posted on Blackboard, and students will have three days after receiving the graded quiz to inform the instructor about any error.

***Exams*:** There will be three midterm exams and each worth 100 points. The Final Exam is cumulative and it is worth 150 points. The midterm exams would focus more on new materials (materials covered after the previous exam).

Exams can be made-up only at the following circumstances:

- Previous arrangements are made with the instructor
- Serious illness (a physician note is required)
- Death in the immediate family

Laboratory: Laboratory work is an essential part of a science course. Students should make every effort to participate fully in the laboratory experience. Students should approach the lab as if it were a research project. Every effort should be made to obtain quality results, record the experimental work completely at the time the work is done, evaluate the quality of the work and take steps to improve results when needed and possible. Material from lab experiments may be covered on lecture exams.

A separate lab manual (pdf) for each experiment will be posted on Blackboard. A hand-written lab report (pre-lab writeup, observation, and post-lab writeup) is required for each lab experiment. The format and due dates for the reports will be discussed in the class.

Course and University Policies:

All students are required to follow the policies and procedures presented in these documents:

Angelo State University Student Handbook[1]
Angelo State University Catalog[2]

Office Hours / Email Communication: Students can walk-in to the regular office hours. If you cannot make it during those hours, please make an appointment by email. Students are expected to frequently check their Angelo State email account and the Blackboard course website announcements for important communication from the instructor. Use CHEM4421 in the subject line of your emails to enable proper filtering. The instructor will only answer e-mails that are sent from an ASU e-mail account. The instructor will respond to legitimate e-mails within 24-48 hours during the week and may not respond until after weekends or holidays if messages are received on any of such days. More general questions will be addressed in the following lecture.

Copyright: All handouts, videos, quizzes, exams and lecture material are copyrighted by Shanmugapriya Dharmarajan. Free (no cost) copying and distribution of these materials among Angelo State University students are allowed. Any other distribution, including distribution for a fee or sharing online are not allowed without my written consent.

Academic Integrity: Students are expected to maintain complete honesty and integrity in all work. Any student found guilty of any form of dishonesty in academic work is subject of disciplinary action and possible expulsion from ASU.

The College of Science and Engineering adheres to the university's Statement of Academic Integrity.[3]

Accommodations for Students with Disabilities: ASU is committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs or activities of the university, or be subjected to discrimination by the university, as provided by the Americans with Disabilities Act of 1990 (ADA), the Americans with Disabilities Act Amendments of 2008 (ADAAA) and subsequent legislation.

Student Disability Services is located in the Office of Student Affairs, and is the designated campus department charged with the responsibility of reviewing and authorizing requests for reasonable accommodations based on a disability. It is the student's responsibility to initiate such a request by contacting an employee of the Office of Student Affairs, in the Houston Harte University Center, Room 112, or contacting the department via email at ADA@angelo.edu. For more information about the application process and requirements, visit the Student Disability Services website.[4] The employee charged with the responsibility of reviewing and authorizing accommodation requests is:

Dallas Swafford
Director of Student Disability Services
Office of Student Affairs
325-942-2047
dallas.swafford@angelo.edu
Houston Harte University Center, Room 112

Incomplete Grade Policy: It is policy that incomplete grades be reserved for student illness or personal misfortune. Please contact faculty if you have serious illness or a personal misfortune that would keep you from completing course work. Documentation may be required. See ASU Operating Policy 10.11 Grading Procedures[5] for more information.

Plagiarism: Plagiarism is a serious topic covered in ASU's Academic Integrity policy[6] in the Student Handbook. Plagiarism is the action or practice of taking someone else's work, idea, etc., and passing it off as one's own. Plagiarism is literary theft. In your discussions and/or your papers, it is unacceptable to copy word-for-word without quotation marks and the source of the quotation. It is expected that you will summarize or paraphrase ideas giving appropriate credit to the source both in the body of your paper and the reference list. Papers are subject to be evaluated for originality. Resources to help you understand this policy better are available at the ASU Writing Center.[7]

Student Absence for Observance of Religious Holy Days: A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. See ASU Operating Policy 10.19 Student Absence for Observance of Religious Holy Day[8] for more information.

Title IX at Angelo State University: Angelo State University is committed to providing and strengthening an educational, working, and living environment where students, faculty, staff, and visitors are free from sex discrimination of any kind. In accordance with Title VII, Title IX, the Violence Against Women Act (VAWA), the Campus Sexual Violence Elimination Act (SaVE), and other federal and state laws, the University prohibits discrimination based on sex, which includes pregnancy, and other types of Sexual Misconduct. Sexual Misconduct is a broad term encompassing all forms of gender-based harassment or discrimination and unwelcome behavior of a sexual nature. The term includes sexual harassment, nonconsensual sexual contact, nonconsensual sexual intercourse, sexual assault, sexual exploitation, stalking, public indecency, interpersonal violence (domestic violence or dating violence), sexual violence, and any other misconduct based on sex.

You are encouraged to report any incidents involving sexual misconduct to the Office of Title IX Compliance and the Director of Title IX Compliance/Title IX Coordinator, Michelle Miller, J.D. You may submit reports in the following manner:

Online: Incident Reporting Form9
Face to Face: Mayer Administration Building, Room 210
Phone: 325-942-2022
Email: michelle.miller@angelo.edu

Note, as a faculty member at Angelo State, I am a mandatory reporter and must report incidents involving sexual misconduct to the Title IX Coordinator. Should you wish to speak to someone in

confidence about an issue, you may contact the University Counseling Center (325-942-2371), the 24-Hour Crisis Helpline (325-486-6345), or the University Health Clinic (325-942-2171).

For more information about resources related to sexual misconduct, Title IX, or Angelo State's policy please visit the Title IX website.10

Information About COVID-19: Please refer to ASU's COVID-19 (Coronavirus) Updates11 web page for current information about campus guidelines and safety standards as they relate to the COVID-19 pandemic.

Modifications to the Syllabus: The instructor reserves the right to change by addition and/or subtraction any and/or all materials contained in this syllabus. This includes, but is not limited to, course content, assignments, due dates, and portion(s) of the grade assigned to individual items within the course. In particular, the COVID-19 pandemic may require significant changes in course delivery and content on potentially short notice.

Tentative Lecture Schedule

Units	Tuesday	Thursday
Unit – 1: **Quality Assurance and Sampling**	**18-Jan** Introduction/Chapter 5: Quality assurance and calibration methods	**20-Jan** Chapter 5: Quality assurance and calibration methods
	25-Jan Chapter 5: Quality assurance and calibration methods	**27-Jan (Quiz-1)** Chapter 28: Sample Preparation
Unit – 2: Spectrophotometry	**1-Feb** Chapter 18: Fundamentals of Spectrophotometry	**3-Feb** Chapter 18: Fundamentals of Spectrophotometry
	8-Feb Chapter 20: Spectrophotometers	**10-Feb** **(Exam-1)**
	15-Feb Chapter 20: Spectrophotometers	**17-Feb** Chapter 21: Atomic Spectroscopy
	22-Feb Chapter 21: Atomic Spectroscopy	**24-Feb (Quiz-2)** Chapter 21: Atomic Spectroscopy
Unit – 3: Electroanalytical Methods and Mass Spectrometry	**1-Mar** Chapter 17: Fundamentals of Electroanalytical chemistry	**3-Mar** Chapter 17: Fundamentals of Electroanalytical chemistry
	8-Mar Chapter 22: Mass Spectrometry	**10-Mar (Exam-2)** Review
	15-Mar Spring Break	**17-Mar** Spring Break
	22-Mar Chapter 22: Mass Spectrometry	**24-Mar** Chapter 22: Mass Spectrometry
Unit – 4: **Separations**	**29-Mar** Chapter 23: Introduction to Analytical Separations	**31-Mar (Quiz-3)** Chapter 23: Introduction to Analytical Separations
	5-Apr Chapter 23: Introduction to Analytical Separations	**7-Apr** Chapter 24: Gas Chromatography
	12-Apr Chapter 24: Gas Chromatography	**14-Apr (Exam-3)** Review
	19-Apr Chapter 25: High-Performance Liquid Chromatography	**21-Apr** Chapter 25: High-Performance Liquid Chromatography
	26-Apr Chapter 25: High-Performance Liquid Chromatography	**28-Apr (Quiz-4)** Chapter 25: High-Performance Liquid Chromatography
	3-May Chapter 26: Chromatographic Methods and Capillary Electrophoresis	**5-May** Chapter 26: Chromatographic Methods and Capillary Electrophoresis
Final Exam	**10-May** Final Exam at 08:00 – 10:00 AM in CAV211	

Tentative Lab Schedule

Date	Lab
20-Jan	No lab this week
27-Jan	Exp 1: Dilutions and calibration curves
3-Feb	Exp 2: Sampling
10-Feb	Exp 3: Signal and Noise (dry lab)
17-Feb	Exp 4: Figures of Merit for UV-Vis Analysis of Iron
24-Feb	Exp 5: TBA
3-Mar	(Exp 4 and 5 – Continued)
10-Mar	Exp 6: Introduction to Analytical Fluorescence*
17-Mar	Spring Break
24-Mar	Exp 7: Mass Spectrometry (dry lab)
31-Mar	Exp 8: Simultaneous Analysis of Two Ions*
7-Apr	Exp 9: Spectrophotometric Determination of pKa of an Indicator
14-Apr	Exp 10: Gas Chromatography-Mass Spectrometry*
21-Apr	Exp 11: Cyclic voltammetry*
28-Apr	(no lab)

*Limited availability of instrument. We will work on alternating the lab time.

[1] https://www.angelo.edu/current-students/student-handbook/
[2] https://www.angelo.edu/academics/catalog/
[3] https://www.angelo.edu/live/files/27603-student-handbook-2020-21#page=96
[4] https://www.angelo.edu/current-students/disability-services/
[5] https://angelo.policystat.com/policy/10659448/latest/
[6] https://www.angelo.edu/live/files/27603-student-handbook-2020-21#page=96
[7] https://www.angelo.edu/current-students/writing-center/academic_honesty.php
[8] https://angelo.policystat.com/policy/10659368/latest/
[9] https://www.angelo.edu/incident-form
[10] https://www.angelo.edu/title-ix
[11] https://www.angelo.edu/covid-19/