

Course Title: Instrumental Analysis

Course Prefix: CHEM

Course No.: 4053

Section No.: P01

Department of Chemistry College of Arts & Science

Instructor Name: Harshica Fernando, PhD

Office Location: EE O'Banion Science Building Room 230H

Office Phone: 936-261-3112

Email Address: hufernando@pvamu.edu

Office Hours: MWF: from 9 am – 11 am, T 10.30 am to 12.30 pm

Course Location: E. E. O'Banion Science Building Room 209 E. E. O'Banion Science Building Class

Meeting Days & Times: TR 1:00 – 2:20 pm

Catalog Description: Instrumental Analysis (3-0) Credit 3 semester hours. An introduction of the theory and application of modern instrumentation and techniques to the analysis of chemical systems. Includes interpretive spectroscopy, computer-assigned experimentation, and the use of the chemical literature.

Prerequisites: CHEM 3413, CHEM 3423 Co-requisites:

Required Text: Undergraduate Instrumental Analysis", 6th ed. by J. W. Robinson, E. S. Frame and G. M. Frame II; ISBN-0824753593

Recommended Text/Readings: Contemporary Instrumental Analysis", by Rubinson & Rubinson; "Fundamentals of Analytical Chemistry", 8th ed. by Skoog, West, Holler, Crouch

**Access to Learning Resources: PVAMU Library:
phone: (936) 261-1500;**

**web: <http://www.tamu.edu/pvamu/library/> University
Bookstore:**

phone: (936) 261-1990;

web: <https://www.bkstr.com/Home/10001-10734-1?demoKey=d>

Course Goals and Overview

CHEM 4053 is a lecture course which provides an introduction to the theories, fundamental principles and applications of modern instrumentation, methods and techniques for the characterization of chemical systems. The course aims to underline the complimentary values of instrumental methods in chemical analysis. It addresses the issues of proper instrument choice for specific chemical analyses, by understanding the nature of the material being analyzed and the type of information gained from different instrumental methods. The principles underlying the interaction of radiation with matter to provide analytical information are emphasized in spectroscopic topics. Analytical chemists are interested in efficiency and selectivity in chemical analysis and are thus seeking new instrumental methods and techniques in the quest of delineating chemical information concerning the constitution of matter.

Course Goals and Outcomes

At the end of this course the student will demonstrate knowledge in:

- The sources and types of noise in measurements and how they affect S/N
- A general knowledge of spectroscopic methods and their characteristic properties
- Typical components of optical instruments
- Molecular Ultraviolet -Visible spectroscopy: Molar absorptivities and their application in spectral interpretation; Analysis of multi-component mixtures
- Reliability of spectrophotometric analysis (Beers Law)
- Mechanistic difference between absorption, luminescence and fluorescence
- Mass spectrometry: analyzers/separation & detection methods
- Artifacts of mass spectrometry used in spectral analysis
- Vibrational spectroscopy: Mechanisms for IR and Raman spectroscopy
- Interpretation of simple IR spectra
- Use of the Michelson Interferometer in FTIR methods
- Quantum description of NMR: Principles underlying chemical shift and spin-spin splitting in first order spectra
- Interpretation of simple first order NMR spectra
- Separation Techniques (GC and HPLC)

Course Requirements & Evaluation Methods

This course will utilize the following instruments to determine student grades and proficiency of the learning outcomes for the course.

Exams – written tests designed to measure knowledge of presented course material

Exercises – written assignments designed to supplement and reinforce course material

Projects –

Grading Matrix

Instrument	Value (points or percentages)	Total
Hour Exams	3 Exams at 100 points each	300
Quizzes		100
Final Exam	100 points	100
Total:		500

Grade Determination:

A = 90-100%

B = 80-89%

C = 70-79%

D = 60-69%

F = 59% and below

Exam Dates (Tentative)

Exam 1: Tuesday, February 13

Exam 2: Thursday, March 8

Exam 3: Tuesday, April 17

Final Exam (Final exam week in May)

Course Procedures

Submission of Assignments:

Formatting Documents:

Microsoft Word is the standard word processing tool used at PVAMU. If you're using other word processors, be sure to use the "save as" tool and save the document in either the Microsoft Word, Rich-Text, or plain text format. **Exam**

Policy

This is a face to face theoretical class. Students are expected to contribute to in- class discussions which are intended to stimulate intellectual thought. Students are encouraged to ask questions and attempt to answer question in a manner that is not disruptive to the proceedings. All assigned work must be handed on time. Exams and quizzes should be taken as scheduled. No makeup examinations will be allowed except under documented emergencies (See Student Handbook).

Professional Organizations and Journals

(if applicable to your course or program, they should be listed here)

References

(if applicable to your course or program, references should be listed here)

16 Week Calendar

Week 1 -3: Topic **Introduction to Instrumental Analysis**

Classification of analytical methods

Types of instrumental methods

Detectors, transducers and Sensors

Signals and Noise

S/N ratio

Reliability in instrumental analysis

Sensitivity and limits of detection

Improving S/N by signal averaging

Chapter (s): 1 & 2

Assignment (s): Problems from chapters one and two

Week Four- 8: Molecular Spectroscopy

Ultra violet – Visible absorption

Beer's Law

Application of Beer's law to mixtures

Limitation of Beer's law

Deviations from Beer's law

Effect of slit width, scattered radiation

Molecular energy diagram

Molar absorptivity and functional groups

Adsorption/luminescence/phosphorescence

Mechanisms of fluorescence and phosphorescence

Quantum yield in fluorescence

Infrared Spectroscopy

Quantum Mechanical description of IR

Vibrational modes/ Vibrational frequencies

Harmonic Oscillator model(calculations)

FTIR

IR sources and transducers

Interpretation of IR

Application of Infrared Spectroscopy

Analyzer houses and NIR in manufacturing

Introduction to Raman Spectroscopy

Theory of Raman

Compare and contrast the quantum basis for IR/Raman

Raleigh and Stokes scattering

Chapter (s): 4 & 5

Assignment (s): Problems from chapters 4 & 5

Week 8 to 10 : Topic Nuclear Magnetic Resonance

Quantum description of NMR

Relaxation processes in NMR

Spin lattice (T_1)

Spin-Spin (T_2)

FT-NMR

Fellget and Jacquinot advantages

Sensitivity of the NMR method

The chemical shift

Shielding

Spin-spin splitting

Pascal theorem and multiplets in Proton

NMR
Rules of first order spectral interpretation
Introduction to Carbon-13 NMR

Chapter (s): 3

Assignment (s): Problems from Chapter 3

Week 12-14: Topic **Optical Atomic Spectrometry (introduction)** Energy level diagrams

Atomic line widths
Atomization methods
Sample introduction methods
Liquid sample/ solids sample

Atomic Absorption

Flame atomization
The AA instrument
Interferences in AA spectroscopy
Spectral/chemical

Atomic emission

Emission based on plasma sources
Inductively coupled plasma
Direct current plasma source
Arc and spark sources

Chapter (s): 6 & 7

Assignment (s): Problems from chapters 6 & 7

Week 14 -15: Topic **Mass Spectrometry**

Atomic masses in mass spectrometry
Types of mass analyzers
Quadropole mass analyzers
Time of flight
Magnetic sector
Tandem spectroscopy using the MS as a
detector
Molecular Mass Spectrometry

Chapter (s): 9 & 10

Assignment (s): Problems from chapters 9 & 10

Week 16: Final Exam Week

University Rules and Procedures

Disability statement (See Student Handbook):

Students with disabilities, including learning disabilities, who wish to request accommodations in class should register with the Services for Students with Disabilities (SSD) early in the semester so that appropriate

arrangements may be made. In accordance with federal laws, a student requesting special accommodations must provide documentation of their disability to the SSD coordinator.

Academic misconduct (See Student Handbook):

You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with your Student Handbook, especially the section on academic misconduct. Students who engage in academic misconduct are subject to university disciplinary procedures.

Forms of academic dishonesty:

1. Cheating: deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not mastered; giving or receiving aid unauthorized by the instructor on assignments or examinations.
2. Academic misconduct: tampering with grades or taking part in obtaining or distributing any part of a scheduled test.
3. Fabrication: use of invented information or falsified research.
4. Plagiarism: unacknowledged quotation and/or paraphrase of someone else's words, ideas, or data as one's own in work submitted for credit. Failure to identify information or essays from the Internet and submitting them as one's own work also constitutes plagiarism.

Nonacademic misconduct (See Student Handbook)

The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. Such incidents will be adjudicated by the Dean of Students under nonacademic procedures.

Sexual misconduct (See Student Handbook):

Sexual harassment of students and employers at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating this policy will be subject to disciplinary action.

Attendance Policy:

Prairie View A&M University requires regular class attendance. Excessive absences will result in lowered grades. Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or in assignment of a grade of "F". Absences are accumulated beginning with the first day of class.

Student Academic Appeals Process

Authority and responsibility for assigning grades to students rests with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the Undergraduate Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint.

Technical Considerations for Online and Web-Assist Courses

Minimum Hardware and Software Requirements:

- Pentium with Windows XP or PowerMac with OS 9
- 56K modem or network access
- Internet provider with SLIP or PPP
- 8X or greater CD-ROM
- 64MB RAM

- Hard drive with 40MB available space
- 15" monitor, 800x600, color or 16 bit
- Sound card w/speakers
- Microphone and recording software
- Keyboard & mouse
- Netscape Communicator ver. 4.61 or Microsoft Internet Explorer ver. 5.0 /plug-ins

Participants should have a basic proficiency of the following computer skills:

- Sending and receiving email
- A working knowledge of the Internet
- Proficiency in Microsoft Word
- Proficiency in the Acrobat PDF Reader
- Basic knowledge of Windows or Mac O.S.

Netiquette (online etiquette): students are expected to participate in all discussions and virtual classroom chats when directed to do so. Students are to be respectful and courteous to others in the discussions. Foul or abusive language will not be tolerated. When referring to information from books, websites or articles, please use APA standards to reference sources.

Technical Support: Students should call the Prairie View A&M University Helpdesk at 936-261-2525 for technical issues with accessing your online course. The helpdesk is available 24 hours a day/7 days a week. For other technical questions regarding your online course, call the Office of Distance Learning at 936-261-3290 or 936-2613282

Communication Expectations and Standards:

All emails or discussion postings will receive a response from the instructor within 48 hours.

You can send email anytime that is convenient to you, but I check my email messages continuously during the day throughout the work-week (Monday through Friday). I will respond to email messages during the work-week by the close of business (5:00 pm) on the day following my receipt of them. Emails that I receive on Friday will be responded to by the close of business on the following Monday.

Submission of Assignments:

Assignments, Papers, Exercises, and Projects will distributed and submitted through your online course. Directions for accessing your online course will be provided. Additional assistance can be obtained from the Office of Distance Learning.

Discussion Requirement:

Because this is an online course, there will be no required face to face meetings on campus. However, we will participate in conversations about the readings, lectures, materials, and other aspects of the course in a true seminar fashion. We will accomplish this by use of the discussion board.

Students are required to log-on to the course website often to participate in discussion. It is strongly advised that you check the discussion area daily to keep abreast of discussions. When a topic is posted, everyone is required to participate. The exact use of discussion will be determined by the instructor.

It is strongly suggested that students type their discussion postings in a word processing application and save it to their PC or a removable drive before posting to the discussion board. This is important for two reasons: 1) If for some reason your discussion responses are lost in your online course, you will have another copy; 2) Grammatical errors can be greatly minimized by the use of the spell-and-grammar check functions in word processing applications. Once the post(s) have been typed and corrected in the word processing application, it should be copied and pasted to the discussion board.