

# Brazosport College

## Syllabus for CTEC 2431 – Applied Instrumental Analysis II

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### I. COURSE DESCRIPTION:

#### **CTEC 2431 - Applied Instrumental Analysis II. CIP 4103010003**

Study of advanced topics in instrumental analysis. Topics include atomic absorption, inductively coupled plasma, nuclear magnetic resonance, gas chromatography/mass spectrometry, liquid chromatography, and infrared spectroscopy. **Credit Hours: 4 (3 lecture, 3 lab)**

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Dr. Judy Chu

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Dr. Kirby Lowery

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Gary Hicks

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Jeff Detrick

January 2021

- A. Prerequisite:** A grade “C” or better in CTEC 1441.  
**Required skill level:** College-level reading, writing and math.

## **II. COURSE OBJECTIVES**

At the completion of CTEC 2431 the student should be able to:

1. Understand and apply the principles of light absorption and emission in spectrochemical analysis.
2. Apply the theory and operation of the FTIR spectrometer in the identification of organic compounds.
3. Understand and the theory and operation of the UV/Vis spectrophotometer in chemical analysis.
4. Understand the theory of atomic spectroscopy and the operation of the AA spectrometer in trace metal analysis.
5. Understand the theory of mass spectrometry and NMR spectroscopy and the operation of the mass and NMR spectrometer.
6. Understand the theory and operation of the high-performance liquid chromatography (HPLC).
7. Understand various physical testing methods such as viscosity measurement, thermal analysis, particle size analysis and hardness testing.
8. Receive a grade of D or better in the laboratory portion of the course.

## **III. STUDENT LEARNING OUTCOMES**

Calibrate, operate, troubleshoot, and maintain analytical instruments; prepare and analyze samples; and use data interpretation for troubleshooting.

## **IV. LABORATORY OBJECTIVES**

**YOU MUST MAKE AT LEAST A “D” IN THE LABORATORY PORTION OF THIS COURSE IN ORDER TO PASS THE COURSE.**

## **V. TEXTBOOK OR COURSE MATERIAL INFORMATION**

### **A. Textbook**

1. Organic Chemistry Lab Notebook, CER, 1998, Publisher Thomson Publishing/ITP. ISBN: 978-0-87540-249-9 (required)
2. Applied Instrumental Analysis Class Notes, Chu Judy, BC Custom Publisher, May 2019. (required)
3. Kenkel, John, Analytical Chemistry for Technicians, 3<sup>rd</sup> Edition, Published by Lewis Publishers, 2003. *The textbook is available as an e-textbook in D2L.*
4. Calculator T130XA (required)
5. Safety Glasses (required)

Required course materials are available at the Brazosport College bookstore, on campus or online at <http://brazosport.edu/bookstore/home.html>. A student of this institution is not under any obligation to purchase a textbook from the college bookstore. The same textbook is/may also be available from an independent retailer, including an online retailer.”

**For Distance Education Courses include the following:** Contact the Brazosport College Bookstore with a credit card for course materials. Phone: 979.230.3651. Fax: 979.230.3653. Email: [bookstore@brazosport.edu](mailto:bookstore@brazosport.edu). Website: <http://brazosport.edu/bookstore/home.html>.

## B. Course Outline

**This is a sample outline which may vary with individual instructors. It will also vary based on whether the course is a summer course or a fall/spring course. Students should contact their instructor for the outline of the course they are taking.**

WEEK	DATE	LECTURE TT 5:35 – 6:50 PM	LAB Tuesday 7-9:50 PM
1	1/11	Introduction to Organic Chemistry	Safety and check-in. See lab syllabus for experiments
2	1/18	Chapter 7 – Introduction to Spectrochemical Methods	
3	1/25	Chapter 8.1-8.5 – UV-Vis Spectrophotometry	
4	2/1	<b>Exam 1</b> Chapter 8.6-8.11 – FTIR Spectrometry	
5	2/8	Chapter 8.6-8.11 – FTIR Spectrometry	
6	2/15	Chapter 9 - Atomic Spectroscopy	
7	2/22	Chapter 9 - Atomic Spectroscopy <b>Exam 2</b> – (FTIR and AA)	
8	3/1	Chapter 10 – Other Spectroscopic Methods – Mass Spectrometry	
9	3/8	<b>Spring Break</b>	<b>No Lab</b>
10	3/15	Chapter 10 – Other Spectroscopic Methods – NMR Spectroscopy	
11	3/22	Chapter 10 – Other Spectroscopic Methods – NMR Spectroscopy Chapter 13 – High Performance Liquid Chromatography	
		<b>Last Date to withdraw is March 26</b>	
12	3/29	Chapter 13 – High Performance Liquid Chromatography <b>Exam 3</b> – NMR, MS and HPLC	↓
13	4/5	Chapter 14 – Electroanalytical Methods	
14	4/12	Chapter 15 – Physical Testing Methods	
15	4/19	Polymer Chemistry	Clean-up
16	4/26	<b>Exam 4 – Tuesday, Apr. 30</b> <b>Final – Thursday, May 2, 5-7 PM</b>	

**Homework Assignments:** A maximum homework grade of 10 points will be assigned to completed homework assignments handed in on time (prior to the start of the exam). These points will be added to the corresponding exam grade as bonus points.

**For Exam 1: Due before Exam 1**

Organic Exercise Sets 1, 2, 3, and 4 (handout)

7 (3, 7, 18, 19, 20, 21, 22, 23, 25, 43, 51, 60, 63, 65))

8 (1, 3, 8, 18, 20, 26, 28, 31)

**For Exam 2: Due before Exam 2**

8 (50, 52, 53, 56, 57, 58, 59, 63, 64, 66, 69, 75, 76)

9 (3, 7, 9, 10, 12, 17, 20, 23, 49, 50)

**For Exam 3: Due before Exam 3**

10 (2, 3, 5, 6, 7, 9, 12, 13, 15, 17, 21, 26, 29, 30, 31, 32, 33, 34, 35, 41, 43, 44, 45)

13 (1, 7, 8, 13, 19, 22, 36, 45, 49, 56, 60, 61)

**For Exam 4: Due before Exam 4**

14 (2, 3, 7, 8, 9, 12, 19, 26, 59)

15 (3, 8, 9, 10, 13, 15, 17, 19, 22, 26, 29, 31, 33, 35, 39, 41, 42, 47, 50)

**Important Semester Dates:**

Last Day to Withdraw from Classes– Check BC Academic Calendar -

<http://catalog.brazosport.edu/index.php>

**VI. LAB REQUIREMENTS**

1. Visorgogs or safety goggles, must meet ANSI Z87.1-1989 certification.

**To pass the course, the student must successfully complete the laboratory experiments with a grade of D or better.**

**Experiments for Applied Instrumental Analysis II Lab**

- 1) UV-Vis
  - a) Experiment 23: Determination of Nitrate in Water by UV Spectrophotometry. (Kenkel, page 234, and Handout)
  - b) Experiment 19: Colorimetric Analysis of Prepared and Real Water Samples for Iron. (Kenkel, page 197)
  - c) Colorimetric Determination of Aspirin. (Handout)
- 2) FTIR
  - a) IR Tutor (Interactive tutorial on the computer)
  - b) Experiment 25: Qualitative Analysis by Infrared Spectrometry - Liquid Sampling. (Kenkel, page 235, and Handout)
  - c) Experiment 26: Qualitative Analysis by Infrared Spectrometry - Solid Sampling. (Handout)
  - d) Experiment 28: Measuring the Pathlength of Various IR Cells (Kenkel, page 237, and Handout)

- 3) GC-Mass Spectrometry
- 4) Viscometry
  - a) Measuring the Viscosity of Polystyrene using a Capillary Viscometer (Handout)
- 5) Proton NMR
- 6) HPLC
  - a) The Quantitative Determination of Methyl Paraben in a Prepared Sample by HPLC.
    - i) Determination of the Optimum Mobile Phase Composition
    - ii) Methyl Paraben Quantization
- 7) Viscometry
  - a) Measuring the Viscosity of Polystyrene using a Capillary Viscometer (Handout)

### **Applied Instrumental Analysis II Lab**

#### **Safety:**

1. Safety goggles must be worn at all times in the laboratory.
2. Know the locations of eyewashes, showers, fire extinguishers and exits.
3. Use common sense.
4. Bare feet are NOT allowed into the laboratory. Open sandals and shoes are discouraged.

#### **Laboratory Housekeeping:**

1. Arrange apparatus neatly and compactly. Keep all books except the laboratory manual and laboratory notebook off the laboratory workbench.
2. Do not throw paper or solid materials into the water troughs or sinks.
3. Keep all reagent bottles clean (especially acids and bases).
4. Keep the lab bench area clean. Pay particular attention to keeping the balances clean and in order. If you spill chemicals, clean them up immediately. Put caps back on reagent containers.
5. At the end of the laboratory period, clean off your workspace with a sponge or wet paper towel. Perform proper shutdown of the instruments. Check to see that the gas and water have been turned off. You are responsible for keeping the area neat. Repeated failure to do so may result in loss of credit.

### **CLEAN UP AND INSTRUMENT SHUTDOWN STARTS 10 MINUTES BEFORE THE OFFICIAL END OF THE CLASS PERIOD.**

When the time is up, you are supposed to be out of the laboratory. Failure to properly budget your time is presumptive of poor planning and your grade may suffer.

#### **Grading:**

1. Come prepared to the lab. The introduction (objective, discussion), safety, material and apparatus, should be written in the Laboratory Notebook prior to the beginning of the experiment.

2. The format for the lab notebook is described in detail in the handout (Report Format for CTEC 2431). This pre-lab write-up (30 points) must be checked and initialed by me prior to the start of each experiment.
3. Experimental data and observations must be recorded in the Laboratory Notebook. The data sheets and observations (20 points) must be completely filled out in ink and initialed by me before you leave the lab. When you make an error, cross it out with a single line. Do not use liquid paper or obliterate the error. For example: ~~error~~ error
4. After a lab is finished, write the date that you finished the lab on the lab sign-up sheet. This signifies that your lab report will be due one week from that date.
5. Analysis of the data, calculations, including any tables and graphs, and summaries and conclusions (50 points) are due one week after the conclusion of the experiment.
6. Carbon copies of the complete experimental write-up are due the week after you finish the experiment.
7. Grading will be based on completeness of the experiments and the submitted report write-up.

## **VII. STUDENTS WITH DISABILITIES**

Brazosport College is committed to providing equal education opportunities to every student. BC offers services for individuals with special needs and capabilities including counseling, tutoring, equipment, and software to assist students with special needs. For student to receive any accommodation, documentation must be completed in the Office of Disability Services. Please contact Phil Robertson, Special Populations Counselor at 979-230-3236 for further information.

## **VIII. TITLE IX STATEMENT**

Brazosport College faculty and staff are committed to supporting students and upholding the College District's non-discrimination policy. Under Title IX and Brazosport College's policy FFDA (Local), discrimination based on sex, gender, sexual orientation, gender identity, and gender expression is prohibited. If you experience an incident of discrimination, we encourage you to report it. While you may talk to a faculty or staff member at BC, please understand that they are "Responsible Employees" and must report what you tell them to college officials. You can also contact the Title IX Coordinators directly by using the contact information below. Additional information is found on the Sexual Misconduct webpage at [www.brazosport.edu/sexualmisconduct](http://www.brazosport.edu/sexualmisconduct)

## **IX. ACADEMIC HONESTY**

Brazosport College assumes that students eligible to perform on the college level are familiar with the ordinary rules governing proper conduct including academic honesty. The principle of academic honesty is that all work presented by you is yours alone. Academic dishonesty including, but not limited to, cheating, plagiarism, and collusion shall be treated appropriately. Please refer to the Brazosport College Student Guide for more information. This is available online at <http://brazosport.edu/students/for-students/student-services/>.

Academic dishonesty violates both the policies of this course and the Student Code of Conduct. In this class, any occurrence of academic dishonesty will be referred to the Dean of Student Services for prompt adjudication. Sanctions may be imposed beyond your grade in this course by the Dean of Student Services.

## **X. ATTENDANCE AND WITHDRAWAL POLICIES**

Class attendance contributes to your final grade, but you must attend class to successfully complete the course. If you are unable to complete this course, you must complete and submit a withdrawal form with the registrar's office. If the student decides to drop out of the class, it is the responsibility of the student to initiate a withdrawal before the withdrawal deadline in order to get a "W" on their transcript. If this is not done the student will receive a grade based on test grades and class grades earned during their attendance and absence (i.e., zeros on all missed materials, exams, skills tests, and final exam).

## **XI. COURSE REQUIREMENTS AND GRADING POLICY TESTING MAKE-UP POLICY**

For this class you complete the following:

**Exams:** There will be a total of four exams. Each exam will last approximately one hour during class. The exact date of each Exam will be announced in class prior to the actual date of the exam. Students are allowed to bring a one-page, hand-written notes containing equations, etc., to the exams.

**Homework:** As assigned by the instructor. A maximum homework grade of 10 points will be awarded as bonus points to the exam for homework assignments handed in on time. Due date for homework is the day of the exam. **All work must be shown to obtain full credit for the homework assignments.**

**Lab:** The laboratory portion of the course consists of weekly 3-hour labs which the student must attend. **To pass the course, the student must successfully complete the laboratory experiments with a grade of D or better.**

**Final Exam:** The final will be given at the end of the course. The final exam is comprehensive.

Each of the above requirements counts toward your final grade as follows:

Exams	40%
Lab	40%
Attendance	5%
Final	15%

Grades are assigned as follows:

Grade	Final Average
A	90-100
B	80-89
C	70-79
D	60-69
F	Below 60

### A. Testing

See the class calendar for the chapters and dates of the tests. Students are allowed to bring one page of hand-written notes, containing equations, etc., to the exams. The material to be covered on each exam is as follows:

<u>Exam</u>	<u>Chapters</u>
1	Intro to Organic Chemistry, Spectrochemical methods, UV/Vis
2	FTIR, AA
3	NMR, Mass Spectrometry, HPLC
4	Electroanalytical Methods, Physical Testing Methods, Polymers
Final	Comprehensive Exam

### B. Make-Up Policy

There will be no make-up exams. The lowest exam grade will be replaced by the final exam grade, if higher. The final exam grade will replace **one** missed exam grade.

## XII. STUDENT CONDUCT STATEMENT

Students are expected to be aware of and follow the Brazosport College Student Code of Conduct. Students have violated the Code if they “fail to comply with any lawful directions, verbal or written, of any official at BC.” Lawful directions include precautions and requirements taken to prevent the spread of COVID-19 at Brazosport College. Students who do not follow safety requirements, including the wearing of a mask, may be removed from class by their instructor and referred to the Dean of Student Services.

## XIII. CAMPUS CLOSURE STATEMENT

Brazosport College is committed to the health and safety of all students, staff, and faculty and adheres to all federal and state guidelines. The College intends to stay open for the duration of the semester and provide access to classes and support services on campus in the safest way possible. The College will also comply with lawful orders given by applicable authorities, including the Governor of Texas, up to and including campus closure. It is possible that on campus activities may be moved online and/or postpone if such orders are given.

## XIV. STUDENT RESPONSIBILITIES

Students are expected to fully participate in this course. The following criteria are intended to assist you in being successful in this course:

1. Understand the syllabus requirements.
2. Use appropriate time management skills.
3. Communicate with the instructor.
4. Complete course work on time, and
5. Utilize online components (such as Desire2Learn) as required.

## XV. OTHER STUDENT SERVICES INFORMATION

Information about the Library is available at <http://brazosport.edu/students/for-students/places-services/library/about-the-library/> or by calling 979-230-3310.

For assistance with online courses, an open computer lab, online and make-up testing, audio/visual services, and study skills, visit Learning Services next to the Library, call 979-230-3253, or visit <http://brazosport.edu/students/for-students/places-services/learning-services/>.



For drop-in math tutoring, the writing center, supplemental instruction and other tutoring including e-tutoring, visit the Student Success Center, call 979-230-3527, or visit <http://brazosport.edu/students/for-students/student-success-center/>.

To contact the Physical Sciences and Process Technologies Department call 979-230-3618.

The Student Services provides assistance in the following:

Counseling and Advising	979-2303040
Financial Aid	979-230-3294
Student Life	979-230-3355

To reach the Information Technology Department for computer, email, or other technical assistance call the Helpdesk at 979-230-3266.



Get the information you need – when you need it. Click <http://geni.us/BRAZO> to install **BC Connect** on your mobile device to receive reminders, explore careers, map your educational plan, be in the know about events, find out about scholarships, achieve your goals and much more.

## REPORT FORMAT for CTEC 2431

### I. Introduction

A. Objective

B. Discussion

I. Theory of operation performed (what happens in the analysis to obtain results).

II. Brief write-up of procedure.

III. Reactions if any.

IV. Method used to calculate or to obtain results.

II. Safety precautions involved.

III. Materials and Apparatus

A. Reagents used. Equipment used (glassware etc.) used.

B. Instrument (type - model number etc.) used.

IV. Results

A. Raw Data and Observations

This is the data obtained in the procedure (weights, titrations, sample volumes, any data used to obtain results). The read-out charts from the instrument determinations and graphs are attached to the reports. The data from them is shown here too, such as peak sizes, etc. No results here! Any deviation from the procedure should be included here.

B. Calculations and/or Results

All calculations, if any, are shown here.

Results are shown here.

V. Summary and Conclusion

A. Short summary of experiment. Results are included in the summary too!

B. Comments pertaining to: Was objective obtained? How did the experiment go? Any problems? Your evaluation of the experiment, etc.

### **Grading:**

Objective	10 points
Discussion	10 points
Safety	5 points
Materials & Apparatus	5 points
Raw Data	20 points
Calculations & Results	30 points
Summary & Conclusion	20 points

Reports on experiments are due one week after they are finished. Each week that the report is turned in late, 5 points will be taken off the grade.

## An Example Report:

Experiment ##

### I. Introduction

#### A. Objective

To determine % ppm or what is in an unknown.

#### B. Discussion

##### 1. Theory

In a chromatographic determination, the components are separated by their interaction between the mobile and the stationary phases as they move through the column. Temperature, carrier gas flow rate and the type of packing in the column affect the separations. (This is in your book as are all theories of the other methods. If it is a titration, tell what a titration is.)

##### 2. Procedure

Short procedure. Do not put all the steps you do in order to get an instrument ready for the analysis.

##### 3. Reactions

Reactions if any.

##### 4. Calculation formulas

How results are arrived at, calculations etc.

### II. Safety

### III. Materials and Apparatus

### IV. Results

#### A. Raw Data and Observations

Sample weights.

Area counts and calculations as in the internal standards method.

Milliliters of titrations.

Linear regression calculations if needed.

Anything that is used to get the results.

Dilutions.

Any deviations from the written procedure.

#### B. Calculations and Results

Calculations for results.

Titration calculations.

Results are shown here. Do not refer to charts, graphs, or readouts. They are backup data only.

### V. Summary and Conclusion

#### A. Summary

Short write up of what was done. Results are shown here too.

#### B. Conclusion

How did it go? Was objective obtained? Problems? Anything good or bad about the experiment.