# Instrumental Analysis

**The University of Toledo**

**Department of Chemistry and Biochemistry**

**College of Natural Sciences and Mathematics**

**CHEM 4300-001, 091 (CRN: 42011, 42021)**

**Instructor**: Jon R. Kirchhoff

**Email**: jon.kirchhoff@utoledo.edu

**Office Hours**: M,W 9:30-11 am; T 2-3 pm

**Office Location**: BO 2024

**Instructor Phone**: (419) 530-1592

**Offered**: Fall 2021

**Course Website**: Blackboard (blackboard.utdl.edu)

**Class Location**: BO 2059 **Class Day/Time**: T,R 11:30 am - 12:25 pm

**Lab Location**: n/a

**Lab Day/Time**: n/a

**Credit Hours**: 2

**SPECIAL UNIVERSITY COURSE EXPECTATIONS DURING COVID-19**

Maintaining a safe campus during the ongoing COVID-19 pandemic remains a top priority. UToledo continues to follow the guidance of the U.S. Centers for Disease Control and Prevention and Ohio Department of Health to keep our campus safe.  
 **ATTENDANCE** The University of Toledo has a missed class policy. It is important that students and instructors discuss attendance requirements for the course. Before coming to campus each day, students should take their temperature and complete a self-assessment for symptoms of COVID-19, such as cough, chills, fatigue or shortness of breath. Anyone with a temperature at or above 100.0 degrees Fahrenheit or who is experiencing symptoms consistent with COVID-19 should not come to campus and should contact their primary care physician or the Main Campus Health Center at 419.530.3451 or Health Science Campus Student Health and Wellness Center at 419.383.5000. For more information on the symptoms of COVID-19, please go to <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>

COVID-19 testing for sick students is available on both Main Campus and Health Science Campus. Call 419.383.4545 for an appointment. Absences due to COVID-19 quarantine or isolation requirements **are** considered excused absences. Students should notify their instructors and follow the protocols summarized in this document on [Navigating COVID-Related Course Concerns](https://www.utoledo.edu/offices/provost/docs/covid-19/COVID%20student%20flow%20chart.pdf).

In the event that you have tested positive for COVID-19 or have been diagnosed as a probable case, please review the [CDC guidance](https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fif-you-are-sick%2Findex.html&data=04%7C01%7CDenise.Bartell%40UToledo.Edu%7Cc3ecf55590d548a6006a08d95c3b8e19%7C1d6b1707baa94a3da8f8deabfb3d467b%7C0%7C0%7C637642233117266556%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=8jvRsGSu5bu%2BPHxfo75XszlKKqTfQig3w8ecZQR863w%3D&reserved=0) on self-isolation and symptom monitoring, and report the disclosure to the Division of Student Affairs by emailing [StudentAffairs@utoledo.edu](mailto:StudentAffairs@utoledo.edu) or by connecting with their on-call representative at 419.343.9946. Disclosure is voluntary and will only be shared on a need to know basis with staff such as in the Office of Student Advocacy and Support, The Office of Residence Life, and/or the Office of Accessibility and Disability Resources to coordinate supportive measures and meet contact tracing requirements.

**FACE COVERINGS**Face coverings are required while on campus, except while eating, alone in an enclosed space, or outdoors practicing social distancing. Students will not be permitted in class without a face covering. If you have a medical reason preventing you from wearing a face covering due to a health condition deemed high-risk by the CDC, submit an [online application](https://teton.accessiblelearning.com/Toledo/) to request an accommodation through the Office of Accessibility and Disability Resources. Students will need to provide documentation that verifies their health condition or disability and supports the need for accommodations. Students already affiliated with the Office of Accessibility and Disability Resources who would like to request additional accommodations due to the impact of COVID-19, should contact their accessibility specialist to discuss their specific needs. You may connect with the office by calling 419.530.4981 or sending an email to [StudentDisability@utoledo.edu](mailto:StudentDisability@utoledo.edu).

**VACCINATION**  
Doctors and other health care professionals agree that the best way to protect ourselves and each other is to get vaccinated. Case data clearly show that vaccines remain highly effective at preventing serious illness from COVID, including the highly contagious delta variant. If you have not yet received your COVID vaccine, the University encourages you do so as soon as possible. No appointment is needed to get the shot at the UTMC Outpatient Pharmacy, University Health Clinic or Main Campus Pharmacy. Once you receive the COVID vaccination, please register on the COVID Vaccine Registry site at: <https://utvaccinereg.utoledo.edu/>.

**SPECIAL NOTES**It is important to note, that based on the unpredictability of the COVID-19 virus, things can change at any time. So please be patient and understanding as we move through the semester. Please refer to [https://www.utoledo.edu/coronavirus/](https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.utoledo.edu%2Fcoronavirus%2F&data=04%7C01%7CDenise.Bartell%40UToledo.Edu%7C08c78d1d6bd948bf874608d95e6a05de%7C1d6b1707baa94a3da8f8deabfb3d467b%7C0%7C0%7C637644631713174655%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=wbjCdV9R%2Fs6FK3F%2BmnBPUqBeqn7JOM1v3b7lr7tKo7E%3D&reserved=0) on a regular basis for updates to current requirements or mandates. I also ask that you keep me informed of concerns you may have about class, completing course work/assignments timely and/or health concerns related to COVID.

**COURSE SPECIFIC INFORMATION**

CATALOG/COURSE DESCRIPTION

An introduction to modern chemical instrumentation and applications to chemical analysis. Topics include electrical, magnetic, nuclear, and spectroscopic instrumentation.

## COURSE OVERVIEW/ TEACHING METHODOLOGY

In Instrumental Analysis, you will be exposed to a wide variety of analytical instrumentation and techniques. We will focus on and discuss multiple instruments of analysis. Students should continually compare and contrast different pieces of instrumentation and understand why different components are necessary to produce the desired measurement. It is the goal of the lecture portion to introduce students to how the instrumentation has been developed and why a particular instrument is useful for a specific type of analysis. Advanced Lab (Chem 4880) provides hands on experience with the modern analytical instrumentation discussed in Chem 4300. This face-to-face course is designed to stimulate student learning though readings, homework exercises and in course lectures.

## **STUDENT LEARNING OUTCOMES**

## Upon completion of this course, the student will be able to:

1. Describe the different components of analytical instrumentation

2. Discuss the operation of the instrument for measurement

3. Define and assess various applications for all instrumentation covered in this course

4. Appraise the limitations and advantages of the different instruments

PREREQUISITES AND COREQUISITES

Prerequisite: CHEM 3310 and 3360

Corequisite: CHEM 3710 or 3730 or 4570

## TEXTS AND ANCILLARY MATERIALS

Skoog, D.A.; Holler, F.J.; Crouch, S.R. *Principles of Instrumental Analysis*; 7th Edition, 2017 (Customized) **ISBN:** (e-book) 9781337783439; (Loose-leaf text) 9781337454001;

### Materials for lecture and supplemental material will be distributed to the student through Blackboard, as handouts, or via your Rockets email address.

TECHNOLOGY REQUIREMENTS

Chem 4300 is designated as a face-to-face class for Fall 2021. Computer access to the internet will be necessary to monitor Blackboard or in the chance the university, and thus the class, revert to an on-line format. Resources for on-line based learning can be found at [www.utoledo.edu/dl/students/required-info-online-learners.html](http://www.utoledo.edu/dl/students/required-info-online-learners.html).

ACADEMIC POLICIES

All students at the University of Toledo are expected to read, understand, and follow the academic policies that govern their attendance at the University. These policies include, but are not limited to, academic dishonesty, academic forgiveness, adding and dropping a course, grades and grading, and the

missed class policy. Please use the following URL to read a comprehensive list of academic policies that pertain to you in this class and throughout your academic journey. If you have any questions after reading through the policies, please let me know.

[**Undergraduate Policies**](http://www.utoledo.edu/policies/academic/undergraduate/)**:** <http://www.utoledo.edu/policies/academic/undergraduate/>

COURSE EXPECTATIONS

Students are urged to communicate with me about any concerns related to the course or any item that might limit your success. All email communications need to be addressed to Dr. Kirchhoff and contain the course name and your name in the email. Emails will generally be answered within 24 hours. I will also be available during office hours listed at the beginning of the syllabus. Other specific items are listed below.

* Attendance is expected, if you are absent, you are responsible for any material covered in lecture including (but not limited to) assignments, policy changes, or schedule changes.
* Exams cannot be made up unless the student is missing for a university sanctioned event, illness, or death of a loved one. Documentation will be required. Please notify me as soon as possible for any of these reasons.
* Vocabulary sets are due at the time of class or before by email submission. If they are turned in late, one point will be deducted per day including weekend days.
* Cell phone use is not permitted during lecture or exams.
* Specific seating will be determined for the entire semester. Students are expected to use the same seat each class period. If you need to arrive late or leave early please do not disrupt the class upon entering.

**Academic Honesty:** The UToledo academic honesty policies will be strictly enforced. Any student found violating the UT academic honesty policies will be penalized in accordance with these policies.

OVERVIEW OF COURSE GRADE ASSIGNMENT

**Exam #1** September 30 100

**Exam #2** November 9 100

**Vocabulary** 5 or 6 sets 50/60

**Final Exam** December 14 150

**Total** **400/410**

**Honors Grading**

**Exam #1** September 30 100

**Exam #2** November 9 100

**Vocabulary** 5 or 6 sets 50/60

**Honors Paper** 50

**Final Exam** December 14 150

**Total** **450/460**

Test dates are subject to change, any changes will be announced at least a week in advance of the test. Great effort will be made to return graded exams to students within one week of the exam. **The Final Exam is scheduled for Tuesday December 14, 12:30-2:30 pm.**

**Midterm Grading**

Midterm grades are assigned to assist students in determining their academic standing.

Midterm grades will be the result of Exam #1 and completion of at least 2 vocabulary sets. The mid-term grade will allow you to gauge where you currently stand in the class, but is not a reflection of your final grade. Midterm grades will be entered between October 4 and October 24, 2021.

**Final Grades** (Directly reflect student performance as follows)

90 - 100% of total points A range

80 - 89% B range

70 - 79% C range

60 - 69% D range

< 60% F

The scale represents guaranteed grades. Depending on the difficulty of the exams, I reserve the right to slide the scale downward.

**Drop, Withdrawal, and Incomplete Grades:** Course drop and withdrawal procedures have been set by the University faculty. Pay attention to the add/drop dates as they pass very quickly during the semester. Dates can be found at <https://www.utoledo.edu/offices/registrar/registration_dates_fall.html>

**The last day to withdraw from a course is Friday November 5, 2021.** Please note that course registration changes might change your financial aid.

If you decide you are not going to attend this class (or any other class you have registered for), you must formally withdraw (drop) from the course. You can do this by logging on to the myUTportal, clicking on the “Student” tab, and then under “MyToolkit” clickon Register/Drop/Withdraw.

A course grade of incomplete is given only to those who have completed all but a small percentage of course requirements for an unexpected and acceptable reason.

## UNIVERSITY POLICIES

Students can find a summary of university policies listed by audience on the [University Policy webpage](http://www.utoledo.edu/policies/audience.html/#students) (<http://www.utoledo.edu/policies/audience.html/#students>) and (<https://www.utoledo.edu/title-ix/policies.html>).

**Institutional Classroom Attendance Policy:** Please be aware that the university has implemented an attendance policy, which requires faculty to verify student participation in every class a student is registered at the start of each new semester/course. For this course, if you have not attended/participated in class (completed any course activities or assignments) within the first 14 days, I am required by federal law to report you as not attended. Unfortunately, not attending/participating in class impacts your eligibility to receive financial aid, so it is VERY important that you attend class and

complete course work in these first two weeks. Please contact me as soon as possible to discuss options and/or possible accommodations if you have any difficulty completing assignments within the first two weeks.

**Policy Statement on Non‐Discrimination on the Basis of Disability (ADA).** The University is an equal opportunity educational institution. Please read the relevant policies related to non-discrimination.

* Nondiscrimination 3364-50-02
* Nondiscrimination on the basis of disability - Americans with Disability Act (ADA) 3354-50-03

**Policies for Student Safety.** Your safety and well-being as a University of Toledo student is important to the faculty, staff, and administration. Please review the following policies.

* Student Code of Conduct 3364-30-04
* The University of Toledo's Title IX (Sexual Misconduct) Policy - 3364-50-01
* Consensual romantic and/or sexual relationships - Policy 3364-25-65

**Academic Accommodations.** The University of Toledo embraces the inclusion of students with disabilities. We are committed to ensuring equal opportunity and seamless access for full participation in all courses. For students who have an accommodations memo from Student Disability Services, I invite you to correspond with me as soon as possible so that we can communicate confidentially about implementing accommodations in this course. For students who have not established affiliation with Student Disability Services and are experiencing disability access barriers or are interested in a referral to healthcare resources for a potential disability or would like information regarding eligibility for academic accommodations, please contact the [Student Disability Services Office](http://www.utoledo.edu/offices/student-disability-services/index.html) (http://www.utoledo.edu/offices/student-disability-services/) by phone: 419.530.4981 or email at [StudentDisability@utoledo.edu](mailto:StudentDisability@utoledo.edu).

## ACADEMIC AND SUPPORT SERVICES

## Please follow this link to view a comprehensive list of [Student Academic and Support Services](http://www.utoledo.edu/studentaffairs/departments.html) (http://www.utoledo.edu/studentaffairs/departments.html) available to you as a student.

The university provides a variety of academic and support services on campus to help you succeed and reach your fullest potential. Whether you need to ask a question, get help with an assignment, seek

advice from a counselor, find a job or join a club, UToledo is there for you! Examples of some of the resources for academic support or service are:

Tutoring: <http://www.utoledo.edu/success/lec/>

Library: <http://www.utoledo.edu/library/>

Success Coaching: <https://www.utoledo.edu/successcoach/>

Student Affairs: <http://www.utoledo.edu/studentaffairs/>

Career Services: <http://www.utoledo.edu/success/career/>

## SAFETY AND HEALTH SERVICES FOR UT STUDENTS

Please use the following link to view a comprehensive list Campus Health and Safety Services available to you as a student. <https://www.utoledo.edu/offices/provost/utc/docs/CampusHealthSafetyContacts.pdf>.

One example is the food pantry.

**Food Pantry:** <http://www.utoledo.edu/studentaffairs/food-pantry/>

INCLUSIVE CLASSROOM STATEMENT

In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, gender identity/expression, socioeconomic background, and a myriad of other social identities and life experiences. We will encourage and appreciate expressions of different ideas, opinions, and beliefs so that conversations and interactions that could potentially be divisive turn, instead, into opportunities for intellectual and personal development.

COURSE SCHEDULE

A. Introductory Material

Instrumental Analysis Chap. 1 1-4, 7,8

Signals and Noise Chap. 5 1,2,7,8,10

B. Spectroscopy

Introductory Concepts Chap. 6 3,7,8,14,15

Fundamental Information Chap. 7 8,12

UV-Vis Chap. 11 (13) 1,2,6-9

Chap. 12 (14) 1

Molecular Luminescence Chap. 13 (15) 1-4,6

Infrared Chap. 14 (16) 1,2,7,9,10

Chap. 15 (17)

Raman Chap. 16 (18) 1,2

NMR Chap. 17 (19) 1-3,6,7,11,13,21,26

Atomic Chap. 8 2,4,7,11

Chap. 9 1,3,5,9,22

Chap. 10 1,2,8,9

C. Chromatography

Introductory Concepts Chap. 23 (26) 1-14

Gas Chap. 24 (27) 1,3,8,9,10,14,22,23

Liquid Chap. 25 (28) 1,3,4,7,8

Capillary Electrophoresis Chap. 27 (30) 1,4

D. Mass Spectrometry Chap. 18 (20) 1,2

E. Electrochemistry

Introductory Concepts Chap. 19 (22) 1,2,6

Potentiometry Chap. 20 (23) 1,2,4,9

Coulometry Chap. 21 (24) 6

Voltammetry Chap. 22 (25) 2,3

\*\*The chapter numbers in parentheses are from the full text version of the hard cover book\*\*

It is the student’s responsibility to use these questions as a study guide. The suggested problems are representative of possible exam questions. Some exact questions may even show up on an exam. Solutions to selected problems are in the back of the text. Students are encouraged to see me if they encounter difficulties in doing the homework. It is your responsibility to attend lecture, to take notes, and to read the material in the text.