# CHEM2490: Organic Chemistry Laboratory II for Majors: Synthesis and Identification

**Spring 2022**
**The University of Toledo**
**Department of Chemistry & Biochemistry**
**College of Natural Sciences & Mathematics**
**CRN: 24295 (Sec. 1) and 24297 (Sec. 3) or 24301 (Sec. 4), or 24298 (Sec. 91) and 24300 (Sec. 93) or 24303 (Sec. 94)**

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| **Name**: | Dr. Joseph Schmidt | **Class Location**: | FH 2050 |
| **Email**: | joseph.schmidt@utoledo.edu | **Class Day/Time**: | T 11:30-12:25 |
| **Office Hours**: | M,T 1:00-2:30 PM (face-to-face) and R 1:00-2:30 PM (virtual) | **Lab Location**: | BO 3097 |
| | | **Lab Day/Time**: | TR 5:30-8:20PM or WF 1:00-3:50PM |
| **Office Location**: | WO 3277 | **Credit Hours**: | 2 |
| **Office Phone**: | 419-530-1512 | | |


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## CATALOG/COURSE DESCRIPTION

*For Chemistry/Biochemistry majors. Application of synthetic methods to elementary organic synthesis with special emphasis on instrumental approaches to problem solving in organic chemistry. Approved chemistry safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.*

## COURSE OVERVIEW

*Welcome to Organic Chemistry! The purpose of this laboratory course is to introduce students to the techniques that organic chemists (as well as biochemists, physical chemists, etc.) use in their daily routines. After learning and understanding those techniques, students will apply their knowledge to new situations to understand synthesis reactions, molecular structure determination, and analysis of (un)known compounds.*

*Organic chemistry laboratory is important for several reasons. It introduces students to many different laboratory practices and concepts that will be used in subsequent chemistry laboratory classes and in other laboratory situations in biology, pharmacy, and chemical engineering (just to name a few!). It is anticipated that by the completion of this course, students will be familiar with all of the following topics and techniques:*

- *Safety in the laboratory*
- *Interpreting and following scientific directions*
- *Keeping a proper lab notebook*
- *Names and proper usage of lab instruments*
- *Understanding of general properties of compounds (including solubility, miscibility, acid/base chemistry, etc.)*
- *Proper usage of glassware*
- *Isolation and purification techniques (including filtration, solvent removal, drying solutions, distillations, chromatography (thin-layer, column, and gas) and crystallization/recrystallization)*
- *Characterization techniques including spectroscopy and melting point determination*
- *Interpretation of scientific results including percent yield and recovery, melting point, boiling point, IR and NMR spectra, and $R_f$ values*

**STUDENT LEARNING OUTCOMES**

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

- *Demonstrate their knowledge of departmental safety rules through their laboratory practice, including the ability to dispose of waste properly.*
- *Apply basic stoichiometric algorithms (calculating limiting reagents, theoretical yield, mole ratios) in the context of organic chemistry.*
- *Demonstrate a command of the rules for assigning significant figures in their work, specifically in calculations and laboratory measurements.*
- *Understand and be able to use the basic operations of an organic chemistry laboratory including gravity and vacuum filtration, liquid-liquid extraction, simple and fractional distillation, reflux, recrystallization, thin-layer chromatography, gas chromatography, column chromatography, drying of solids and solutions, and the theories behind these techniques.*
- *Know the significance of $pK_a$ values in experimental steps.*
- *Identify and assess the purity of organic compounds using analytical techniques, including melting point, thin-layer chromatography, IR, and gas chromatography.*
- *Deduce organic structures using spectroscopic methods, including infrared (IR), $^{1}$H-and $^{13}$C-nuclear magnetic resonance spectroscopy, and mass spectrometry.*
- *Determine molecular formulas from a mass spectrum by using the Rule of 13 and other techniques.*
- *Deduce hydrogen deficiency from a molecular formula and use this information to help deduce a structure.*
- *Be able to follow a detailed experimental procedure and construct a flow diagram to illustrate it.*
- *Demonstrate proficiency using literature searching tools for compound property searches, compound availability, and known reactions.*
- *Depict and explain detailed chemical mechanisms for all laboratory reactions (and related reactions in these reaction classes).*
- *Demonstrate the ability to maintain a properly laboratory notebook.*
- *Construct a lab report that includes an analysis of the data collected, and discussion of the outcomes and answers to open questions associated with the experiment.*
- *Develop a hypothesis-driven experimental procedure regarding an outstanding research question.*

**PREREQUISITES AND COREQUISITES**

*Students must have completed the General Chemistry sequence before enrolling in this course (CHEM 1230/1240, 1280/1290) as well as Organic Chemistry I (CHEM 2410/2480) with a grade of C- or better, as well as having declared chemistry or biochemistry as a major. Students also are required to be concurrently enrolled in (or have successfully passed) Organic Chemistry II lecture (CHEM 2420). A student, registered for both CHEM 2420 and 2490 concurrently, who is intending to drop/withdraw from the lecture course by mid-semester (in first 8 weeks) must also drop the associated lab course. A student withdrawing from the lecture during the last weeks of allowed withdrawal (weeks 9-10) may be allowed to finish the lab course if they have a grade of C or better in the lab and permission of the lab instructor.*

**REQUIRED INSTRUCTIONAL MATERIALS (TEXTS AND ANCILLARY MATERIALS)**

*A. Required Materials:*

- A laboratory notebook with carbon(less) pages (can be purchased from the UT bookstore)
- Approved safety goggles (can be purchased from the UT bookstore or from the UT-ACS group)
- Lab manual will be posted through Blackboard – courtesy of Prof. Michael Young!!

**UNIVERSITY POLICIES**

*Policy Statement on Non-Discrimination on the basis of Disability (ADA): The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.*

**ACADEMIC ACCOMODATIONS**

*The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations/adjustments in this course please contact the Student Disability Services Office.*

**COURSE EXPECTATIONS**

*You are expected to come to both the lectures and labs on time. Failure to attend the prelab lecture will lead to your being excluded from the lab for that particular day. You are expected to come to each lab, and there will be pre-lab assignments which must be complete before you will be allowed to participate in the lab.*

## COURSE STRUCTURE

**Lecture**

- *Lecture sessions are designed to clarify the concepts covered in the lab, as well as give an overview of techniques that will be used in the lab.*
- *Attendance is expected: The labs are only 3 hours in duration, so these lectures will be where you learn everything that you'll need.*
- *Lab exercises will be available on Blackboard for each week.*
- *Please be considerate of your fellow students during the lecture period. Disruptions of any kind will not be tolerated and may result in expulsion from the classroom.*

**Laboratory**

- *Labs will be principally conducted by your TA, with assistance from myself (Prof. Schmidt), as well as Dr. Yong-Wah Kim or the NMR TA (Mathieu Geremia), although you should be relatively independent with NMR usage this semester.*
- *You will be required to have appropriate clothing before being allowed to enter the lab.*
- *Prelabs are due prior to the beginning of the lab, and results and postlabs are due approximately 1 week after completion of the experiment! All deadlines will be noted on the Blackboard site for this course.*
- *You will be expected to adhere to all of the lab safety rules.*
- *You are all expected to do your part to maintain a clean lab environment as part of GLP (Good Lab Practices):*
    - *All reagent and solvent bottles should be completely closed immediately after use;*

- *All spills and dribbles should be cleaned immediately;*
- *All glassware should be put away at the end of the lab, and walkways should be kept free of debris.*
  - *Failure to adhere to these rules will lead to punitive measures in the form of lost points as decided by your TA!*

- *Your TA will regularly ensure that you know what you're doing – Failure to adequately comprehend the lab may also lead to punitive measures in the form of lost points, so pay attention during pre-lab lectures!*

**Blackboard**

- *Blackboard is a course management system provided by the University of Toledo and can be accessed at https://blackboard.utdl.edu/ . Your access code is your UTAD user name and password.*
- *You should consult the site regularly for news and announcements. Handouts, lecture notes, and lab experiments will be posted. The system also permits you to check your grades at any time and to email your instructor or other students in the class.*

**Inclement Weather Policy**

*If classes are cancelled on a lab day, lab will proceed at the next scheduled meeting. We will adjust the experiments to adjust for the reduced availability of lab time. If both portions of a lab are cancelled, your grade will be determined based on the labs we have been able to complete.*

**Lab Absence Policies**

*Refer to UT Missed Class Policy (https://www.utoledo.edu/policies/academic/undergraduate/pdfs/3364-71-14%20Missed%20class%20policy.pdf).*

**Communication**

*You are urged to communicate with Prof. Schmidt or the Teaching Assistant (Geraud or Prem) about any aspect of the course which concerns you or which might limit your success. We want you to be successful in this course, so let's work together!*

**Chemistry Help Center**

*The Chemistry Help Center is where the teaching assistants hold their office hours so it is a great place to receive assistance. The Help Center will be staffed starting January 24, MW 9-12, 1-4, 5-8; TR 9-8; and F 9-4; until the end of classes. No appointment is necessary.*

**OVERVIEW OF COURSE GRADE ASSIGNMENT**

**Course Points:**

The following is the distribution of possible points in the course:

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|---|---|---|
| Lab Notebook and Reports (50 pts/lab) | 500 pts | 58.8 % |
| Capstone Project | 200 pts | 23.5 % |
| Lab Final (April 26th, Lecture Time, FH 2050) | 100 pts | 11.8 % |
| Lab Cleanliness | 50 pts | 5.9 % |
| **Total:** | **850 pts** | |

**FORMAT FOR LABORATORY NOTEBOOK REPORTS**

Keeping an accurate laboratory notebook is essential to your success in this class. Some guidelines are given below:

- The laboratory notebook **must not** be loose leaf or spiral bound. Lab notebooks are available from the campus bookstore and are designed so that they permanently contain the original pages of your Prelab and Postlab reports.
- Use permanent blue or black ink only (ballpoint pen, NO red ink!).
- Other textbooks, lab manuals, loose sheets of paper, iPads or cellphones are not allowed in the laboratory. The complete outline of procedures must be written in your laboratory notebook prior to performing the experiment.
- **Copies** of your lab notebook pages are required for grading. The assigned notebooks are designed so that the carbon copies can be removed and handed in to your TA.
- Your TA may periodically inspect your notebook.

**YOUR LAB REPORT CONSISTS OF THREE (3) PARTS**

**Part I - Prelab Report.** A copy of your lab notebook pages containing the lab write-up and answers to any prelab questions. This is due in advance of each experiment.

**Part II - Results.** A copy of your notebook pages containing observations noted during the lab experiment. Is due with **Part III** one week from the conclusion of the experiment.

**Part III - Postlab Report.** A summary of results and answers to postlab questions. This can be written on separate loose-leaf paper. Is due with **Part II** one week from the conclusion of the experiment.

**I. PRELAB REPORT (30% of the report grade)**

The initial part of your lab report must be written in your laboratory notebook. A copy of the original pages of this report will be collected prior to the experiment and will be returned to you after the whole lab is graded. It will consist of:

- Your name, lab section and the name of your TA (on each page) (-1 pt if it isn't done).
- The title and number of the experiment (-1 pt if it isn't done).
- Objectives. This should include hypotheses about the outcome of the lab, which you will test by experiment. ***It is your responsibility to propose what you expect to determine from each experiment.*** (2 pts).
- Prelab question answers. These will always require an analysis of the hazards and risks associated with the experiment. It will also include the list of chemicals: masses or volumes, structures, and amounts. Look up molecular masses and calculate the material amount in moles (if appropriate), boiling/melting points (bp/mp, if appropriate) and density (if appropriate). Your prelab will suggest what is needed in the *Reagent Table*. (11 pts)

- List of equipment (sketch complex apparatus). (1 pt)
- Outline of procedure. This must be sufficiently detailed to allow you to perform the experiment. Make sure you note any necessary safety precautions. (1 pt).

**The copy pages of this report must be handed in BEFORE you begin the experiment.**

**II. RESULTS (10% of the report grade)**

This section should be started on a fresh page of your notebook, after the prelab report. A combined copy of the Results/Postlab report will be stapled and turned in to your TA after the experiment is complete.

This section should be completed ***during*** the lab session and consists of:

a) Your name, lab section and the name of your TA (on each page). (-1 pt if it isn't done)

b) The title and number of the experiment. (-1 pt if it isn't done)

c) Results: Date, times, measured masses and volumes used in the experiment (if you use different amounts from the procedure, note this), measured mp/bp of your products and any other observations (color changes, etc) recorded during the lab session. (1-2 pts, as appropriate)

d) Characterization materials: include copies of *labeled* spectra, etc., recorded during the lab session. (0-4 pts, as appropriate)

**III. POSTLAB REPORT (60% of the report grade)**

This section does not need to be written in your lab notebook - it can be written on separate loose leaf sheets and stapled to your results copy pages. It is to be completed **after** the lab period at home, and consists of:

- Your name, lab section and the name of your TA (on each page). (-1 pt if it isn't done)
- The title and number of the experiment. (-1 pt if it isn't done)
- Analysis of results: In 5-15 sentences, comment on the outcome of your experiment, notably the quality of your results. Describe problems that may have occurred and possible solutions. If there was any deviation from what you expected, explain how and why did the outcome differ from that predicted in your prelab report? What was learned from the experiment? (5-20 pts, as appropriate)
- Answers to postlab questions, including labelling of spectral characterization. (5-20 pts, as appropriate)

**Staple Parts II and III together and turn in during the lab lecture session when it is due. You should keep a copy of Part III for yourself.**

## Midterm Grading

*Midterm grading serves as a point in the term where the instructor of record may provide a midterm grade assessment and may identify any student who has never attended, has stopped attending, or who is not actively participating in the course. In addition, students may use their midterm grade to help make a decision in regards to withdrawing from the course.*

*The U.S. Department of Education requires the University to document both active participation and satisfactory academic progress as part of the compliance with federal financial aid regulations. Students receiving Title IV Federal Aid funds are required to have regular attendance and satisfactory academic progress in their courses to receive federal aid.*

**Final Grading**

*Your final grades will be calculated based on a total of 850 points.*

**Grade Scale** These are the minimum percentages (points) needed to receive the indicated grade:

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|---|---|---|---|---|---|---|---|
| A | 90% (765) | A– | 87% (739.5) | B+ | 84% (714) | B | 81% (688.5) |
| B– | 78% (663) | C+ | 75% (637.5) | C | 72% (612) | C– | 69% (586.5) |
| D+ | 66% (561) | D | 63% (535.5) | D– | 60% (510) | | |

**Drop, Withdrawal and Incomplete Grades**

- *Course drop and withdrawal procedures have been set by the University faculty. Dropped courses do not appear on your transcript. If you are in a course after that date, there will be a grade on your transcript (A-F, W, or Incomplete). The deadline for dropping is* ***Feb. 1st****.*
- *You may withdraw from the course and receive a grade of* ***W****. W's do not affect your GPA. For both dropping the course or withdrawing you should go to the Registrar's Office in Rocket Hall. You do not need your instructor's permission for either process. Please note that course registration changes might change your* ***financial aid****. The deadline for withdrawal is the end of the 10th week,* ***March 25th****.*
- *A student, registered for both CHEM 2420 and 2490 concurrently, who is intending to drop/withdraw from the lecture course by mid-semester (in first 8 weeks) must also drop the associated lab course. A student withdrawing from the lecture during the last weeks of allowed withdrawal (weeks 9-10) may be allowed to finish the lab course if they have a grade of C or better in the lab and permission of the lab instructor.*
- *A course grade of* ***Incomplete*** *is given only to those who have completed all but a small percentage of course requirements for an acceptable reason.*

**Attendance/Class Participation**

*On two occasions during the term, instructors are asked to report student attendance. However, you will remain enrolled in the class independent of these reports. That is, you remain registered for the class and will receive a final grade unless <u>you</u> take the action of dropping or withdrawing.*

## SPECIAL 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 the document on Navigating COVID-Related Course Concerns.

In the event that you have tested positive for COVID-19 or have been diagnosed as a probable case, please review the CDC guidance on self-isolation and symptom monitoring, and report the disclosure to the Division of Student Affairs by emailing 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 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.

**SOCIAL DISTANCING**

Students should practice social distancing inside and outside the classroom. Please follow signage and pay attention to the seating arrangements. Do not remove stickers or tape from seats and/or tables; this is there to provide guidance on the appropriate classroom capacity based on the recommended 6 feet of social distancing between individuals. Please be conscious of your personal space and respectful of others. Also be cognizant of how you enter and exit the room; always try to maintain at least 6 feet of distance between yourself and others.

**DESKS AND WORK SPACES**

Students will need to sanitize their desks and/or work space before class with the University provided sanitizing spray and paper towels.

**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 omicron 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/ 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.

**IMPORTANT COVID-19 SPECIFIC RULES FOR OUR CLASS**

Due to the current additional requirements implemented to prevent the spread of Covid-19, the following summary outlines some important changes to this semester's lab course.

- For the lecture portion, seats in FH 2050 should be clearly marked as seats to be used or not. Please choose a seat that is marked to be used.
- There will be **no loaner goggles** supplied by the Chemistry Stockroom. You must own your own goggles. You must arrive appropriately dressed (no exposed skin except for arms shoulders down, closed toe shoes that will not be penetrated by a simple spill) and with approved goggles.
- We recommend that you bring a spare mask to lab in case yours gets exposed to chemicals by accidental touching etc.
- When you arrive at the lab, wash your hands with water and soap, and put on gloves. There will be paper towels sprayed with ethanol that you should use to wipe your cubicle and your work area. When you are finished for the day, you should wipe your work area(s) and cubicle again. Whenever you use a shared instrument or piece of equipment, wipe it off with a paper towel/ethanol as soon as you are finished.
- The lab doors will be a "one-way", where one door serves as entrance and the other serves as exit.
- If you show any kinds of symptoms – do not attend lecture or lab. Virtual materials will be made available, and you will be able to finish your work and earn your grade this way.