Spring 2020

CHEM 238-102: Analytical/Organic Chemistry for Chemical Engineers

Chunmeng Lu

NJIT New Jersey Institute of Technology

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF CHEMISTRY AND ENVIRONMENTAL SCIENCE

CHEM 238 – Organic Chemistry Laboratory
Spring 2020 Course Syllabus

COURSE INFORMATION

Course Description: This course is designed to acquaint and educate students on the basics of organic preparations and analytical techniques such as distillations, sublimations, purifications of products, liquid-liquid extractions and preparation of organic compounds. Also the experiments will help students to understand and learn the instrumental analytical techniques including gas chromatography, thin layer chromatography, infrared-, and UV spectroscopy.

Number of Credits: 2

Prerequisite: CHEM 124 with a grade of C or higher and CHEM 243 - Organic Chemistry I
Co-requisite: CHEM 244 – Organic Chemistry II

Lab section: 102

Instructor: Dr. Chunmeng Lu
Email: Chunmeng.lu@njit.edu
Laboratory time: Thursday, 5:45PM - 09:50 PM
Tiernan Hall (TIER) 207

Office Hours: By appointment only, please email me or call me at 201-772-7675

Required textbook: available from Department office at Tiernan 151 for $20

Other required material:

- Hard-cover laboratory notebook
- Lab coat (white color, available online)
- Safety goggles (available at the NJIT Bookstore or Home Depot)
- Disposable nitrile gloves (available online or at Home Depot)

The Department of Chemistry also sells a limited amount of Personal Protective Equipment (PPE) kits that include the lab coat, goggles, and 20 pairs of gloves. You are responsible of bringing your own PPE to the lab.

LEARNING OUTCOMES

After completing this course, students will be able to:

- Find information on compounds, reactions and authors in the chemical databases;
- Identify the key scientific journals in the field of organic chemistry and use their websites;
- Actively read and critique research articles by identifying important features, learning about precedents and analyzing the data presented.
- Discuss research results in a scientific report and presentation;
- Relate the molecular structure to orbital arrangement, stability and reactivity;
- Distinguish between the various types of stereoisomers and conformations;
- Propose experimental and computational techniques for the study of specific reaction mechanisms
- Propose plausible reaction mechanisms based on experimental data, using the curved-arrow formalism.
- Use molecular orbital theory to describe sigma and pi bonds, conjugated, or aromatic systems
- Describe the mechanisms of reactions happening to aromatic systems;
- Describe the mechanisms of substitution reactions such as the S_N1 and S_N2 reactions;
- Estimate the stability and reactivity of various cationic, anionic and radical intermediates;
- Describe the mechanisms of addition and elimination reactions;
- Use carbon nucleophiles for the synthesis of C–C bonds;
- Describe the mechanisms involved in the addition or substitution reactions of carbonyl compounds;
- Identify free-radical reactions and explain the various steps in their mechanisms.

POLICIES

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu*

Grading Policy: The final grade in this course will be determined as follows:

Individual grades	
Attendance and laboratory notebook usage	10%
Safety and cleanliness	10%
Quizzes	30%
Group grades	
Laboratory reports	40%
Oral presentation	10%

Your final letter grade in this course will be based on the following tentative curve:

A	100-90%	**C**	74-70%
B+	89-85%	**D**	69-65%
B	84-80%	**F**	Below 65%
C+	79-75%		

The experiments will be conducted as a group of 3-4 students, as chosen by the instructor. Laboratory reports will be a group assignment, and each group will do an oral presentation on one of the experiments at the end of the semester. Each student is however required to attend and participate in the laboratory, by recording their own notes in their laboratory notebook and helping in keeping the lab safe and clean. In addition, quizzes will be given to each student.

Attendance and laboratory notebook usage: Attendance to all laboratory sessions is mandatory. A missed laboratory session without an excused absence will result in a grade of zero (0) for that experiment. A second unexcused absence will result in a grade of zero (0) for the course. An excused absence must be obtained from the instructor before the relevant lab. An excused absence will only be granted for verifiable documented reasons of serious illness or family emergency. Students will be asked to sign the attendance sheet each week when arriving in lab.

Lateness to lab will NOT be tolerated (changes in directions/safety concerns may be given during the pre-laboratory lecture). The instructor reserves the right to dismiss you from the lab and you get a ZERO for the week. College policy states that students must notify faculty within the first three weeks of the semester if they anticipate missing any classes due to religious observance.

Students working in the same group must arrive in lab and begin the experiment at the same time. All students must remain in lab until the experiment is completed. Students working in the same group can perform the experiment together, work on calculations together, but each of them must be filling their own notebook.

See below for the guidelines to good laboratory notebook practices. The completeness and accuracy of the notebook will be checked by the instructor at the beginning of each lab, and its proper usage during the lab period will be checked before students leave.

Safety and cleanliness: Wear your safety goggles at all times while in the laboratory. Clothing that covers your legs and shoulders is required. No shorts or skirts. Everyone will be required to wear lab coats and gloves during all experiments. Closed shoes must be worn at all times. Food or drinks are not allowed in the lab. Turn off cell phones and do not use them in the lab. Properly dispose of waste materials. Clean up your workspace at the end of each lab session and wash your hands prior to leaving the laboratory.

Quizzes: There will be three quizzes during the semester, on the next laboratory period following experiments #2, #4, and #6. They will each be worth 10% of your grade and can cover any material or safety procedures covered in the course.

Laboratory reports: Each group must submit their lab report one week after the end of each experiment. There are 6 lab reports due and they are worth a total of 40% of the grade. The format of the laboratory report can be found below, and the exact rubric used for grading will be circulated to the students via email.

Laboratory reports must be submitted on Canvas in .doc, .docx, of .pdf format, and will be checked for plagiarism by Turnitin.

Oral presentation: Each group will present one of the 6 experiments during a 15-20 minutes presentation during the last lab session of the semester. This group presentation will be worth 10% of the final grade. Detailed assignment information and grading rubric will be provided during the semester.

Email Policy: In accordance with College policy, the instructor will use your NJIT email address (@njit.edu) and Canvas to communicate with you about all course-related matters. Please make sure that you check these

accounts regularly.

Make-up Laboratory or Quizzes Policy: There will be **no make-up laboratories or quizzes** during the semester. In the event that a student has a legitimate reason for missing an exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the laboratory and/or quiz, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the CES Department Office/Instructor that the laboratory period will be missed so that appropriate steps can be taken to make up the grade.

Syllabus modification: Any modification of this syllabus will be distributed in class and via e-mail.

ADDITIONAL RESOURCES

Chemistry Tutoring Center: Located in the Central King Building, Lower Level, Rm. G12. Hours of operation are Monday – Friday 10:00 am - 6:00 pm. For further information please click here.

Accommodation of Disabilities: **O**ffice of **A**ccessibility **R**esources and **S**ervices (***formerly known as Disability Support Services***) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director at the Office of Accessibility Resources and Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall Room 260. A Letter of Accommodation Eligibility from the Office of Accessibility Resources Services office authorizing your accommodations will be required.

For further information regarding self-identification, the submission of medical documentation and additional support services provided please visit the Accessibility Resources and Services (OARS) website at http://www5.njit.edu/studentsuccess/disability-support-services/

Important Dates (See: Spring 2020 Academic Calendar, Registrar)

Please check the academic calendar by the following link:
https://www5.njit.edu/registrar/calendars/

COURSE OUTLINE

Week	Topic	Lab report due
1	Check-in and safety lecture	
2	**Experiment #1**: Extraction and purification of caffeine	
3	Experiment #1, part 2	
4	Experiment #1, part 3	
5	**Experiment #2**: Pinacolone reduction	#1
6	Experiment #2, part 2	
7	**Quiz #1** **Experiment #3**: Pinacoyl alcohol dehydration	#2
8	Experiment #3, part 2	
9	**Experiment #4**: Esterification	#3
10	Experiment #4, part 2	
11	**Quiz #2** **Experiment #5**: Aldol reaction	#4
12	**Experiment #6**: Aspirin synthesis	#5
13	**Quiz #3** **Oral presentations** Check-out	#6

Each laboratory period will begin with a 30-minute discussion of the theory and procedure of the experiment, as well as safety reminders.

Laboratory notebook guidelines:

This is a research journal. In it you will record exactly what you did. Below is the format you will use:

- Fill in all sections on the top of the page on every page you use.
- Before you come to class:
    - List all chemicals you will be using in the lab in your notebook. Include the chemical name, the chemical formula, and the CAS number.
    - Copy the reaction scheme
    - Make a table showing the physical properties of the reagents
    - Outline the experimental procedure, objectives and safety in your laboratory notebook.

The instructor will verify and initial this entry and your Lab Manual at the beginning of each class. Failure to complete the list and provide your lab manual will result in a maximum of 10-point penalty.

The laboratory notebook is a journal that records your activities in the lab in detail. It is written in "stream of consciousness"; that is...as it is happening. You should record:

- Everything you do in enough detail that a stranger could reproduce your work using only your lab notebook as a guide.
- All observations as you see them.
- All values including masses, lengths, pressures, volumes...etc using correct significant figures and units.
- All calculations. Any calculations should be done in your notebook. If they are done outside of class, you should submit the carbon copies of the work in the next lab session.
- Before leaving class you must:
    - Sign and date the bottom of every completed page
    - Have the instructor sign your last notebook page completed in the lab session.
    - Submit the carbon copies of your notebook pages for that lab session.

Corrections to the notebook

Mistakes will occur when recording data as you collect it. The proper way of correcting mistakes in a laboratory note is to cross out the mistake with a single or double line as seen below and initial the correct entry. Do not scribble out mistake. The mistake must be clearly readable under the line. (This is a legal requirement because laboratory notebooks are legal documents admissible as evidence in court) Cross out mistake and initial it.

Unused space on notebook page

When you are done with a page, you must draw a diagonal line through any blank unused places on the page before you sign, date and submit the carbon copy. This is also a legal requirement. It prevents anyone from adding additional information to the page after the fact.

Laboratory report format and guidelines:

Laboratory reports are an important part of science education. Students in chemistry and biology will be expected to write professional laboratory report. Therefore, in this course you will be introduced to several of the major components of writing a laboratory report. It is my hope that this course will give you an advantage in upper level courses.

The format
Clarity of expression, correct grammar, spelling and paragraphing are expected. The lab report will consist of the following and must be in the order below: All components will be in paragraph form and must be double typed double spaced in Times New Roman 11-point font with 1" margins. Do not list anything. Data and results must be put in tables. Schemes and figures must be prepared using a proper software such as Biovia (free), ChemSketch (free), ChemDoodle (free), or ChemDraw. They can also be neatly written down in ink. See Laboratory Manual for further details.

Tables
You must use tables. They must be numbered using Roman Numerals: (I, II, III----etc) Figures & Graphs should be numbered using alpha numerals (1, 2, 3------etc).

Introduction: Objective and Theory
The introduction must contain a discussion of the basic principles the lab is illustrating. This must be in your own words and not a paraphrase of the published experiment in your lab manual. You must cite statements of fact not ordinarily known using the following method: [#] at the end of the sentence containing the information. Do not include extraneous facts that do not pertain directly to the objective of the lab. Any equations used should be included along with a discussion of how they will be used. Be sure to identify all variables in every equation you discuss.

Procedures and observations
Writing a procedure for a chemical experiment involves using a formal and stylized writing approach. The experimental section will consist of a short paragraph that includes a sentence that refers the reader to some source for the procedure. Details from the published procedure and any experimental hints or tips that may aid the reader in understanding and repeating the experiment should be included. All reagents used must be reported in as the quantity you actually used (in parentheses, followed by the number of moles). All products used must be reported in as the quantity you actually used (in parentheses, followed by the number of moles) and % yield.

Results
The results section should contain tables, graphs and illustrations.

- Tables should be numbered using ROMAN NUMERALS. (Table I, Table II, Table III...)
- Graphs and illustrations should be numbered using ALPHANUMERICS (Figure1, Figure 2, Figure 3...)
- Label the x and y axes of your graphs with an informative label and include the units. For instance for a titration the x axis would be "Volume NaOH (mL)" while the y axis might be "Voltage (mv)".
- Do not just connect the dots. At this level most graphs can be fit to the best straight line (y = mx +b) using linear regression. In MSExcel you can use TRENDLINE.
- All tables, graphs and illustrations should have an informative title: "Table I – Experimental Melting Points"
- All raw data that is used to perform calculations must be put in a table.

Calculations
Show all equations you used to calculate your result. For instance, if you are calculating percent error you must first include the equation for percent error as follows:

% error ={ [|*ExpVal* – *AccptVal*|] / *AccptVal* }100

- This can be typed (good time to learn how to use the equation writer in MSWord) or neatly handwritten in ink.
- Follow with the actual calculation (can be neatly hand written in ink) using correct significant figures and units.
- If your lab requires repetitive calculations, you only need to include one of these calculations in your report.
- Percent yield calculations: Refer to General Chemistry 1 notes on limiting reactant, theoretical yield and percent yield calculations. Show all steps for full credit.

Discussion (400 and 1200 words)

This is an important part of your laboratory report. In this section you will do the following:

- Restate your final results: “The molecular mass of copper sulfate was found to be -------”
- If possible compare your results to expected or literature values.
- Explain the meaning of your results:
    - Did you achieve your goal? Why or why not.
    - Did your results match literature values? Report literature value and % error.
    - If your value was too high, explain why. Be specific.
    - If your value was too low, explain why. Be specific.
    - Discuss how this laboratory relates to chemistry. Explain what principles and concepts it illustrates.
    -

Conclusion

Provide a global conclusion regarding your experimental results. This section should be 100 – 250 words.

Questions

There are questions related to each experiment in the lab manual. You must answer all questions in the lab report. Type the question itself in bold then answer using complete sentences using regular font. If the question requires a calculation use the rules found under the CALCULATION SECTION above.