MSE 396 – Introduction to Research

Spring 2022

Instructor: Prof. David Cahill
Lecture: W 5:00-6:20 PM MSEB 305
Meeting/Contact Hours: One 80-minute lecture per week, plus guided research work.

Email: d-cahill@illinois.edu
Office: 1022 MRL
Office Hours: By appointment
Course Website: Canvas

Course Credit

Students register for 3 hours of credit the first time they take this course. The course can be repeated for 1 - 3 credit hours. If the student's safety and ethics trainings have been completed in the past year, they do not need to repeat these trainings.

Credit Toward Graduation

Students outside of the biomaterials focus area may use up to three hours of MSE 396 for "Technical Elective" credit in Materials Science and Engineering. Additional credit in MSE 396 may be used for free elective credit.

Recommended Text

- *Research Methods for Science*, Cambridge University Press, M. P. Marder, 2011

Other texts available in electronic format from Grainger Library or other sources are listed below.

- *An Engineer's Guide to Technical Communication*, Pearson Prentice Hall, Sheryl A. Sorby and William M. Bulleit, 2006
- *How to Write and Publish a Scientific Paper*, Greenwood Press, Robert A. Day and Barbara Gastel, 2006
- *Scientific Papers and Presentations* [electronic resource], Academic Press, Martha Davis, 2013
- *Style and Ethics of Communication in Science and Engineering* [electronic resource], Morgan & Claypool Publishers, J.D. Humphrey and J.W. Holmes, 2009
- *Introduction to Error Analysis: The Science of Measurements, Uncertainties, and Data Analysis*, CreateSpace Independent Publishing Platform, Jack Merrin, 2017

- *Introduction to Probability and Statistics for Engineers and Scientists* [electronic resource], Academic, S.M. Ross, 2009
- *Small Message, Big Impact: How to Put the Power of the Elevator Speech Effect to Work for You*, Greenleaf Book Group Press, T.L. Sjodin, 2012
- *Presenting to Win*, Prentice Hall, J. Weissman, 2010

Class Description and Objectives

Students must be involved in research during the semester they are enrolled in MSE 396. The MatSE faculty recognize that Materials Science and Engineering is an important area of research within other departments and therefore Materials Science and Engineering students conducting research with faculty in other departments are allowed to register for this course.

The fundamental tenets of research will be covered, including an introduction to laboratory safety, the ethical conduct of research, constructing a hypothesis and the design of experiments to test the hypothesis. Students will be exposed to error analysis and the statistical analysis of data. Exposure to the basic procedures comprising engineering communication and the importance of clear and concise verbal and written communication will be emphasized. Students will be required to give an elevator talk in class and give a research talk at the end of the semester. During the semester, there will be written assignments which will relate to the final research paper.

The safe conduct of research is essential. The section on laboratory safety has been developed in conjunction with the Division of Research and Safety on campus at University of Illinois, Urbana-Champaign. The safety section concludes with an online safety exam that the student must complete with a satisfactory grade and hand in the certificate that demonstrates that the online training was completed in a satisfactory manner. **Successful completion of the safety training is necessary to participate in research. You must complete the safety training to receive a passing grade in this class. Please contact Prof. Cahill if you have any questions about this requirement.**

Ethical training is now a requirement by funding agencies, including the National Science Foundation, which has rules governing the Responsible Conduct of Research. Unethical behavior means that researchers throughout the world cannot trust your reported results. If you do not conduct your research ethically, then you will waste other researchers time and resources as they attempt to confirm your results. **The section on the ethical conduct of research requires that the student complete the online ethical training.**

Course syllabus and lecture materials adapted from those prepared by Dr. Matthew Sherburne and modified over the past several years by Profs. Cahill, Sottos and Shim, and Dr. Nagel.

Grading Policies

Student learning and growth will be assessed based on the following:

- **Laboratory Research Work (70% of total grade)**
  - The faculty member overseeing the research will assign this portion of the grade.

- **Course Work (10% of total grade)**
  - ***All written assignments must be word-processed. Please see the calendar for assignment due dates.***
  - HW 1: Safety Training
  - HW 2: Elevator Talk
  - HW 3: Revised Elevator Talk
  - HW 4: Research Hypothesis
  - HW 5: Research Paper Introduction
  - HW 6: Ethics Training

- **Final Presentation (10% of total grade)***
  - You will be expected to give a presentation on your research to the class.
  - The last two class dates are reserved for student presentations.
  - This talk will be 15 minutes in length (12 minutes for the presentation, 3 minutes for Q & A). The presentation length may be adjusted depending on the number of students registered in the course.
  - The format for this talk will be covered in lecture.

- **Final Paper (10% of total grade)***
  - The final paper is due the last day of final exams by 5 PM; submit through the Canvas website.
  - The paper is to be 5 pages in length and should follow the standards laid out in lecture.

** If you are repeating this course for 1 or 2 credits, either the final paper or the final presentation will count as 20% of your grade, and you won't have to complete both assignments.*

Late Assignments

- **Submitting late assignments should be discussed with the instructor prior to the due date.**
- If you have concerns, I am happy to discuss your specific situation with you.

Proposed Calendar – Subject to adjustment and change as the class develops

Class Date		Class Topic	Assignments	Assignments Due
Wed.	Jan 26	No class		
Wed.	Feb 2	No class		
Wed.	Feb 9	**Introduction, Safety**	HW 1: Safety	
Wed.	Feb 16	No class		
Wed.	Feb 23	**Elevator Talks**	HW 2: Elevator talk	HW 1
Wed.	Mar 2	**Elevator Talks**	HW 3: Revised Elevator talk.	HW 2 (in class)
Wed.	Mar 9	**The Scientific Method**	HW 4: Describe your Hypothesis	HW 3 (in class)
Wed.	Mar 16	No Class		HW 4
Wed.	Mar 23	No Class		
Wed.	Mar 30	**Elements of the Research Paper**	HW 5: Write the Introduction to your paper	
Wed.	Apr 6	**Ethics**	HW 6: Ethics	HW 5
Wed.	Apr 13	No Class		HW 6
Wed.	Apr 20	No Class		
Wed.	Apr 27	**Presentations**		
Wed.	May 4	**Presentations**		
Fri.	**May 13**	**Final Paper Due**		**Final Paper Due: 5 PM (submit to Canvas)**

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: wecare.illinois.edu.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Religious Observances
Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Disability-Related Accommodations
To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to https://www.disability.illinois.edu. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting "Request an Academic Screening" at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA)
Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

APPENDIX A – Laboratory Notebook Overview

This appendix is adapted with permission from the resource produced by Matt Sherburne, Nicole Robards, and Angus Rockett for use in MSE 307.

The Laboratory Notebook

The purpose of a laboratory notebook is to record what you did in sufficient detail that you can reproduce what you did (for example through a detailed description of the apparatus and the procedures used to acquire the data), explain problems with the data based on information you recorded in the lab notebook, record any events that might have affected the data, record things that went well, etc.

Suppose that the data looks good but the values change suddenly in the middle of the experimental run. You find that if it were not for the sudden change, your data would have explained the behavior you observed very well. What caused the sudden change? Referring to the lab notebook, you find that you bumped the lab bench between those two measurements. Conclusion: the change in the data was due to bumping the table. You may be able to correct for that change and show that the data works.

Suppose that the position of the sample in the apparatus matters? If you write down where you placed the sample in the apparatus you can reproduce the behavior. At least all samples will be measured at the same position.

Suppose that you and another group run the same experiment but get different results. How do you account for the difference? You refer to your lab notebook and they refer to theirs and you find that the difference was the heating rate (so the experiments in fact were not the same). So the difference in the results may be due to the different heating rate. Now you have learned not only what you set out to learn but also what the effect of heating rate is.

NOTE: the purpose of the lab notebook is NOT to record only your successes. Indeed, it is most important to record the things that went wrong as these are most likely to affect your results. Experiments almost never go completely right. Consequently, you are often faced with how to deal with bad data. If you always insist that all data agree with a trend you will never succeed. You also cannot just ignore data points that do not fit your idea of what the trend should be. However, if you can sort through your data and figure out what the problem was, you may be able to correct for it, determine what to change about the experiment, and possibly show which data is reliable and why.

Elements of the Laboratory Notebook

The following outlines the expectations for your laboratory notebook and what should be included in it for each laboratory portion of the course:

- Your laboratory notebook needs to be either of a stitched or glued type of binding. A three-ring binder and/or loose paper will not be acceptable for this class, nor are they acceptable in the real world once you are employed.
- The size of the notebook you use is a personal choice; just remember that if you choose a notebook that is small, drawing detailed figures will not be easy. A notebook that is standard page size allows you to easily print out figures or data and go back and glue it into your notebook next to the original figure or data.
- Your pages will need to be numbered; whether you number them or the notebook comes numbered is up to you.
- Every page should be dated. If you start a new experiment or start a new day of work begin a new page in the notebook.
- A sketch or photographs of the apparatus should be included in the notebook along with a description of how the apparatus was connected together (as appropriate). If you measured out a sample, record how the sample was prepared.
- For example, 10 mg of camphor was measured out from the reagent bottle onto a glass slide. Next 15 mg of succinonitrile was measured out from the reagent bottle onto the same glass slide. Both materials were white powders. The two measured samples were mixed on the glass slide with a spatula. After mixing the combined sample weighted 24 g (1 g apparently was lost, perhaps due to adhesion to the spatula).

- On the outside of your notebook you should put your name, course number, instructors name and your email address.
- If your laboratory notebook does not have a prelabeled section for the table of contents then you should reserve several pages at the front of your laboratory notebook for your table of contents.
- Electronic/digital notebooks are not acceptable for this course. The main reason for this is that their veracity has not been tested in patent litigation cases. Until a legal standard exists for the use of digital notebooks they will not be allowed.
- All writing should be done using permanent ink. What tends to work best is the classic ballpoint pen, as these cannot be erased and do not smear. Other pens work but tend to smear either by your hand running across the writing prior to its drying or from an accidental spill. Pencil is never acceptable.
- If you make a mistake, and you will, do not attempt to ease or apply white out to the mistake. Simply put a line or an “X” through the error and continue on from that point. Draw an “X” in any large empty are of your notebook. This way data cannot be inserted into the space later.
- Your notebook needs to be recorded in chronological order.
- Make notes with small written sections about anything that is odd, out of place, or could potentially impact the outcome of the experiment. For example, note that you bumped the table or something of this type.

Practical Aspects

The following outlines some practical aspects that should be kept in mind when working on your experiments and filling in your laboratory notebook.

- Record your raw data immediately, do not wait and get distracted, or think that I will remember it. You can very easily transpose digits or just forget the correct number if interrupted. Without the correct data it will be much more difficult to write up your lab report.
- Your lab notebook is not to try to carry lab equipment on and should not be used to carry anything around the lab. It is too easy for you to drop and break the items you are carrying.
- Make every effort to keep your lab notebook away from any liquid such as the sink, or other spills which may occur in the lab. While water may not make your ballpoint pen ink run it does make it difficult to write on wet pages.
- Include more detail in your notes than you think you actually need. This will help when you are attempting to write up your lab report. This means record anything and everything you observe in your experiment.
- If it matters in what order devices were connected or turned on then you should record that. It is better to write too much than too little.
- Record how you did the experiment. In what order did you make measurements? What were the values you set the apparatus controls to and in what order? Did you observe any effect of this sequence? Record as much of what you did as reasonable. The more you write down the more likely you are to be able to diagnose problems with the results.
- Any experimental values not recorded by a computer should be written in the lab notebook. (What was the gas flow rate? What voltage did you set the power supply to? Etc.)
- If possible/reasonable, capture your results in a printed form and incorporate them into the lab notebook. When practical, print out the data and tape it or glue it into the notebook. Paper can always be read somehow. Electronic data gets lost, deleted, or becomes obsolete.
- Make notes of things that did or might have gone wrong. If you don't notice anything go wrong during the measurement write that down. That way you know that you did not notice anything strange about the measurement.
- Remember: there are few things in science more annoying than trying to write up an experimental result and realizing that the observation does not fit the theory but you did not write down some key experimental procedure that would have allowed you to at least know why the results did not agree with expectations.