Teaching Evidence

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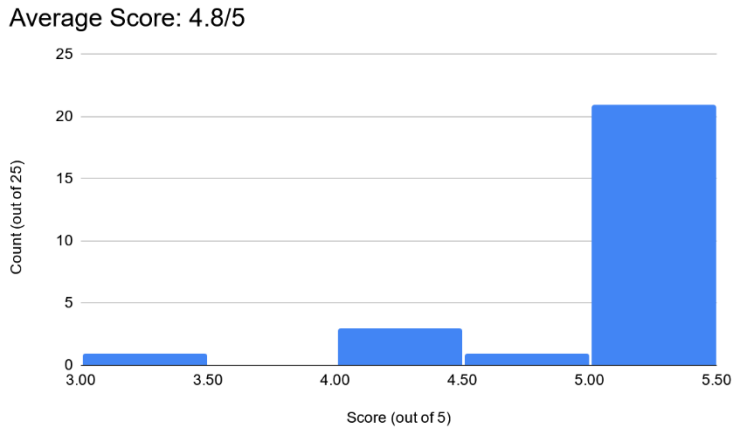
Teaching Evaluations: SCI 123 The Science of Food and Cooking at Augsburg University

SCI 123 is a 4-credit lecture and lab class that meets a Natural Sciences and Mathematics requirement as part of the Liberal Arts Foundation at Augsburg University. This class primarily serves a diverse group of non-STEM majors.

Midterm Evaluations (Informal)



Comments Related to the Rating

- Great
- I love how organized the class is and how the professor checks on students.
- You have been doing a great job on choosing the labs. I hope you continue to do so throughout the rest of the semester.
- Couldn't ask for a better professor
- She is doing great!
- Very nice and sweet professor
- In my opinion you're doing great :)
- Everything that is being taught is well thought out, there are sometimes examples given throughout the lecture that make the context of the lecture make sense. She always asks if we are confused so that she can explain it in different ways. There are times when the lectures are a little long, but overall the teaching skills are on point and engaging.
- I think she is doing fine and good enough for me to go back on the slide to understand this midterm.
- Doing good with teaching, would be nice to simplify the heavy science terms.
- I have learned a lot from this course and although I may not be able to fully describe my knowledge with the most academic and scientific terms, I have a good baseline understanding of how science and physics relate to the process of cooking food. I also learned more about general information about food in terms of its packaging and what labels like organic mean.
- The terms we are learning are easily found on the slides and the videos/examples you show us are really helpful. It's easier to learn about the science terms when you have visuals and examples, just like the burger video I watched that helped explain conduction and whatnot.

Although no one really participates when it comes to lectures, I still think the information we learn is useful and straightforward. I just feel like no one has energy by that time.
- So far in the class I'm enjoying learning the science of cooking
- She is doing great!
- You're doing a great job! Really easy to comprehend and follow the way you're teaching.

What is going well in the class?

- Learning during the experiments and seeing the concepts applied in real time
- Doing the labs is going well for me. I think the professor should keep up with the reminders since they are very helpful and keep me motivated.
- Independent team time. It is structured well.
- The labs for sure. I'm learning how to cook things I've never cooked or baked before.
- Having engaging activities that help us learn about the topic
- Taking notes and understanding the material a little bit. Overall everything is going well.
- Explanations on things as well as bringing back the class together and asking us questions so we remember what we just learned.
- Group work
- Giving us breaks and checking in on us
- I am able to keep up with the work and understanding the lessons that are introduced, such as chemical reactions in food, protein bonding, different phases and equilibrium and as well as the different elements required/responsible for the change in foods.
- I think that the lectures are very well-structured. They are rarely too long that they completely lose me, and they have a good mix of different types of media (text, video, diagrams). And of course I love doing the labs.
- Having the lecture slides available and explaining each concept. You do an amazing job with examples. This is very helpful for me.
- I think that the labs are going well and getting hands on with the actual cooking
- I like that we get to do our own thing for the lab.
- Learning some of the material is good because of the slides she has ready
- We are spending a good amount of time with the hands on learning
- Overall, the class is going well. I am most successful with hands-on learning, so the lab parts have been really helpful for me.
- Letting us know when something is due.
- Being interactive with the entire class. Good communication with others in my group.
- I enjoy the labs, pace, and structure of the class with lab/background info first and then us conducting the lab experiment. I also enjoy getting out of class early :)
- I think everything is going well. I love how the class is structured. It's nice to actually experiment and physically learn the topics in class after we do a lecture instead of just doing worksheets the whole time.
- I appreciate the clear explanations followed by hands-on lab activities.
- Trying my best to get my assignments in. Professor Loh is very understanding which is very helpful for this process.
- Even though recently I have been turning in assignments late, I think the HW are great as in doing them and also the content.
- The class is going well. I like how we do not push the full three hours.

What could be improved in the class?

- I suggest more explanations of formulas to help students learn how to use them
- I think we should be able to do exams in class the day we have class instead of on our own time but other than that, nothing.
- Go over recipes in more depth.
- Everything is straightforward, there's nothing that should be changed.
- I think the videos shown could be improved. Some videos are not attention grasping. After a while, they are a little too long. I think finding videos that are more entertaining but I know that it is hard! Videos are nice to watch though!
- More activities like Kahoot because it was fun and competitive. I just like doing competition because it gives students a chance to engage in class.
- Keeping the lecture shorter. Maybe go over the recipes and instructions with us so we don't make too many mistakes?
- Professor Loh should not clean after students. She should make it a more important priority for us to complete. Also, frequent breaks instead of a large one. Maybe a 5-minute break after the first hour and then another one after the second hour before lab starts.
- Doing more examples. I like it when you give examples of the concepts talked about, which give me a better understanding of what I am learning and in a way I can envision how it would look like. Giving more simple instructions or ingredients to follow could be improved. Sometimes it can be confusing to do the lab not knowing which directions to follow, like what ingredients to do when there is also something else written to the side.
- I don't think there is anything you shouldn't keep doing or that needs improvement upon in particular. Maybe more in depth analysis of the science during the lecture and less reading off the slides? Very minor.
- Maybe there isn't enough detail in the lessons in the right places. I don't really understand or particularly care about long scientific papers. I just want to know how to cook my steak right and the science behind it. Maybe add more recipes that I can use in my personal life? I'm not exactly dying to make custard every night.
- I have struggled with some of the processes. This isn't a Professor Loh problem, it's a ME problem and it's just part of why I have always struggled with math and science (plus the last time I took a science class, it was 1995, so a lot of this stuff isn't as fresh in my head as it would be if I just graduated high school a year or two ago). I have always been really intimidated by science and have historically not been very good at it. I think going over more of the science terminology and maybe having homework that goes over vocabulary and terms every week might be helpful for me. I can cook and (generally) explain what's happening, but answering questions on this test was tough for me.
- Would be nice to have a class schedule.
- Maybe add more group discussions or games like Kahoot to get the class more energized to participate.
- Nothing, this is a fun class.
- Professor Loh is great. I don't have any changes to request.
- I like how things are going right now. It's been a great experience so far.
- Making the lecture part of the class easier to swallow in the sense of not elongating it too much. For example, if it is a short lecture, no need for a break. I would rather go through it all then break/ or move on.

Final Evaluations (Formal)

Fall Semester (2024) UCS - 2024SEM1 T2/full Nov-Dec — Augsburg University

Print Report

SCI123 - 2024SE1C - The Science of Food and Cooking

Department: Science

Responsible Faculty: Kristine Loh

Response Rate

68 %

Received 17

Expected 25

University Course Survey

Course Structure

Q1 Opportunities to communicate with the instructor (during office hours, via email, via phone, or through Moodle) were			Total: 17
Satisfactory	17	100 %	
Unsatisfactory	0	0 %	
I did not attempt to communicate with the instructor outside of class	0	0 %	

Q2 Class time, readings, and activities were generally relevant to course learning goals/outcomes:			Total: 17
Yes	17	100 %	
No	0	0 %	
Not Sure	0	0 %	

Q3 Sufficient information (syllabus, schedule, expectations, assignment descriptions) was provided for the course.			Total: 17
Yes	17	100 %	
No	0	0 %	
Not Sure	0	0 %	

Q4 The Moodle course website was managed and organized effectively.			Total: 16
Yes	16	100 %	
No	0	0 %	
Not Sure	0	0 %	
The instructor did not use moodle	0	0 %	

Course Specific Items

Q5 Required materials (textbooks, software, supplies) were used:			Total: 17
Rarely/Never	2	11.8 %	
Sometimes	8	47.1 %	
Almost Always/Always	7	41.2 %	

Q6 Feedback on my work was timely:			Total: 17
Rarely/Never	1	5.9 %	
Sometimes	0	0 %	
Almost Always/Always	16	94.1 %	

Q7 Feedback on my work was helpful:			Total: 17
Rarely/Never	1	5.9 %	
Sometimes	1	5.9 %	
Almost Always/Always	15	88.2 %	

Course Comparison

Q8 Writing			Total: 17
Higher	1	5.9 %	
Typical	15	88.2 %	
Lower	1	5.9 %	
Not Sure	0	0 %	
Not Applicable	0	0 %	

Q9 Reading			Total: 17
Higher	1	5.9 %	
Typical	14	82.4 %	
Lower	2	11.8 %	
Not Sure	0	0 %	
Not Applicable	0	0 %	

Q10 Mathematical/Quantitative Reasoning			Total: 17
Higher	0	0 %	
Typical	11	64.7 %	
Lower	3	17.6 %	
Not Sure	1	5.9 %	
Not Applicable	2	11.8 %	

Q11 Workload and Activities Outside of Class Sessions			Total: 17
Higher	1	5.9 %	
Typical	14	82.4 %	
Lower	2	11.8 %	
Not Sure	0	0 %	
Not Applicable	0	0 %	

Q12 Expectations for In-Class Participation			Total: 17
Higher	1	5.9 %	
Typical	15	88.2 %	
Lower	0	0 %	
Not Sure	1	5.9 %	
Not Applicable	0	0 %	

Class Questions

Q13	Classes usually started on time and ended on time.	Total: 17
Yes	16	94.1 %
No	1	5.9 %
Not Applicable	0	0 %

Q14	I was able to determine my grade in the course throughout the term.	Total: 17
Yes	17	100 %
No	0	0 %
Didn't attempt to know my grade	0	0 %

Q15	Based on the planned syllabus schedule , how many times during the semester was a class cancelled?	Total: 17
0	17	100 %
1-2	0	0 %
3-4	0	0 %
5 or more	0	0 %

Q16	I was able to ask questions, share ideas and be included in discussion:	Total: 17
Most or all of the time	17	100 %
Only sometimes or rarely	0	0 %

Q17	When a class was cancelled, was there assigned alternative instruction or activity to make up for the cancellation?	Total: 17
No classes were cancelled	16	94.1 %
Yes there was always alternative instruction or activities	0	0 %
Only for some sessions	1	5.9 %
There was no alternative instruction or activities for the cancelled sessions	0	0 %

Q18	Please add any additional comments on the quality of your experiences in this course:	Total: 8
AMAZING Professor. One of the best i have ever met. She is very understanding and knows what she is teaching and always helps us out when we feel stuck.		
It was fun for how much time we spent in class.		
Amazing course! Amazing Professor! I wish they taught more courses!		
The course was great.		
Great professor!		
Christine was a great instructor. She took time to explain everything in a way that was easy to understand. I felt that grading was fair and I received the score I deserved.		
The professor was very understanding, helped students and explained concepts very well.		
you did great! thumbs up emoji		

Example Laboratory Design in SCI 123: Meringues

Foam Structure and Meringues

Introduction:
Egg whites are made up of water, proteins, and small amounts of minerals and sugars. When egg whites are beaten, the proteins denature and unfold. At this point, they self-assemble so that their hydrophobic parts interact with water and the hydrophilic parts interact with air. Then, they can form a foam, which has trapped pockets of air in the egg white network.

Alternatives to egg whites have been explored with the rise in veganism. Aquafaba, the liquid that's used in canned beans, has been discovered as a superior egg substitute, especially for making meringue cookies. From this blog:

> Aquafaba is rich with substances that enhance water's foaming abilities because legume seeds like chickpeas and soybeans contain albumins and globulins, the same proteins found in eggs that make them so useful in creating culinary foams. They're also rich in saponins, plant-derived organic chemicals that act like soaps in that they can dissolve in both fat and water, and they, too, can help to form stable foams. The combined presence of albumins, globulins, and saponins in chickpea cooking liquid means that, when agitated, it will produce a stable foam.

In this lab, you will explore foam structure by making meringue cookies out of egg whites and aquafaba. **Can this vegan substitute make the same or better meringues than its non-vegan counterpart?**

Group Deliverable:
Create a series of photos that show your progression from your liquid ingredient, to soft peaks, to stiff peaks. Measure the different stages of foam formation using a consistometer or with a ruler to measure the height of the foam in your mixing bowl. Attach this data in a graph.

Individual Deliverable:
Answer three of the following questions:

1. Where do you see evidence of saponins in the aquafaba?
2. Why does the meringue get more opaque and glossy as you whip it?
3. What were the differences between the egg white meringues and the aquafaba meringues? Could you taste the difference?
4. Why is cream of tartar added at the beginning of the recipe?
5. Which ingredient took longer to whip up to stiff peaks? Why?
6. What is one other vegan recipe you would be interested in trying?
7. What is one thing you could change about this recipe? (Ingredients, processing step, etc.)
8. Why did the aquafaba recipe need more sugar?
9. Is a meringue an open or a closed foam? Why?
10. Were you surprised by the change in volume by the end of the whipping process? Why or why not?

Vegan French Meringues: adapted from https://itdoesnttastelikechicken.com/vegan-meringue-cookies/

- Ingredients:
  - Liquid from one can of chickpeas
  - ¼ tsp cream of tartar
  - ½ tsp of vanilla extract
  - ½ cup sugar
- Steps:
  - Add cream of tartar and vanilla extract to the liquid aquafaba. Immersion blend for 2 min until frothy.
  - Add in sugar slowly (roughly ⅛ cup at a time) every 45 seconds or so while using the immersion blender or whisking. After all the sugar has been added, switch to hand whisking and whisk until stiff peaks form (roughly 5 - 10 min).
  - On parchment paper, spoon or pipe meringue into cookie shapes roughly one inch in diameter and bake at 250 F for 35-40 min.
  - Done meringues should peel easily off the parchment paper. Turn off the oven and open the door slightly to let the meringues cool. They don't like big temperature fluctuations!

Egg-based French Meringues: adapted from https://cookwithsunshine.com/easy-meringues/

- Ingredients:
  - 4 egg whites (½ cup of liquid egg whites)
  - ¼ tsp cream of tartar
  - ½ tsp of vanilla extract
  - ¼ cup sugar
- Steps:
  - Add cream of tartar and vanilla extract to the egg whites. Immersion blend for 2 min until frothy.
  - Add in sugar slowly (roughly 1 tsp at a time) every 45 seconds or so while using the immersion blender or whisking. After all the sugar has been added, switch to hand whisking and whisk until stiff peaks form (roughly 5 min).
  - On parchment paper, spoon or pipe meringue into cookie shapes roughly one inch in diameter and bake at 250 F for 35-40 min.
  - Done meringues should peel easily off the parchment paper. Turn off the oven and open the door slightly to let the meringues cool. They don't like big temperature fluctuations!

Tips:

- Immersion blend in a quart container (or a container with high sides) as you're not working with much liquid at the beginning. Transfer to a larger bowl for hand whisking to incorporate more air.
- When immersion blending, move the blender up and down to incorporate more air.
- Switch partners during hand whisking because it can get tiring.
- Use this hummus recipe with your remaining chickpeas.

Award Nominations for the Council of Graduate Students Outstanding Teaching Assistant Award

The Council of Graduate Students Outstanding Teaching Assistant Award is a student-nominated award that reflects student learning/development outcomes identified by the University of Minnesota. I received this award in recognition of my teaching assistantship for CHEN 3401W: Junior Chemical Engineering Lab in the Spring of 2023.

How has your TA helped you achieve the student learning outcomes?

- She was very good at helping us figure out what we were supposed to be doing in lab. She would always answer our questions in a way that made us actually think about the answer and get to the solution on our own while still making sure we were on the right track. I think she was very good at getting us to think critically abut why we were doing different things in lab as well as why every detail mattered. She helped me understand the labs better and made it much less stressful to be inlay because I knew she would help us if we really needed it and wouldn't lead us astray. She was easy to talk to and never condescending which made it a lot easier to talk to her without feeling dumb. Overall, she really helped to get us through a very difficult course by always allowing us to learn but also helping us without just outright giving the answer.
- Kristine encouraged me to answer my own questions in the lab and encouraged critical thinking. When I would ask her questions, she would respond to my questions with questions, encouraging me to think through my questions and try to answer them myself by providing me with guiding questions. For example, during the DEE experiment, she did not simply tell us the purpose of each piece of equipment, but rather guided us to the purposes of the pieces of equipment ourselves. Additionally, she would suggest that we think about potential problems we may encounter during lab. She encouraged us to consider how to get the best data and the most out of the lab period and to identify, define, and solve problems.
- Kristine Loh went above and beyond in our laboratory. She made sure the instructions from the professor were clear and would elaborate on them if need be. This helped me to be able to locate and critically evaluate information in a setting that was often overwhelming and stressful. Kristine treated me with respect and made me feel valued as a fellow woman in engineering, and this led me to acquire skills for effective citizenship and life-long learning. She was very approachable and made sure I knew that there was no such thing as a "dumb" question, which helped to improve my communication skills with superiors.

How has your TA helped you achieve the student development outcomes?

- A lot of things in this lab we done individually, she helped us to be able to work on our own but we also felt comfortable enough to ask for help when we needed it. A big part of the lab was being able to work as a group but also delegate tasks and she was helpful in making things run smoothly. Additionally, my group had a lot of issues with one particular member and she was very good about helping us get through the lab and made it easier to deal with him after he had been continually making the whole class harder. She knew what we were going through and that it wasn't fair but she helped us get through it. Additionally, one thing about this class is that there seemed to be a few things interpreted differently by instructors but she was helpful at helping us figure out what our group specifically needed to do even when things seemed confusing.

- Kristine thoroughly encouraged independence and interdependence within my lab group. She created a safe environment in lab in which we felt comfortable and safe working independently in the lab while also knowing she was there to support us when needed. At times when we did not feel confident operating the equipment, especially at the beginning of the semester, she would remind us that we were capable and safe. She also helped us achieve responsibility and accountability. She would encourage us to celebrate the progress we made in lab and take responsibility for any successes in lab, such as achieving steady state on the DEE.
- In this laboratory course, the instructors were not supposed to directly tell us what to do. Kristine followed this by posing questions that helped me to gain a tolerance of ambiguity that will help me in the workplace. I achieved the outcomes of independence and interdependence because Kristine would rotate between helping different groups in the laboratory. She taught me to be independent when work needed to be divided, which helped me develop responsibility and accountability. She also led me to be interdependent on my two lab mates that I had not worked with before. One of the labs we did was very challenging to figure out, and Kristine helped me to be resilient at a time when it was difficult to decide how to move forward by bringing a calm and supportive attitude to the room.

Thank You Notes from Guest Lecturing in Introduction to Engineering

The following thank you notes were compiled after I gave two guest lectures in the Introduction to Engineering class at Columbia University. This summer class served high-achieving high school students who were interested in engineering careers.

- Thank you so much for sharing your experiences with us!! It was awesome!!
- Thank you very much for this nice virtual visit. It was a nice lesson and I learned a lot of new stuff about chemical engineering which made it more interesting. Thank you.
- Thank you Kristine for taking the time to give us this talk. Thank you for all of your valuable insight and giving us a view of what the world of engineering is like from a woman's perspective which was something refreshing for me to hear as a girl interested in engineering and also very insightful.
- Thank you so much, Kristine! You have now secured my interest in chemical engineering, and hope that someday, I could become like you.
- Thank you for spending your time to teach our class about chemical engineering. Your insights into the field were much appreciated.
- Thanks for taking the time to talk to us about chemical engineering. I found the talk very interesting and informative.
- Ms. Loh, thank you so much for taking time out of your day to come and talk to us about your work in Chemical Engineering. I didn't know much about the field going into the meeting, but you really enlightened me on the work that you guys produce, and your role in the field of engineering. It was fascinating to learn how you guys use chemistry, math, and physics in order to work with substances on a macro level and make sure they work efficiently in the job that they need to do, and doing so safely. Thank you so much!
- Your speaking inspired me to consider chemical engineering as a career option. You gave me a comprehensive understanding of the skills and subjects in chemical engineering. Thank you for your time.
- Thank you so much for taking the time to talk to us! I found what you said very interesting.
- Thank you for joining us in class about chemical engineering. It really helped me understand this branch of engineering better, and maybe made my future career choice easier.
- Thank you very much for the class. I really liked hearing you speak, specially about being a woman in the engineering world. It really helped too hearing you speak about how maths was not your strongest subject at high school, and it has not been a problem doing engineering.
- Thank you so much for taking time out of your day to come and speak to us! I enjoyed learning about chemical engineering and your job life, such as working with the putty world! Additionally, it was very helpful to hear you speak because I really like chemical engineering so I thought it was very interesting to learn about your college and job life.
- Dear Kristine Loh, I wanted to thank you so much for coming to speak with us today and answering our questions. You were amazing at giving us an insight of how your work is.
- I would like to extend my gratitude for making me understand the importance of chemical engineering and hard work and how to never give up on your dream and keep working forward. You have inspired me to understand my interests and work towards them in the future.

- Thank you so much for coming and speaking with. Your talk inspired me a lot as a women who want to get into the engineering field, as a chemical engineer. It fully cleared to me what I want to do and what I should study. Thank you so much.
- Dear Ms. Loh, Thank you very much for explaining to us what is like being a chemical engineer and telling us a bit about your life as one. The talk was very encouraging for me as a girl to continue pursuing my journey to one day become an engineer.
- Thank you so much for your talk, you really inspired me to be determined because even though you struggled with math you persisted through your math classes and when there was no lab equipment for your size, you bought your own.
- Dear Ms. Loh, Thank you for taking the time to speak with our class today. Your insights into the implementation of advanced chemical processes were incredibly inspiring. I particularly appreciated your emphasis on problem-solving, communication, and analytical thinking as essential skills for success in chemical engineering. Your discussion on managing production standards and safety regulations provided valuable lessons.
- Thank you so much for introducing us to what being a chemical engineer is like! The little Q&A session we had after the presentation really changed my perception of what chemical engineering is, and it really inspired me to research more about the field!
- Thank you for coming to speak to us! Your talk was very insightful and I appreciate the representation you gave as a woman in STEM and an obviously very male dominated field where you weren't respected by many others. It was very inspiring and helpful, thank you!
- Thanks for sharing your personal experience with university life and chemical engineering. I learned a lot from your speech! Your answers to our questions were clear and inspiring, giving me a deeper understanding of this discipline.
- Thank you for coming to talk to us. It made me have more interest into chemical engineering.
- Thank you so much for not only sharing your career, but your life with us. Your transparency really showed how passionate you are about your field and helped me understand the struggles you have faced. You are an amazing engineer and strong woman.
- Thank you Kristine for sharing your knowledge and experiences in chemical engineering with us.
- Dear Kristine Loh, Thank you so much for speaking with us and sharing your experiences in chemical engineering. Your insights into the diverse applications of the field, from working on Tylenol and toys were truly fascinating and inspiring. We appreciate your time and the valuable information you provided.
- Dear Kristine, Thank you so much for taking the time to meet with our class and share your experiences. I really want to thank you as your talk actually opened my eyes up to chemical engineering and made me consider it when I never had before. I really appreciate it.
- Thank you for taking your time to speak with us. I found it really insightful to what a chemical engineer actually does compared to my previous idea of it. It was helpful to understand what it involves and also the importance of self advocating.
- Thank you so much for coming to speak with us today. I learned a lot about what it takes to be a chemical engineer.
- Thank you for taking time to talk with us Kristine! It was really great to hear you talk about your journey and success with chemical engineering, and you have opened my mind to chemical engineering.
- THANK YOU :)

Sample Syllabus Rationale

The following rationale and sample syllabus were prepared as part of the Preparing Future Faculty Program at the University of Minnesota. The lengthy syllabus is intended to be talked through on the first day of class. Furthermore, this syllabus was designed to dispel the "hidden curriculum" by explicitly naming appropriate methods of communication and strategies for success in this course.

Objectives and Alignment

The objectives of this course focus on the students' growth as engineers and aim to help students decide if chemical engineering is the field for them. They will gain foundational skills to solve chemical engineering problems, but more importantly, will get a taste for engineering problem solving and critical thinking. They will also be exposed to a wide variety of chemical engineering disciplines and will become aware of a diverse range of current, notable chemical engineers. As such, they will practice solving mass and energy balance problems (the foundation of chemical engineering calculations) in structured homework assignments as well as ungraded weekly in-lecture activities. They will be assessed on this skill in midterm exams to reinforce their knowledge. The final project will them allow them to use their STEAM (science, technology, engineering, art, and math) capabilities to design their own process inspired by a notable chemical engineer. This final project will be a summative assessment of their problem-solving skills and will provide them an opportunity to explore the careers of current chemical engineers. Not only will they explore these careers, but they will also (hopefully) see themselves reflected in these engineers as they narrow their own career interests.

Assessments

To balance both formative and summative assessments, this course includes exams, weekly ungraded quizzes, and a final project as grading mechanisms. The students will be able to excel in the format that will suit them best given the time and resource limitations of both the instructor and the course. The weekly ungraded quizzes will be designed to prepare the students for the types of problems they will have to solve on their exams and will also provide a space for them to provide class feedback or comment on any of their needs. The final project is a summative assessment that includes a formative assessment in its progression (peer review). The final project will require students to explore notable chemical engineers from a variety of backgrounds in myriad fields, from consumer goods to pharmaceutics. Hopefully, they will learn about the career opportunities for them and will discover that chemical engineers can make a positive impact in almost every field. This assignment will also give them the framework to start picturing themselves in these roles.

Grading Strategy

This course focuses more on homework assignments and the final project over the midterm exams, thus shifting the stress away from rigidly timed assessments. The homework assignments have the heaviest weight as the solutions will be provided to the students 24 hours prior to the submission deadline, so they should have the opportunity to get higher scores. The lowest two scores will also be dropped should a student not have the time to submit a homework assignment that week or struggled with the material. The next largest portion of their grade is the final project, which will be graded based on effort and not on accuracy. I will not prioritize whether the process they designed is effective, but instead will prioritize that they provided a creative design inspired by current processes. The peer review portion of the final project will also be graded so the students will be exposed to the rubric-grading style. Next, there will be three midterm exams, but the lowest midterm grade will not be included in the final grade calculation; each scored exam will be worth 10% of the grade. The lowest scores will be dropped should a student need to miss an exam or just has a particularly bad day. The students will also get two "freebie" weeks to mix the ungraded lecture

activities (participation grade) as these activities will occur later in the week, which might conflict with conferences, visits home, or other needs.

Teaching Strategy

By using both lectures and in-class problem-solving, this course will use active learning techniques in addition to the traditional pedagogical style in chemical engineering classrooms. The in-class problem-solving exercises will be centered on case studies so the students will be exposed to realistic processes (there will not be a problem like "Timmy purchases 20 watermelons and eats 5; how many does he have left?). Through multiple choice polls, group problem-solving, and ungraded lecture quizzes, the course will be more interactive than traditional chemical engineering classrooms.

Areas of Resistance

The final project may receive pushback from students who do not value diversity and inclusion in the classroom, or who believe that the field is diverse enough. The final project allows them to feature any chemical engineer of their choosing, so they can choose to feature a cis, white, able-bodied, man engineer if they so choose. They will not be graded on how diverse their featured engineer is. I will reinforce the fact that if other students choose to feature diverse engineers, it is their choice to do so, not a requirement. I hope that this will passively expose those who are resistant to DEI implementations to a broader range of engineers. The peer review rubric will also be designed such that the students are evaluating each others' processes, not each others' choice of featured engineer.

Sample Syllabus: CHEN 201 Material and Energy Balances

Fall 2025

Class Information

Days and Times	Class Location	Prerequisites
Tuesdays and Thursdays, 10 – 11:50 am September 6 – December 22	Amundson Hall, Room 130 OR on Zoom (>24 h notice)	CHEM 121 and MATH 122 OR ability to apply principles of stoichiometry and familiarity with solving linear systems of equations

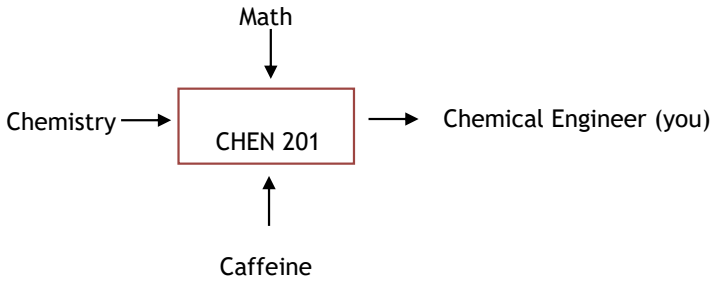
Instructor Information

Instructor	Email	Office Location & Hours
Dr. Kristine Loh (she/her)	kloh@umn.edu **Zoom: umn.zoom.us/kloh201**	Amundson Hall, Room 488 Mondays and Wednesdays, 10 – 11 am or by appointment

General Information

Why We're Here

To introduce you to the first step in your journey as chemical engineers. You'll get a taste for the driving principles of the field and get a comprehensive sense of how chemical engineers can make a difference in various industries. You'll also learn how to read and make a diagram like this:



Course Description

This course will prepare you to break down complex systems into manageable units (smaller control volumes) within the context of chemical processing problems. You will learn how to make sure every moving part in your system is accounted for by formulating and solving material and energy balance equations. Most importantly, you will learn how to *think like an engineer*: with the information you have been given, you will identify unknown variables (find what you are trying to solve for), establish relations between known and unknown parameters (set up your equations), and obtain your solution using appropriate computational methods (get your final answer!).

Course Goals

After completing this course, you should be able to:

- Identify your process constraints and make appropriate assumptions
- Convert a verbal description of a process into a well-labeled process flowchart
- Formulate material and energy balance equations for single-unit and multiple-unit processes, processes with recycle and bypass, and reactive processes
- Use spreadsheets (Excel) to solve material and energy balance problems
- Understand the breadth of a chemical engineering career and become aware of notable chemical engineers from diverse backgrounds

Expectations

As chemical engineers, we adopt a shared Code of Ethics (see this example from the American Institute of Chemical Engineers). As professionals, we should strive to uphold and advance the integrity, honor, and dignity of the engineering profession. While this classroom is a bit different from a company, we should hold ourselves to the same standard codes of conduct. At a company, this would look like carefully checking your calculations, informing clients if something is unsafe, and accepting responsibility for your actions. In the classroom, this looks like attempting each homework problem, paying attention and asking questions during class time, learning from your mistakes, and so on:

For the Students	For the Instructor
• Be present and on-time to class • Be respectful of others • Participate in class activities • Submit original and high-quality work • Put forth your best effort given your capacities • Be accountable for your portion of work in team settings • Advocate for yourself and your needs by communicating with the instructor in a respectful manner	• Be well-prepared for class instruction • Use data-driven teaching techniques • Give thoughtful and timely feedback • Use inclusive language and celebrate diversity in the classroom • Provide course-related and career-related resources • Provide a safe and positive learning atmosphere • Be mindful of students' needs while respecting her own boundaries

What does a respectful manner mean?

If you are making an earnest effort in the course, I will do everything in my power to help you. However, I am not going to be accessible 24/7 through email. Emails sent after 5 PM CST will not be returned until at least the following business day. I will try my best to get a response back to you within 24 hours. When sending emails, please include a greeting and signature in the email text. In the subject line, include "CHEN 201" and a brief descriptor of your message. Always address your instructors as "Professor *Last Name*" or "Dr. *Last Name*" unless told otherwise.

Course Materials

Required Text

R.M Felder, R.W. Rousseau, and L.G. Bullard, *Elementary Principles of Chemical Processes*, 4th Edition.

Course Grading and Assignments

CHEN 201 uses the A-F (non-contract) grading system. Grades will be assigned as follows: A > 93; A- = 90-93; B+ = 87-89; B = 84-86; B- = 80-83; C+ = 77-79; C = 74-76; C- = 70-73; D+ = 67-69; D = 64-66; F < 63.
Participation in the class will be considered to round up grades when calculating final scores. Grades will *never* be rounded down.
Your grade will be determined as follows:

- **Homework assignments (40%, lowest two grades dropped):**
  There will be approximately nine homework assignments in this course, spaced out roughly once a week. Homework assignments will be posted on the Canvas page at least one week prior to the due date. Your solutions need to be submitted to the **CHEN 201 mailbox on the due date before 4 PM CST**. Please print out Excel sheets if needed. The CHEN office closes at 5 PM, so be sure to submit your homework on time for collection. **Late homework assignments will only be accepted without penalty if you communicate your needs in advance**. Please email me if you need more time at least 12 hours before the 4 PM on the due date following the email guidelines in the expectations section.

  Strategy for Learning: You will be provided with the solutions to the assigned problems 24 hours prior to the deadline. Despite being provided the solutions, you must submit **your own solution set** which should be different than the solution set I provide for you. Engineers do not work alone – we all need some help sometimes. However, you are still expected to do your own work and **not plagiarize** the solutions. The provided solution sets should serve as hints for you to guide you if you get stuck, **not** as an answer for you to copy down.

  Strategy for Success: Skim through the homework assignment once it is posted on Canvas. Consider going to office hours if you are not sure about what a particular problem is asking for. Attempt each homework problem before looking through the solutions for a hint. To distinguish your solution from the provided solution set, add more information! Be clear about the assumptions you make, what your variables are, and why you are using certain values to solve the problem. This will demonstrate to me that you put in a sincere effort into this assignment.

- **Final project and peer review (30%):**
  You will be creating a presentation on a notable chemical engineer and designing a simple mass and/or energy balance problem around their area of expertise. You will also need to work through the problem with the class and explain why you designed the process that you chose. I strongly recommend you to review AIChE's features of diverse engineers as a starting point (i.e. this series on featured LGBTQ+ engineers). No more than two students per class will be highlighting the same engineer. I will send out a Google sheet for you to submit the engineer you would like to feature and to see if others have already chosen that engineer. Prior to the final presentation date, you will be submitting an outline of your presentation and a process flowchart. You will also be peer reviewing another classmate's work following a rubric that will be posted on Canvas.

- **Midterm exams (20%, lowest grade dropped):**
  There will be three midterm exams during lecture periods and I will drop the lowest grade when calculating your final score. The exams will be open-book and open-notes, but I **strongly recommend making a reference sheet** with important equations, concepts, and

diagrams. This will not only help you study, but will also save you time wasted on flipping through your textbook to find the right equation. You are also expected to bring your own calculator to each exam. Since the lowest grade is dropped, there will be **no makeup exam**. Please contact me if you need to miss two exams or more.

- **Participation (10%):**
  There will be weekly ten-minute, closed book/notes, quizzes in lecture on Thursdays that will be ungraded, but still collected. These quizzes will assess your knowledge of the week's content but will also provide space for you to give feedback on the course and my instruction. Attending class and submitting these quizzes will count toward your participation grade.

Policies and Practices

Ethics and Inclusivity Statements: We acknowledge that the University of Minnesota Twin Cities is built within the traditional homelands of the Dakota people. It is important to acknowledge the peoples on whose land we live, learn, and work as we seek to improve and strengthen our relations with our tribal nations. We also acknowledge that words are not enough. We must ensure that our institution provides support, resources, and programs that increase access to all aspects of higher education for our American Indian students, staff, faculty, and community members. We embrace a notion of intellectual community enriched and enhanced by diversity along a number of dimensions, including race, ethnicity and national origins, gender and gender identity, sexuality, class and religion. We are especially committed to increasing the representation of those populations that have been historically excluded from participation in U.S. higher education. This course also affirms people of all gender expressions and gender identities. If you prefer to be called a different name than what is indicated on the class roster, please let me know. Additionally, feel free to correct me on your preferred gender pronoun. If you have any questions or concerns, please do not hesitate to contact me.

Mental Health: It's OK to not be OK. Please get the resources and support you need to stay mentally healthy. University services are available to assist you. Learn more about the broad range of confidential mental health services, including both counseling and asynchronous wellbeing programs, offered both on campus and virtually through the Student Mental Health Website.

Disability Accommodations: I respect that each student has their own learning needs and we will work together to dismantle the notion of what a "respectable student" looks like. If you need time during class to eat, decompress, listen to white noise, or other things to help you stay engaged in class, all I ask is that **you are mindful of your classmates needs as well**. This would look like wearing appropriate headphones, refraining from making rude comments in class, or sitting close to the exit if you know you will need to leave during the class time. The University views disability as an important aspect of diversity, and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you have, or think you have, a disability in any area such as, mental health, attention, learning, chronic health, sensory, or physical, please contact the DRC office on your campus (UM Twin Cities - 626.1333) to arrange a confidential discussion regarding equitable access and reasonable accommodations.

- Students with short-term disabilities, such as a broken arm, can often work with instructors to minimize classroom barriers. In situations where additional assistance is needed, students should contact the DRC as noted above.
- If you are registered with the DRC and have a disability accommodation letter dated for this semester or this year, please contact me within **the first three weeks of the course** to review how the accommodations will be applied in the course.
- If you are registered with the DRC and have questions or concerns about your accommodations please contact your drc@umn.edu

Scholastic Dishonesty: I understand the pressures you all face during the academic semester can be intense, and that the temptation to engage in academic dishonesty can at times be high. However, the department is committed to the highest standards of academic honesty and integrity. You are expected to do your own academic work and give credit where it is due (i.e. cite sources in your final presentation). Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. The Office for Community Standards (OCS) has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty. If you have any questions about whether something is scholastic dishonesty or not, please contact me and ask.
If a student is found to have engaged in academic dishonesty, the following will occur:

1. I will present the student with evidence of the scholastic dishonesty in a one-on-one meeting.
2. The student will have the opportunity to respond, in accordance with the policy from the Office for Community Standards.
3. If I have found that the dishonesty has not occurred, no report will be made to OCS and no sanctions will occur.
4. Otherwise, the case will be referred to OCS and the following sanctions will occur:
    a. If the academic dishonesty is confined to a single examination and the student has admitted fault, the student may be given the option to take an oral examination or closely proctored written examination to demonstrate their understanding of the material on the exam where they engaged in academic dishonesty. The grade on that supplemental exam will, at most, replace the original exam grade. If the student fails the supplemental exam, they will receive an F in the course. The decision to offer a supplemental exam is at the instructor's discretion. In the absence of a supplemental exam, the student will receive a grade of zero on the exam in question. In either case, the student will receive a grade no higher than a C- in the course.
    b. If the academic dishonesty is confined to a single examination and the student challenges the finding of academic dishonesty, the case will be referred to OCS with a sanction of an F in the course.**
    c. If academic dishonesty extends beyond a single exam to an additional exam or homework, the program policy for sanctions is that the student receive an F in the course.**
    d. If the academic dishonesty is not related to an exam, the sanction will be determined by the instructor.**

** In all cases, students may challenge the findings of academic dishonesty, in which case the disagreement will be resolved by OCS

Regrading of Exams and Homework: You will be allowed to submit request for regrading within **48 hours** of the grade being returned to you. You will not be able to request a regrade after this deadline. The request should be made verbally either after class or in office hours or in writing through email. For an email request, please indicate the possible error. I am happy to make reasonable adjustments but discourage nitpicking or grade grubbing. Submitting an altered exam or problem for regrading is **scholastic dishonesty** and can result in an "F" for the course.

Sanctuary Class: CHEN 201 is a sanctuary class. Recent hateful rhetoric and policies have moved me to protect you all to the best of my ability, and this start with making this class a safe space for learning for all students. Fortunately, the University of Minnesota supports being a sanctuary campus. A sanctuary class means that I won't help law enforcement officials in the marginalization, exclusion, or deportation of undocumented students, colleagues, or staff. I will vigorously defend against bullying and harassment of those targeted for any aspect of who they are.
If ICE finds its way to our door, I'll 1) ask what they are there for; 2) ask for identification, and; 3) ask to see and inspect a warrant signed by a judge. If the agent fails to produce the warrant, or if it's defective, I will state, "I don't consent to your entry." These agents are not entitled to the immigration status of my students and I will put my best effort into keeping you all safe.

Statement References:
Prof. Anna Marie LaChance from the University of Massachusetts at Amherst's STEAM Zine Syllabus (Ethics and Inclusivity statements)
Prof. Matthew Neurock from the University of Minnesota's CHEN 3102 Syllabus (Scholastic Dishonesty statements)
Prof. Ron Bishop from Drexel University's COM 160 Syllabus (Sanctuary Class statements)

UMN Policies

Student Conduct Code: The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

As a student at the University you are expected to adhere to Board of Regents Policy: Student Conduct Code. Please review the Student Conduct Code.

Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach and/or a student's ability to learn." The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities.

Use of Personal Electronic Devices in the Classroom: Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also

for other students in the class. To this end, the University establishes the right of each instructor to determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference the guidelines for student responsibilities.

Scholastic Dishonesty: You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. If it is determined that a student has cheated, the student may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please reference the guidelines for instructor responsibilities.

The Office for Community Standards has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty. If you have additional questions, please clarify with your instructor for the course. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class, e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam.

Makeup Work for Legitimate Absences: Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see the policy on makeup work.

Appropriate Student Use of Class Notes and Course Materials: Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please reference the guidelines for student responsibilities.

University Grading Scales: The University has two distinct grading scales: A-F and S-N.

A-F grading scale: The A-F grading scale allows the following grades and corresponding GPA points:

Grade	GPA Points	Definitions for undergraduate credit
A	4.000	Represents achievement that significantly exceeds expectations in the course.
A-	3.667	
B+	3.333	
B	3.000	Represents achievement that is above the minimum expectations in the course.
B-	2.667	
C+	2.333	
C	2.000	Represents achievement that meets the minimum expectations in the course.

C-	1.667	
D+	1.333	
D	1.000 -	Represents achievement that partially meets the minimum expectations in the course. Credit is earned but it may not fulfill major or program requirements.
F	0.000	Represents failure in the course and no credit is earned

S-N grading scale: The S-N grading scale allows for the following grades and corresponding GPA points:

Grade	GPA Points	Definitions for undergraduate credit
S	0.00	Satisfactory (equivalent to a C- or better)
N	0.00	Not Satisfactory

For additional information, please refer to the policy on grading and transcripts.

Sexual harassment, sexual assault, stalking and relationship violence: The University prohibits sexual misconduct, and encourages anyone experiencing sexual misconduct to access resources for personal support and reporting. If you want to speak confidentially with someone about an experience of sexual misconduct, please contact your campus resources including the Aurora Center, Boynton Mental Health or Student Counseling Services. If you want to report sexual misconduct, or have questions about the University's policies and procedures related to sexual misconduct, please contact your campus Title IX office or relevant policy contacts.

Instructors are required to share information they learn about possible sexual misconduct with the campus Title IX office that addresses these concerns. This allows a Title IX staff member to reach out to those who have experienced sexual misconduct to provide information about personal support resources and options for investigation. You may talk to instructors about concerns related to sexual misconduct, and they will provide support and keep the information you share private to the extent possible given their University role. For more information, please refer to the policy on sexual harassment, stalking, and relationship violence.

Equity, Diversity, Equal Opportunity, and Affirmative Action: The University provides equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, membership or activity in a local commission created for the purpose of dealing with discrimination, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult the Board of Regents Policy.

Disability Accommodations: The University views disability as an important aspect of diversity, and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you have, or think you have, a disability in any area such as, mental health, attention, learning, chronic health, sensory, or physical, please contact the DRC office on your campus (UM Twin Cities - 626.1333) to arrange a confidential discussion regarding equitable access and reasonable accommodations.
- Students with short-term disabilities, such as a broken arm, can often work with instructors to minimize classroom barriers. In situations where additional assistance is needed, students should contact the DRC as noted above.

- If you are registered with the DRC and have a disability accommodation letter dated for this semester or this year, please contact your instructor early in the semester to review how the accommodations will be applied in the course.
- If you are registered with the DRC and have questions or concerns about your accommodations please contact your (access consultant/disability specialist).

Additional information:

Crookston - https://www.crk.umn.edu/units/disability-resource-center, myers062@crk.umn.edu
Duluth - http://www.d.umn.edu/disability-resources, access@d.umn.edu
Morris - http://www.morris.umn.edu/academicsuccess/disability/, hoekstra@morris.umn.edu
Rochester - http://r.umn.edu/student-life/student-services/disability-resources, sdzavada@r.umn.edu
Twin Cities - https://diversity.umn.edu/disability/, drc@umn.edu)

Mental Health and Stress Management: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website.

Academic Freedom and Responsibility: Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.*

Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost (reach out to me for these contacts).

* Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".

Course Schedule

Week	Date	Topic	What's Due?
1	Sep 6	Intro, Syllabus, Course Policies & Procedures	
	Sep 8	Engineering Calculations	HW1
2	Sep 13	Processes & Process Variables	
	Sep 15	Fundamentals of Material Balances	HW2
3	Sep 20	Degrees of Freedom and how to use Excel	
	Sep 22	Material Balances: Single-Unit Processes	HW3
4	Sep 27	Material Balances: Multiple-Unit Processes	
	Sep 29	Material Balances: Multiple-Unit Processes + Review	HW4
5	Oct 4	**Midterm Exam 1**	
	Oct 6	Material Balances: Reactive Systems	
6	Oct 11	Material Balances: Reactive Systems	
	Oct 13	Material Balances: Reactive & Combustion Systems	HW5
7	Oct 18	Material Balances: Reactive & Combustion Systems	
	Oct 20	Single-Phase Systems: Ideal Gases	HW6
8	Oct 25	Multiphase Systems: Single Component Gas-Liquid	
	Oct 27	Multiphase Systems: Single Component Gas-Liquid	HW7
9	Nov 1	Final Project Discussion + Review	
	Nov 3	**Midterm Exam 2**	
10	Nov 8	Multiphase Systems: Multicomponent Gas-Liquid	
	Nov 10	Multiphase Systems: Multicomponent Gas-Liquid	HW8
11	Nov 15	Fundamentals of Energy Balances	
	Nov 17	Energy Balances: Thermodynamic Data Tables	HW9
12	Nov 22	Energy Balances: Steam Tables	
	Nov 24	NO CLASS – HAPPY THANKSGIVING!	
13	Nov 29	Energy Balances on Nonreactive Processes + Review	Project Outline
	Dec 1	**Midterm Exam 3**	
14	Dec 6	Energy Balances: Single-Phase, Nonreactive Systems	Peer Review
	Dec 8	Energy Balances: Phase Change Operations	
15	Dec 13	Final Presentations	
	Dec 15	Final Presentations	

Example Laboratory Design in Physics for the Fine Arts

As part of my completion of the Preparing Future Faculty Program at the University of Minnesota, I co-taught Physics for the Fine Arts at Augsburg University. This class primarily served non-STEM majors and fulfilled the Quantitative Reasoning course requirements. I designed a new lab on the forces of stage design and included critical thinking questions rooted in engineering ethics. I co-wrote a working paper with my mentor, Professor Moumita Dasgupta, and presented it at the ASEE Midwest Section Conference.

Stage Design: Force Body Diagrams and the Normal Force

Materials for each group:

- Metal track with adjustable height on one side
- Angle detector (protractor)
- Digital Scale
- Two weights: 100 g and 500 g

Imagine that you're a stage designer and you're trying to determine how much force your raked stage can withstand. Use the following experiment to estimate the change in measured force depending on the angle of the stage.

1. Place the electronic scale securely on the track (match the rubber feet to the grooves in the track) and place the 100 g mass on it. Record the mass in the table below (angle = 0).

2. Tilt the track such that the angle detector reads 10 degrees. Record the new mass readout.

3. Tilt the track to 10, 15, and 20 degrees and record the new mass readout in the table at the end of the worksheet for each tilt angle.

4. Calculate the theoretical mass of the 100 g weight using the following equation:
   Calculated mass = m_0*cos(angle)
   where m_0 is the recorded mass when the angle is 0 degrees. Make sure that you are calculating the cosine in degrees and not in radians!

5. Calculate the difference in the recorded and the calculated mass by subtracting one from the other. How different are the recorded mass and the calculated mass? If they are different, what could explain the difference?

6. Repeat steps 1 - 5 with the 500 g weight. How different are the recorded mass and the calculated mass? If they are different, what could explain the difference?

100 g Mass			
Angle	Recorded Mass (g)	Calculated Mass (g)	Difference in Mass (g)
0	m_0 =		
10	m_{10} =		
15	m_{15} =		
20	m_{20} =		

500 g Mass			
Angle	Recorded Mass (g)	Calculated Mass (g)	Difference in Mass (g)
0	m_0 =		
10	m_{10} =		
15	m_{15} =		
20	m_{20} =		

– – PAUSE HERE FOR LECTURE PART TWO – –

7. Draw a force body diagram of the 100 g (0.1 kg) mass on the 15 degree inclined plane. Clearly label the normal force (F_N), the force of gravity (F_g), and the force of friction (F_f). Use the following table to calculate each of the forces. Assume the friction coefficient (μ) is equal to 0.3.

F_g = Mass * 9.8 m/s^2	N
$F_N = F_g * \cos(\text{angle})$	N
$F_f = \mu * F_N$	N

8. (Not related to problem 7): As a stage designer, you need to choose the right stage material that can handle the weight of your performers. You want a stage that has a 5 degree incline. The cheapest material available to you can only withstand 5,000 N of force. Assuming your dancers weigh around 60 kg (60,000 g) on average, how many performers can safely stand on your stage? Be sure to show your work.

9. Consider the ethical and design implications of a raked stage. What is the largest tilt angle you would design? Why did you choose this angle?

Example STEM Outreach Worksheet for Eureka! Camp

This worksheet was designed as part of the Eureka! Camp for middle school girls. I co-designed and led this hour-long workshop on polarized light art for two years. The workshop began with a brief presentation, including a team activity, then transitioned into a scaffolded exercise that taught students how to make their own piece of artwork that can be seen using polarizer films.

Polarized Light Art

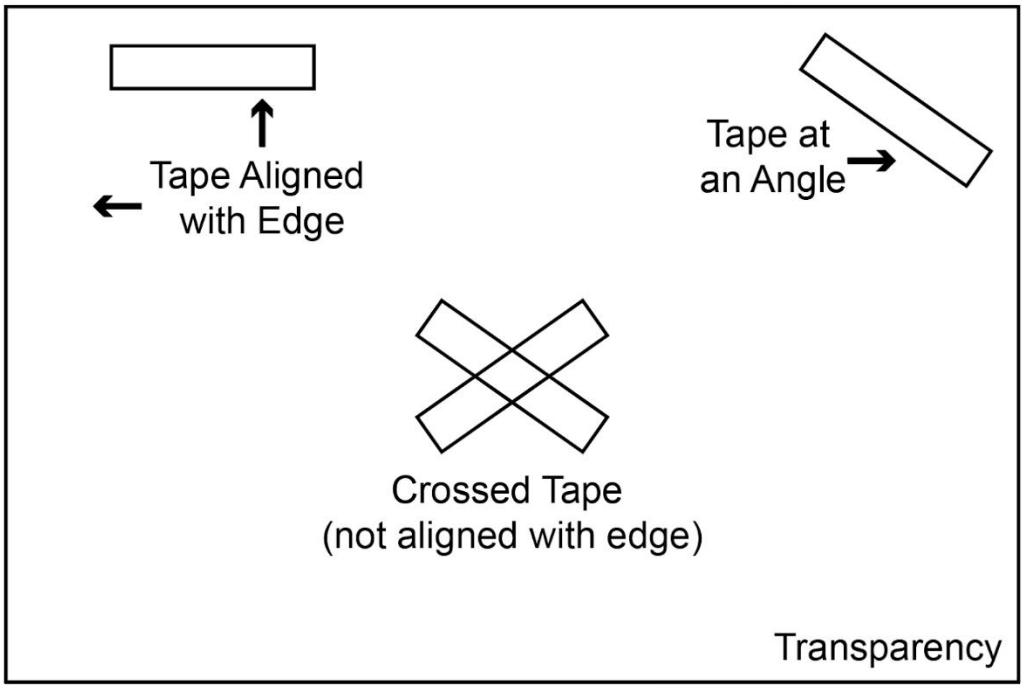
What is polarizer? A material that filters light waves vibrating in many different directions so only light waves vibrating in one direction pass through.

Why is it useful / where is it used? Polarizers are used all around you, from sunglasses that help prevent reflections off of bodies of water to the screens of your devices. They can even be used in microscopes by forensic scientists studying small pieces of evidence and matching where they came from, or by materials scientists looking for regions of stress in plastic or glass products.

Activity

Materials that act as polarizers can also be used to create works of art! Today, you will be thinking like a scientist to determine how layers of packing tape can create different optical features, and then applying what you learn to make a piece of art that is only visible under polarized light.

Please work through this worksheet with your partner in the first 10 minutes of the activity time. When you are done, show it to the instructors to receive a transparency to make your piece of art.



1. Put one strip of transparent tape on your transparency that is aligned with the edge of the transparency. Hold this up to the light with one polarizer in front of the transparency and one polarizer behind. What do you notice?

2. Now put a piece of tape on your transparency at an angle (not aligned with the transparency edge). How does this change what you see?

3. Now put a second strip of tape directly on top of the tape from **step 2**. What changed?

4. Add a third strip of tape to the stack from **step 3**. What do you notice?

5. Now make an X with two pieces of tape making sure neither piece aligns with the edges of the transparency. What do you see?

6. When you are done, show this completed worksheet to the instructors to get a fresh transparency for creating your work of art!