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Return to the Teaching Trenches — Lessons Learned, and Lessons Relearned

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Return to the Teaching Trenches – Lessons Learned, and Lessons Re-Learned: An Autoethnographic Study

Introduction

An academic career may involve a semester or even years away from the classroom as one pursues research or enters administration. Unlike a sabbatical, where you may engage students while expanding relationships in industry or another university, returning to the classroom after a while in an administrator role has challenges and opportunities. This paper describes some of my experience as a veteran administrator who recently returned to the classroom after nearly a decade away and shares lessons learned that I hope new educators find valuable.

My early academic career was focused almost entirely on teaching and advising. For more than a decade, each year, I taught over a thousand students. In addition, I supervised nearly a dozen graduate students to deliver the core 2nd-year statics and mechanics of materials courses at an Eastern University in the United States. Even though the fundamental principles of mechanics didn’t change, I would continuously update my course structure and activities based on an improved understanding of effective pedagogy and student feedback, conducted learning outcome studies with my students, and regularly presented at ASEE on relevant teaching topics. In January 2014, I moved into a full-time administrative role focused on undergraduate student support that did not include teaching responsibilities. But the itch was always there, so in the Fall of 2022, I volunteered, on top of my administrative responsibilities, to teach a 90-student section of mechanics of materials.

This paper aims to provide lessons learned, highlight some teaching techniques that work, convey class management advice, and tips on balancing priorities when teaching is not your only responsibility. But as I began to put the details together, I realized that given the wide range of institutions and content areas of the audience for this paper, the broad-stroke perspectives toward teaching and classroom management would likely be more beneficial than a highly detailed litany of content and classroom decisions I made for my course last semester. In writing this paper, I hope my observations will provide insight and inspiration that new engineering faculty can use as they dive into this wonderfully fulfilling world of teaching.

Theoretical Framework

A reflective teaching framework guided the framing of this article. In this adopted reflective framework, the instructor “focuses on themselves, their beliefs, and personalities, and how these inform their classroom practices.” [1, p. 3]. In addition to this, the evocative theoretical approach to autoethnography in which the author carries out a systematic self-introspection and recall of their personal story is adopted in this study[2], [3]. Auto-ethnographers recall their lived experience to understand and relate them [3].

When writing this article, the first author reflected on her classroom experiences of what pedagogical strategies have worked in the classroom. To further explore the first author's lived teaching experience, a team member with pedagogical and engineering education expertise utilized participatory design in constructing a meaningful lived teaching experience of the author from which new faculty can benefit. This took the form of semi-structured conversation and questioning investigating other evidence-based pedagogical practices the instructor has successfully implemented in the classroom.

Methodology

This article can be characterized as an autoethnographic study. In autoethnography, the researcher relates their lived experiences[4], and provides "highly personalized accounts that draw upon the experiences of the author/researcher to extend sociological understanding"[5, p. 21]. Autoethnography, otherwise known as critical autobiography, is based on two assumptions. "First, that it is possible to learn the general form from the particular; and second, the self is a social phenomenon. In which my subjectivity is filled with other people's voices".[6, p. 5]. In this context, the first author relates her lived teaching experiences with the hope that new faculty will learn from them, knowing that the experiences and related practices that have worked for her in the classroom are replicable since they are evidence-based practices. Readers should note that autoethnographies are written in first person[3]. It is hoped that new faculty will find this article as a go-to manual as they navigate their journey in engineering education.

Result

When I reflected on my return to teaching and the various things that went well and the things that fell flat, the following themes emerged as very important. The themes were

- Avoid Perfectionism (manage time)
- Keep it Simple (limit complexity)
- Engage in Positive Help-Seeking (leverage resources)
- Employ Good Educational Practices

Theme 1: Avoid Perfectionism

Perfectionism is setting an extremely high-performance standard, excessively critically evaluating one's effort, and seeking flawlessness [7]. The impact of perfectionism has been seen as positive, negative, and mixed in literature[8], [9]. While, perfectionistic striving has been seen as healthy; perfectionistic concern has been seen as unhealthy[9]. When faculty insist on perfection, it often prevents implementing good educational practices. The 80-20 rule (also known as the Pareto principle) applies to teaching when trying to reach 'perfection'. If you consider the amount of time it would take to make a whole course or even an individual course component 'perfect', and determine that you could achieve an outcome that is 80% there in a short amount (20%) of the total time, the choice becomes either spending the remaining 80% of time completing the 20% needed to reach perfection or spending that additional 80% time building 4 other things to a level that is 'almost' (80%) perfect. Instructors must pay attention to how they manage their time, to ensure they are spending time on activities that make the most difference for their students.

In my early career, I was working part-time with teaching as my only professional responsibility, giving me the luxury of focusing my time on just two things: preparing for class and working with my partner to raise our young children. In hindsight, I'm sure I spent too much time refining the details of each class presentation where the extra time made me feel better about the class delivery but probably didn't add a proportional amount of benefit to the students.

In stark contrast, during my return to teaching last semester I had a more than full-time set of administrative responsibilities and my mind had significantly underestimated the amount of time I used to spend preparing for each class. So, I was routinely forced to choose between sacrificing sleep in the wee-hours or telling myself that what I had just prepared was 'good-enough.' And now reflecting on the nights I stayed up late to move the needle from 'good-enough' toward 'perfect,' I seriously doubt it made a significant difference in what the students got out of the class activities the next day.

I suspect that most of you reading this paper have arrived where you are because you work very hard and have exceptionally high standards for the quality of what you produce. And I hope you are enthusiastic about being in the classroom, with all kinds of creative ideas of how to engage students and excite them about learning, reading about different elements you could incorporate into your class, remembering the times as a student when you said to yourself 'I really loved how my teacher did …' or 'If I ever teach, I will definitely change ….' But be mindful of your own professional and personal time constraints to prioritize which things to try now and which things to try next time. And remind yourself that many times "good" is good enough. Sometimes the price of spending the time to move things from good to great is too high when that choice has the potential to detract from activities that also need to take priority, particularly in the early years of your career (like writing the research proposal that will get the grant that will enable you to get tenure, or spending that time with your kids before bedtime making memories of reading stories and singing songs that will last significantly longer than the length of a semester or the tenure clock) [10].

Theme 2: Keep It Simple S___ (KISS)

The KISS principle states that design works best when it is simple rather than complex. Other variants include "keep it short and sweet", "keep it short and simple". This principle has been used in various domain including scientific reasoning, arts, software development, and survey design [11]. The following is the narration of how I applied the KISS principle in designing and instructing my course.

Emphasize course objectives rather than 'topics to be covered.'

In the frantic fray of preparing to teach, especially the first time, it is easy to get caught up in 'delivering content' or 'covering topics,' which almost always is a list longer than there is time for in the semester. Rather, focus the course on a core set of objectives that can be phrased as 'by the end of this course; students will be able to ….' This will help simplify decisions for the entire semester, from what activities to do during class and what homework to assign to what kind of questions you put on your assessments, leading to a much more impactful experience for your students [12].

Provide this list of objectives in an easily accessible place for your students (such as on the course management system). Clearly convey to your students at the start of the course and throughout the semester that these objectives are driving all your course decisions. Highlight at the start of each unit, each week, or even each class which objective(s) are to be supported by the activities and homework problems. And remind them that these objectives tie directly to what you will ask them to do on exams and projects and will drive how you weigh things in your grading rubrics. By doing this, you clarify to students why they are doing what they are doing and what to study. For example, when they ask, 'What will be on this exam?' you can say, 'This exam will test you on objectives 4, 5, and 6.' Using objectives as a study guide to students increases the probability that students will learn the objectives[10]. Through this practice, you are not only clarifying how students prioritize their time for your course, but you are also simplifying and focusing your work in creating the assessments and activities. In addition, clear objectives allow you to describe "intended learning outcomes in performance terms"[13, p. 35].

Create a course structure that supports diverse learners.

Having a course where you only have one exam and a final, and no other means to incentivize student engagement and evaluate student outcomes, might simplify your life as the instructor but is not a good design to support learning. From my past years of teaching experience, I knew that some students would benefit most from reading the book, others would benefit most from doing additional problems, and still others would benefit most from coming to tutoring. Designing a course structure that respects diverse learners has been suggested in the literature [14]. My initial thought on the fall semester course design was to require each student to complete all elements for the first three weeks to give each student the opportunity to recognize which element(s) were most helpful to their individual learning. Then in week four, I would shift the structure of the course points to allow students to pick and choose what element(s) work best for them. In theory, this sounded great. But in practice, when I tried to write the syllabus and to program this grading structure into the course management system, I realized that it was far more complicated than it needed to be.

Ultimately, I kept multiple ways for students to earn out-of-class points (completing guided reading assignments, doing additional problems in an area they struggled to complete on the assigned homework, or attending a tutoring session). I allowed students to start the semester choosing freely from the list of activities, requiring just one activity to be completed to receive the out-of-class participation points for that week. Giving students the autonomy to choose is implementing self-deterministic theory in the classroom. The theory of self-determination postulates that when students take autonomy of their learning and perceive themselves as originator, they are more motivated to learn [15]. In addition, this decision created simplicity in how points were earned but retained flexibility for the students to choose what they felt best supported their learning.

I also decided to give every student the ability to drop the three lowest weeks from their participation and homework scores to simplify the student's ability to manage their priorities through the semester and to simplify my time in dealing with individual situations that might warrant an exception. This choice was also supported by the rationale of prioritizing students learning over grading. Grading in itself is to track student learning, and an indicator of improvement in areas where the student learning is lagging [16].

Set clear expectations regarding the tasks and expected time commitment (Education practice).

[14] noted that setting a clear and high expectation, and emphasis on time commitment on tasks is an educational practice faculty should adopt in the classroom. Another way to avoid complexity is to clearly convey to yourself and your students why you have incorporated each element of the in-class activities and out-of-class assignments. If you don't have a clear reason for including a particular element, maybe it isn't necessary.

Support academic integrity by being clear about how you expect each task to be completed.

- Articulate how your 'rules' for completing one type of assignment might be different from your expectations on how they complete a different type of assignment. (You might encourage them to use on-line tutorials to understand a concept while completing the homework but expect them to solve the take-home exam questions without using any physical or digital resources.)

- It is also important to acknowledge that your expectations could be different from the expectations of their other course instructors. (When you say 'you can solve this together but turn in your own work' you might mean that they can talk about general ideas, but must each do their own calculations separately, while another instructor might mean they can work through all the details as a group, but each student has to turn in their own copy).

In my syllabus, I created three sections for each element of the course describing 1) what they were expected to do, 2) how they were expected to complete each task (with integrity), and 3) why they were expected to complete each task (See Appendix A)

Recognize that students have multiple classes, not just yours, and many different things are going on in their life. This doesn't mean you avoid having reasonable standards for attention to your course, but you will save them and yourself much trouble if you structure things in a way that makes it clear for them to follow and flexible to accommodate their different schedules and learning styles. Therefore, my syllabus/course included the following:

- An example weekly schedule to clarify the expectation of 9-12 hours per week devoted to my class while indicating flexibility as to when they would do the work.
- Regular cadence of deadlines and reasons for those deadlines.
- Partial credit incentive (rather than zero credit) to complete and submit work past the deadline.
- A few automatic 'free-pass' drops to accommodate reasons they may need to miss class and/or miss an assignment.

Theme 3: Engage in Positive Help-Seeking

Most of you will start teaching something that many others have taught before, not just at your institution. So why would you start from scratch? Do not try to do it alone; it is an ineffective approach [10]. Instead, before the semester, gather input and ideas from others who have taught the course (the ASEE conference is an excellent place for this!) and professionals at your school designated to support good teaching practices.

I had a great resource from my institution's office of digital learning, the college of engineering. I leveraged this resource for advice on setting up my class's Canvas course management site. The last time I taught, we had an entirely different course management system. And while I could have read several articles on the best practices for using Canvas, the learning designer from this in-house resource provided direct and targeted guidance on best practices and saved me significant time in getting ready for the semester. I encourage you to seek out similar local resources at your institution. Likely there are people in such units who help you get off to the best start possible.

I also talked to colleagues pursuing an advanced degree about what elements of their course structure helped vs. hindered their learning. As a result, I receive some very straightforward advice about how to structure the materials in the course management system to enhance access and learning of my students most effectively.

In addition, when I taught, I was lucky enough to be paired with a faculty member who taught the course last year and I could emulate many of the things (like sequence of topics and selected HW problems) he had used the previous year for the course. I came in with many pie-in-the-sky ideas about how to modify the course. Some he was open to adopting (such as using the textbook publisher's homework submission software), and some he questioned (such as the plan mentioned earlier to overly constrain at the beginning of the semester how students would conduct their work) which, upon reflection, were over the top either violating the 'Keep It Simple' philosophy and/or created significant additional time and violated the 'Don't let Perfect be the Enemy of Good' approach. I believe listening to each other was valuable to both of us, for me to temper my enthusiasm to modify a lot of different things and for him to try a few new things within reason.

Theme 4: Employ Good Educational Practices

In addition to the practices already shared earlier in the sections on course objectives, structure, and student expectations, here are a few additional educational practices that I have found effective in enhancing student learning.

Active learning

Active learning has always been a cornerstone of my teaching philosophy, and I incorporated many of my educational practices again last semester. The use of physical demonstration and interactive concept questions are strategies I have implemented to engender active learning in the classroom. Every week I included at least one physical demonstration using common objects to help students better visualize the physical behaviors of materials we were discussing and learning to analyze. Examples are rubber bands to show axial strain, swim noodles to show torsional deformation, and spaghetti to show buckling modes.

Early in my teaching career, inspired by Eric Mazur's book "Peer Instruction" [17]. I incorporated interactive questions into nearly every class period. Using four different colored index cards, each with a single letter: A, B, C, or D, students would answer multiple choice questions by holding up the card indicating their answer. Based on the colors of cards I saw from the front of the 200-seat classroom, I could get a sense if a significant number of students were still confused by a particular concept. And if they were, I could remain on that topic longer. And if they were not, I could move on to the next topic. It was not only helpful for me to see that groups of students did not understand the concept, but it was also validating and empowering to the students who were confused with having confirmation that others in the class were confused as well so they did not feel so alone and would be more confident about asking questions for clarification.

Over the years, I transitioned to several different personal response systems (clicker systems) and, last semester, used the web-based TopHat system to capture the results of these interactive questions. These systems provide the benefit of allowing students to answer privately without worrying that others around them would see whether or not they had chosen the correct answer. And once a question was completed, these systems allowed me to project a chart of the answers provided, which I often used as a springboard for conversation about the underlying misconceptions that would lead someone to choose one of the incorrect answers. Using this technology to facilitate student learning has proved beneficial [10], [12].

Cooperative Group Learning

Cooperative learning has been suggested as an excellent instructional practice for teaching STEM in college [10]. Cooperative learning groups during lectures have been noted to help students cognitively process class material and information [17]. Authors have found that cooperative learning promoted academic achievement in terms of student retention, problem-solving, creativity, and metacognition [18]. On many occasions, after asking the question the first time and capturing individual responses, I would tell the students to talk with their neighbor for a few minutes about the question and why they chose their answer, either convincing their classmate why the answer they initially chose was correct or learning from their classmate why the answer they initially chose was not right. Then I would open the question again, after which I would show both sets of results and discuss with the class why their answers changed, ultimately letting them know the correct answer. A few examples of these questions are shown in Appendix B.

Other times, rather than doing an example problem for the students, I would post a question similar to the HW they would be doing that week and ask them to get in groups of 3 to spend 10 minutes laying out the starting points of that problem. The main goal of this activity was to highlight that often getting started on the problem is the hardest part. And for them to identify what types of questions they encounter as they start a problem in a setting where the TAs and I could answer them in real time. Having them struggle a bit and collaborate to identify how to start the problem was often a better use of class time than simply watching me solve a problem from start to finish while they copied down what I wrote. However, they also appreciated having access to the complete solution, which I made sure to post for them after class.

Gather Feedback and Give Prompt Feedback

Muddiest Point

I have always been fond of the Muddiest Point technique of giving students the last minute or two to write down what they are still most confused about from the current topic. In the past, I would collect these on individual pieces of paper and have the graduate assistants spend time compiling and grouping them to produce a report of the most common responses. However, this semester, TopHat allowed me to capture open-ended responses, which I could easily cluster into themes before the next class. When I asked these questions, I would often start the next class with a table showing the result and begin that day's discussion with an example or explanation to help clear up confusion on the most common responses. This was particularly helpful before each exam, where I would list the general topics on the exam and ask students to indicate which topics they felt needed additional attention. Based on that feedback, I would select review problems to present at the next class that addressed the primary concerns.

Mid-Semester Feedback

Nearly everyone conducts end-of-semester surveys, which can provide valuable feedback you can use to improve future course offerings. But this type of feedback only helps future students. It is equally powerful to ask your current students for their input mid-semester while you still have a chance to adjust their experience in your course. When you ask for this input, it is important to acknowledge some of the results publicly and make at least one change based on their feedback to let them know they have been heard. If you ask the right questions (such as 'What element of this course has most enhanced your learning?' as opposed to 'What do you LIKE most about this class?'), you can get valuable feedback from the people you are trying to serve regarding how you are doing.

But take it with a grain of salt because they don't always know what is good for them. For example, in my mid-semester evaluations last semester, many students complained about the Group Problem-solving time, saying that they felt their time was better spent seeing a problem fully solved from start to finish during class. From this feedback, I heard their request for more time in class to see fully worked out problems. But I also knew there was still merit in spending some time on their group work during class. So, I adjusted to cut back and have the group work problems only once per week instead of during every class and replaced the other group work problems with time to work through individual solutions fully. Below is a student comment from the student rating of teaching effectiveness evaluation.

> Class time was generally productive; homework was a fair assessment of content learned in class, exam resources were readily available, and extra help sessions were plentiful. I also appreciated the extremely clear exam grading rubrics to eliminate subjectivity. The Canvas page was well-managed and usually up to date. I learned many topics and techniques throughout the semester. Thank you, Dr. M!"

Student Faculty Interaction

Student-faculty interaction is a highly encouraged educational practice [14]. Class contact, office hour, and question-and-answer session for examination preparation are ways I engender student-faculty interaction. The description of how I do that is written below.

Class contact

I have always worked to create a relaxed and supportive classroom environment. I typically arrive to class early, so I have a few minutes to visit with students before class or be available for questions. Similarly, I set the expectation of valuing the student's time and recognizing that my class is not the only thing they have going on. To demonstrate this core value, I inform students that I set a timer for myself every class period that will go off when the class is scheduled to end. And no matter how critical the thought is that I am sharing at that moment, I stop class so they can move on to their next activity. This practice serves two purposes. First, it significantly reduced the shuffling students would do in the last 10 minutes of class, typically intended to remind the instructor that the period was ending. Second, it increases the likelihood that students will have time to come up and ask questions right after class.

Office hours

I do not plan office hours to check off a box. This is a time meant to be a resource for students who need extra attention to clear up confusion and master the material. I have always tried to arrange my office hours to suit the students' schedules, being mindful that some students have heavier schedules on Tuesdays and Thursdays while others have less availability on Mondays, Wednesdays, and/or Fridays. I also recognize that students are far less likely to attend office hours early in the morning or on Friday afternoons. For this reason, I set my office hours for Tuesdays, 11 am – 1 pm, and Fridays, right after class, from 12:30 pm -2:00 pm. And finally, the physical location of office hours can also make a difference in whether or not students take advantage of this valuable resource. Last semester I held my Tuesday hours in my office to offer a more private setting, but my Friday hours were held immediately after class in the lobby area just outside the classroom. Many students took advantage of this time to stay after class to ask questions. And in the lobby area, if more than one student was staying for help, all could benefit from hearing the questions asked and answers provided to others.

The student's specific questions always guided the conversation during office hours. When the student asks me a question or particularly when they say they have no idea how to start a particular problem, I would rarely just start solving the problem for them while they watched. Instead, I would ask them questions to consider, trying to lead them to discover the answers.

Question and Answer Sessions for Examination Preparation

A week before each exam I would post a set of practice exam questions, pulled from exams I had given in previous semesters. These questions were clustered by a core concept for each topic covered since the last exam (typically 3-4 per concept), one version with just the questions and another version with my hand-written solution. Then a day or two before each exam, I would hold a 2-hour evening exam preparation question and answer session. I specifically did not call these ‘review’ sessions because I was not coming in with any prepared presentation. These sessions were more like group office hours. I emphasized this point by saying that if students came, but no one had any questions, we would end the session early. This approach emphasized that they needed to go to the session with specific questions in mind, meaning they needed to have done some practice work beforehand. There were ALWAYS questions, and rarely did these sessions end early. And quite often most of the questions during these sessions came from students having worked through many if not all of the practice exam questions.

Encourage Procedural Problem Solving

One of the goals of education is to develop proficient students who are on their way to becoming experts [19]. While experts use procedural approach in solving problems, novices uses mean-end analysis [19]. To encourage the expert-like behavior of my students in the classroom, I help students develop an organized approach to problem-solving in general [19]. Throughout all my courses, I emphasize (and often require) that students follow a 5-step process [19].

Read/Define the problem. This involves stating explicitly what they are given (or what is known) and what they are trying to find. I would often remind them that even in simple home problems and especially complex real-world problems, there will be many different things they can calculate and solve for. But they can often waste their time if some of these things are unrelated to achieving their goal.

Plan. Before they write a single equation, they should draw sketches of the relevant parts of their system and plan their path from what they are given to what they are trying to find. Often this planning works better in reverse, particularly for more complicated problems… to find “this,” I need to know “that.” To find “that,” I need to know “the other thing”… When that logic finally reaches back to the point where “the other thing’ is what they were given, the last piece becomes the first step in their plan.

Apply. Along the way of planning, they will identify concepts and equations they need to apply to connect the dots. Tying these concepts and equations (without doing the calculations yet) to the steps in their plan can help them see how everything in their solution ties together before getting bogged down in the individual numbers.

Solve. This is where most students want to start their work but jump in and crunch numbers. But if they work through steps 1-3 first, they will understand the problem and solution better and will be much better able to follow their work and communicate it to others.

Check. I always emphasize that knowing how to confirm a reasonable answer is equally important to solve a problem. This does NOT mean ‘checking’ the answer in the back of the book because real-world problems will not have an answer key. Instead, this can be through doing an alternate calculation, confirming that the sign and/or the magnitude of the answer is reasonable to the physical situation, and/or checking that the answer came out in appropriate units.

Connect Concepts

"Concepts are not words but organized and interconnected knowledge clusters"[12, p. 37]. Understanding is facilitated when instruction is integrated into the learner's previous knowledge by connecting concepts [20]. In Mechanics of Materials, there are three main concepts for every type of problem: Internal Loads, Geometry of Deformation, and Material Relations. And it is the Material Relations that inherently tie Internal Loads and Geometry of Deformation together. Each core unit in a Mechanics of Materials course can be linked to these three concepts. While preparing for the 2011 ASEE presentation on our collaborative development of supplemental learning tools [21], my colleague Cliff Lissenden developed a great graphic to help students visualize this connection. He called this image the Pillars of Strength. I used this image throughout the semester last fall to show these connections with each new topic. Using visuals to provide a course holistic perspective to students and connecting core concepts is termed cognitive maps or content frames [12]. This practice has been encouraged in literature [12]. The evolution of this graphic throughout the semester can be shown in Appendix C.

Conclusion

The big thing to remember when getting input from many different sources is that they are just 'suggestions.' Whether the input comes from colleagues or from teaching best practices literature, this is YOUR class, and you need to stick to what you are comfortable with and not bite off more than you can chew. It is important to continuously expand your knowledge of good educational practices that have been proven effective by others. But know that not every suggestion will fit your comfort level (don't try to be something you are not). And once you have identified a variety of effective teaching techniques that resonates with you, don't try to implement them all in the same semester. Trying too many different things at once will violate the KISS principle and overload you to the point of letting perfect be the enemy of good. Please remember, you have a whole career ahead of you to try different things in your classes. You don't have to try every idea all at once. Not only is this overwhelming, it is not good science because if things go exceedingly well, you won't know which elements to keep, and if things don't go as well as expected, you won't know which items to eliminate.

And finally, seek help from multiple sources; instructional designers at your institution, your peers at ASEE teaching the same subjects, and your past self. If you are in this teaching profession for the long haul, recognize that only YOU genuinely know how the semester went. Be a support person for your future self by reflecting on each semester while it is still fresh. Take time each week (or at least each semester) to dump out a page of bullets about what felt like it went well and what things you would think about changing next time. Don't just limit yourself to the particular topic at hand but also take notes on general teaching practices that can apply to any subject you teach in the future. Break comments into two categories: 1) next time you teach THIS class and 2) next time you teach ANY class.

I hope you have found some of these insights valuable as you head down this path of Engineering Education that I have discovered so wonderfully rewarding. Remember to keep it simple (KISS Principle), don't let perfect be the enemy of good (Avoid Perfectionism), you don't have to do it alone (Engage in Positive Help Seeking) and continue to seek out effective teaching techniques (Employ Good Educational Practices). Please feel free to reach out to the first author if you would like additional details about my recent or past teaching experiences.

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Appendix A – Fall 2022 course syllabus

The Pennsylvania State University
Department of Engineering Science and Mechanics
Fall 2022

E MCH 213 - Strength of Materials - Section 2 – Fall 2022

GENERAL COURSE INFORMATION

Instructor:
Dr. Christine B. Masters (she, her, hers) cbm100@psu.edu
208 Hammond Building

Textbook: Mechanics of Materials 10th edition, R.C. Hibbeler, Prentice Hall

Background:
Engineering Mechanics is the engineering science that relates **Forces** (push, pull) and **Torques** (twists) to the **Motion** (deformation, acceleration, velocity) of bodies. The understanding of such concepts is essential to those who wish to design efficient engineering components ranging from a bridge to a wing strut to a robot arm to the motherboard of a computer. **Statics** is the foundation course in which three stems are constructed; Dynamics (E MCH 212) for motion; **Strength of Materials** (E MCH 213) for deformation and fracture criteria for solids; and Fluid Mechanics. These mechanics courses are founded on modeling engineering components via the **Free Body Diagram**, applying the equations of motion, then solving for the particular set of boundary conditions appropriate to the expected situation.

Course Objectives:
Strength of Materials will provide you with the tools and guidance to allow you to master the use of deformation and stress equations to solve real engineering problems. You should leave this class with the ability to analyze and calculate the stresses at any point in a structural component, determine the deformation of long thin members subjected to stretch, pressure, twist and bending, consider the possibility of buckling for a compressive member and *utilize these to consider if a given loading is "safe" for a particular material.*

Expectations:
- You are expected to have a working knowledge of STATICS, particularly with regard to sketching FBDs and writing and solving equilibrium equations.
- You are expected to devote appropriate time to study and problem solution (approximately two hours for each hour of class, i.e. about ninety hours for the semester.)
- **You are expected to attend ALL scheduled classes and attempt ALL assigned homework.**
- **You are expected to read the specified textbook sections prior to each class.**

Partial Credit Grading:
- Partial credit will be given on exams **only if** your work is clearly organized.
- Problem solutions without **FBD's** (sketches) and supporting calculations will receive a much reduced, or zero, grade. FBD's must be neatly sketched and include all relevant dimensions, forces, and couples.

General Advice:

- **Don't fall behind!** If you need help, see your TA or instructor ASAP.
- The three most important things you can do to be successful in the course are:
  1. Do all the homework problems,
  2. Do **ALL** the homework problems,
  3. Do **ALL** the homework problems.

STEPS TO SUCCEED WITH INTEGRITY IN THIS COURSE:

- **Read:** the textbook – before each class as indicated on the syllabus
- **Attend:** each and every class (that's just 3 hours a week)
- **Practice:** the concepts by working through the on-line tutorials and practice problems
- **Check:** your understanding by completing the assigned HW problems
- **Show:** what you have learned by completing the exam questions

STEPS TO SUCCEED WITH INTEGRITY IN THIS COURSE

1) Read, 2) Attend, 3) Practice, 4) Check, 5) Show

READ (Chapter Reading Assignments)	WITH INTEGRITY	IN ORDER TO…
• Read the assigned textbook sections before each class with the guided reading questions in hand • Enter responses to the guided reading questions as you go along • Start early and do not try to complete it in one sitting! Save as you go along but be sure to SUBMIT before the deadline. NOTE: A saved assignment that has not been submitted will receive no credit.	This means: • Referring only to the textbook • Completing the guided reading independently (I want to know if YOU understand what you're reading, not if your friends do) • Quoting phrases or sentences from the textbook when appropriate and with citation o E.g., place (Hibbeler) at the end of the phrase or sentence that is directly from the text. • Doing all of this yourself (i.e., NOT copying responses from others or having another submit responses for you.)	• Come to class familiar with the next terms and topics. • Inform me of key concepts that need extra attention during lecture. • Identify what you do and don't understand so you can ask questions during class. • Contribute your knowledge to group class problems

<table>
<tr><th>ATTEND (All EMCH 213 classes)</th><th>WITH INTEGRITY</th><th>IN ORDER TO…</th></tr>
<tr><td>Attend and participate in every class, all semester
That’s just 3 hours each week and is the simplest way to support your learning of this subject.
Participation will be measured in several different ways including, group work, clicker responses, and discussion boards.</td><td>This means:
Do NOT miss class unless you have a legitimate conflict, such as being sick, a university trip, a family emergency, or a job interview.
In class use your own device to log attendance and answer interactive questions.
Do NOT send the class code to students who are not in class, or attempt to obtain the class code from someone else if you are not in class.
On group problems, sign your own name and no one else’s.</td><td>See example problems to improve your understanding.
Practice applying the concepts by working through group class problems.
Ask questions to clear up confusion.</td></tr>
</table>

<table>
<tr><th>PRACTICE (supplemental materials)</th><th>WITH INTEGRITY</th><th>IN ORDER TO…</th></tr>
<tr><td>Practice the concepts outside of class by working through suggested tutorials and practice problems.
Your work on these optional assignments will not be graded.</td><td>This means:
Working in groups. Solving practice problems with others outside of class is a very efficient way to learn.
YOU must actively work to solve the problems, don’t just watch others solve the problems or copy down someone else’s steps.</td><td>Practice applying the course concepts
Identify where you have questions about the course content.
Build skills you can use in your career.</td></tr>
</table>

CHECK (Assigned HW problems)	WITH INTEGRITY	IN ORDER TO…
• After reading, attending class, viewing tutorials, and solving practice problems, check your understanding by completing the assigned HW problems • If you earn 100% you are ready to move on to the next topic. If you do not earn 100% get help to find your errors, then re-try the problems. Your 2nd and 3rd trials will have similar questions with different numbers.	This means: • Completing the problems on your own. • Do not reference solutions on-line or from friends for the assigned problems. If you are having trouble with a particular problem, pick out a different problem from the book on a similar topic and use friends and on-line resources to understand that problem. Then return to your assigned HW problem to complete on your own. • Fully write out your work and upload to Canvas so we have a record of the work that led to the answers you submitted.	• Test your understanding. • Identify areas where you need more practice. • Review your written work with a TA or instructor to improve your understanding and skills.

SHOW (Exams)	WITH INTEGRITY	IN ORDER TO…
• Show that you have mastered the course concepts by answering questions and solving problems during exams. • All personal items (book bags, hats, coats, etc.) must be left in the front or the back of the exam room.	This means: • Submit only your own work. Do not look at anyone else's paper during the exam. • Calculators are allowed but do not share your calculator with others. • All exams are closed book, closed notes. We will supply the equation sheet. • Bring your ID to each exam. • During the exam you should only have your calculator, a pencil and an eraser at your desk.	• Demonstrate your knowledge of general problem solving. • Indicate your ability to apply each course concept. • Allow the teaching team to assess what you have learned.

WEEKLY SCHEDULE

On average you should expect to spend 2-3 hours out of class for every hour in class. For a typical 3-credit course (3 in-class hours per week) you should plan on 9 – 12 hours total each week. While there are several different activities associated with this course, you do NOT have to be doing something for EMCH 213 every day of the week. Here is one possible way for you to arrange your time to complete work for this course.

Monday:
1 hr Attend class and ask questions
1-2 hr Work on Monday HW problems, for help view tutorials, try related practice problems.
1 hr Read the textbook sections for the week and complete the Reading assignment

Wednesday:
1 hr Attend class and ask questions
1-2 hr Work on Wednesday HW problems, view Pearson tutorials, go to tutoring

Friday:
1 hr Attend class and ask questions

Friday, Saturday, or Sunday:
1-2 hr Work on Friday HW problems, for help view tutorials, try related practice problems.
1 hr Still short of 100% on HW? see Canvas discussion board, go to Sunday night tutoring
1 hr Re-try problems you missed. Scan all HW problem written work and upload to Canvas

Total time = 9 - 12 hours each week, INCLUDING class time

Top Hat

We will be using Top Hat to facilitate participation and discussion during class. Your answers on Top Hat will also provide the instructors with valuable, real-time feedback regarding your understanding of the course material. Therefore, it will be used during most class meetings.

Top Hat participation is subject to all the rules of academic integrity. Students participating in any activity aimed at gaining participation credit for themselves if they were not present in class or for others who were not present in class will be cited with an academic integrity violation.

Top Hat set-up guide can be found at https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide For assistance with Top Hat registration contact our Support Team directly by emailing support@tophat.com

E-Mail:

If you have an E MCH 213 policy question, first read this syllabus and notices posted on Canvas. If the information you need is not contained in the syllabus nor on Canvas, e-mail the teaching team through Canvas by selecting ‘All Teachers’ and ‘All Teaching Assistants’.
Problems in this course are heavily equation and diagram intensive, making them difficult to explain via e-mail. If you have a question about a problem, bring your work to class, office hours or tutoring. Do NOT send your HW or exam question through an e-mail, as it will not be answered.

GRADING POLICY

Course Grade Calculation

This course content is vital to the determination of an engineering design's success or failure. And truly the only way to learn these concepts is to practice them by working through practice problems.

Course grade assignments will be determined by the following percentages

	Total
Participation (10%) HW (15%), Exam 1(25%), Exam 2 (25%), Final (25%) =	100%

Approximate Grade Distributions:

A's : 90+ B's : 80+ C's : 70+ D : 60+ F : Below 60%

Your final course grade will be determined by your performance without reference to that of your classmates. (i.e. I do not grade on a curve.) So you are encouraged to work with your classmates when solving the homework problems and studying for exams so that everyone can learn the material at a higher level.

Participation

Many elements have been set up in this course to encourage you toward activities that we know will improve your performance and support your work in learning this material. You can think of this 10% portion of your grade as a bucket that can be filled up in a variety of different ways. No single element is sufficient to earn the full 10%. But combined there will be significantly more opportunities to earn participation points than you need in order to fill this 10%. You are encouraged to participate in all the elements during the first few weeks, but then keep going throughout the semester with the elements that help you the best.

Each week will bring the potential to earn 5 total participation points:

- 3 points from in-class attendance and engagement through Top-hat responses (1 point per class meeting)
- 2 points from completing any ONE^ of the optional activities available that week.
  - Take the chapter reading assignment quiz
  - Complete practice problems (try at least 3 problems/tutorials in the Practice Problems Mastering assignment)
  - Attend a tutoring session or visit someone's office hours (the 'week' begins on Monday and ends on Sunday)
  - Completing Adaptive Follow-up assignment (only available if you did not earn full credit on the associated HW assignment)

^ If you complete more of than one of the optional activities in a particular week, it will not add to your total points for that week's participation score, but we will keep track of all the things you participated in each week. And at the end of the course, if you are on the borderline between two letter grades, we will take your extra participation activities into consideration for the final determination of your course grade.

Homework

You are expected to complete every assigned HW problem (typically 3 problems per class), submitting answers on-line through the Mastering Engineering system and uploading a weekly file to Canvas of your written work for all attempts.

The only way to develop your ability to solve strength of materials problems is to practice solving strength of materials problems. To assist you in achieving this goal, each week we will post tutorial, homework, and additional practice assignments on the Mastering Engineering site to provide you instruction and practice on the current topic. The probability of failing this course is very high if you do not practice the concepts by completing all the homework. You should attempt all of the assigned homework problems after reading the assigned sections of the textbook and participating in class. If you are unable to successfully complete this set of problems, you should re-review the text and sample problems from the book for the related topic, compile questions that target your confusion, ask these questions in class, office hours, or tutoring sessions, then attempt the problems again. If you need more practice in one or more concepts, you can view supplemental tutorials and attempt supplemental practice problems for that topic. Once you are confident that you could solve any of these problems from scratch without assistance, you are ready to move on to the next week's topic.

Exams

Two 90-minute evening exams will be given during the semester on the nights indicated on the course schedule from 8:00pm – 9:30pm. The dates of the exams are:

Thursday, September 22nd and Wednesday, October 26th

If you have a conflict between either of the evening exams and **regularly scheduled** University functions, notify your instructor no later than two weeks prior to the exam date. No conflicts are permitted for other than **regularly scheduled** University functions. In the event of illness, notify the ESM Office (865-4523) **PRIOR** to 5 pm on the day of the exam.

Final Exam

The final exam is cumulative and will be given during finals week as scheduled by the Registrar. **DO NOT** make plans to leave for break until the official final exam schedule has been posted.

EXAM POLICIES

- Calculators may be used during all exams, but sharing calculators is not permitted.
- All exams are closed book, closed notes. Bring your ID to each exam.
- All personal items (book bags, hats, coats, etc.) must be left in the front or the back of the exam room. Only calculators, pencils and erasers are permitted in the seats.
- Academic dishonesty will not be tolerated.

COURSE SCHEDULE

E MCH 213 Engineering Mechanics – STRENGTH OF MATERIALS

Class	Date	Topic	Reading
1 - wk 1	M 8/22	Intro and Statics review	
2	W 8/24	Internal Force & Stress	1.1-5
3	F 8/26	Allowable Stress & Design	1.6
4 - wk 2	M 8/29	Deformation & Strain	2.1-2
5	W 8/31	Deformation & Strain	2.1-2
6	F 9/2	Sample Problems	
- wk 3	**M 9/5**	***Labor Day***	
7	W 9/7	Mechanical Properties	3.1-6
8	F 9/9	Stress-Strain Curves	
9 - wk 4	M 9/12	Axial Load	4.1
10	W 9/14	Axial Deformation	4.2
11	F 9/16	Statically Indeterminate - Axial	4.4
12 - wk 5	M 9/19	Thermal Effects & Stress Concen	4.6-7
13	W 9/21	Sample Problems	
	R 9/22	**Exam 1**	
14	F 9/23	Torsion Formula	5.1-2 + Video
15 - wk 6	M 9/26	Power Transmission & Twist	5.3-4
16	W 9/28	Statically Indeterm. - Torsion	5.5
17	F 9/30	Sample Problems	
18 - wk 7	M 10/3	Bending – Deform, V & M	6.1
19	W 10/5	Bending – Internal V & M	6.2
20	F 10/7	Bending – Moment of Inertia	App. A .2
21 - wk 8	M 10/10	Bending – Stress Formula	6.3-4
22	W 10/12	Bending – Stress Formula	6.3-5
23	F 10/14	Sample Problems	
24 - wk 9	M 10/17	Shear Stress in Beams	7.1-2
25	W 10/19	Shear Stress in Beams	7.1-2
26	F 10/21	Pressure Vessels	8.1
27 - wk 10	M 10/24	Exam 2 review	
28	W 10/26	Combined Loadings	8.2
	W 10/26	**Exam 2**	
29	F 10/28	Combined Loadings	8.2

Class	Date	Topic	Reading
30 - wk 11	M 10/31	2D Stress Transformation	9.1-3 + Video
31	W 11/2	2D Stress Transformation	9.1-3 + Video
32	F 11/4	Mohr's Circle	9.4 + Video
33 - wk 12	M 11/7	Sample Problems	
34	W 11/9	3D Stress Transformation	9.5 + Video
35	F 11/11	3D Hooke's Law	10.6
36 - wk 13	M 11/14	Beam Deflection	12.1-2
37	W 11/16	Deflections w/Singularity funcs	12.3
38	F 11/18	Sample Problems	
	21-25	***Thanksgiving Break***	
39 - wk 14	M 11/28	Statically Indeterminate beams	12.6-7
40	W 11/30	Statically Indeterminate beams	12.6-7
41	F 12/2	Sample Problems	
42 - wk 15	M 12/5	Ideal Column Buckling	13.1-2
43	W 12/7	Columns w/Different Supports	13.3
44	F 12/9	Review for final exam	all

Final Exam date/time TBD

LEARNING ACCOMMODATIONS

I strive to make the learning environment accessible and effective for all students. If you have ideas for modifications that I can make to the way I interact with the class or the way I develop and post materials that will lessen a potential barrier for learning, I welcome that input and will give your suggestions careful consideration.

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Student Disability Resources (SDR) website provides contact information for every Penn State campus: http://equity.psu.edu/sdr/campus-contacts.
For further information, please visit Student Disability Resources: http://equity.psu.edu/sdr.

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: http://equity.psu.edu/sdr/guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

Academic Integrity

The Department of Engineering Science and Mechanics at the Pennsylvania State University considers academic training to be apprenticeship for practice in the professions. Students are expected to demonstrate a code of moral integrity and ethical standards commensurate with the high expectations that society places upon professional practice. Accordingly, it is the policy of the department to maintain the highest standard of academic honesty and integrity.

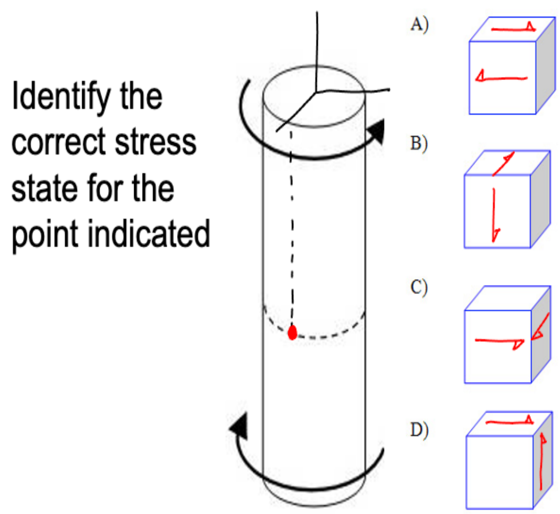
Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

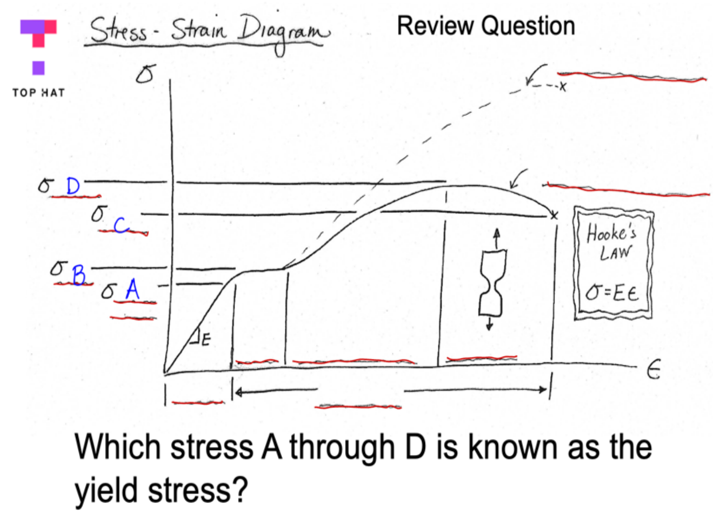
Academic integrity includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others. Academic dishonesty includes, but is not limited to, cheating, copying on tests, plagiarizing, acts of aiding or abetting, unauthorized possession of materials, tampering with work, ghosting, altering examinations and theft of any property (hardware, software, lab equipment and supplies, intellectual property, etc.). Students are encouraged to report incidents of academic dishonesty to their instructors in order to promote a fair academic climate and equal opportunity learning environment.

A student charged with academic dishonesty will be given written notice of the charge by the instructor. A student contesting such a charge may seek redress through informal discussions with the instructor. If the instructor believes that the infraction is sufficiently serious to warrant referral to the Office of Conduct Standards, or if the instructor believes that academic sanctions are appropriate, the student and instructor will be afforded formal due process procedures governed by Penn State Senate Policy 49-20. Policy 49-20 and procedures can be found in the document "Policies and Rules for Undergraduate Students" issued annually by the Senate Office and available through each student's home department or college dean's office. See more Academic Integrity policy information from the College of Engineering at https://advising.engr.psu.edu/student-resources/academic-integrity.aspx.

Vincent Meunier
P. B. Breneman Department Head Chair
Professor of Engineering Science and Mechanics

Appendix B – Examples of class engagement concept questions





Appendix C – Pillars of Strength images