Teaching Portfolio for the Certificate in College and University Teaching (CCUT)

Eric Jones, Department of Physics

March 31, 2020

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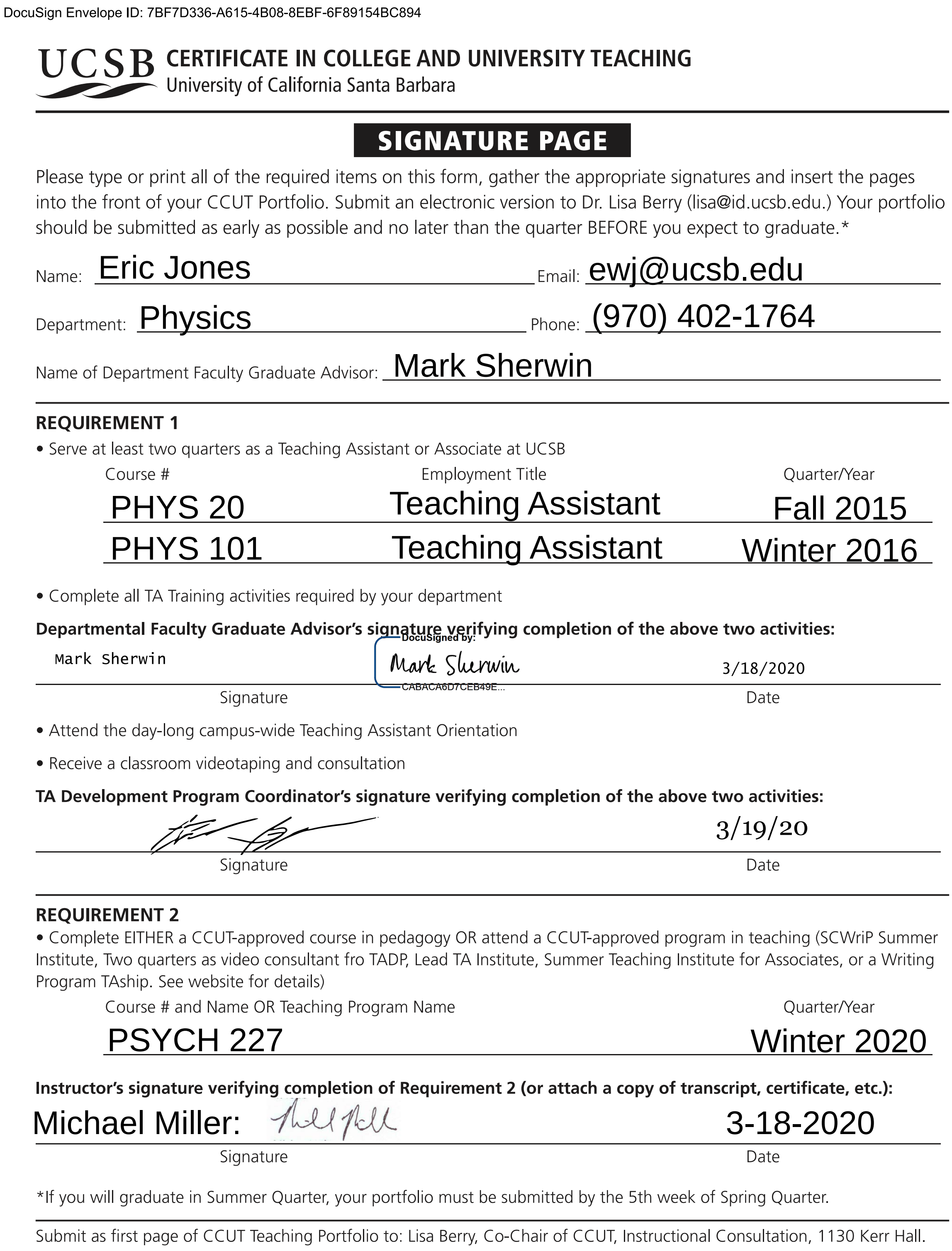

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UCSB CERTIFICATE IN COLLEGE AND UNIVERSITY TEACHING
University of California Santa Barbara

SIGNATURE PAGE

Please type or print all of the required items on this form, gather the appropriate signatures and insert the pages into the front of your CCUT Portfolio. Submit an electronic version to Dr. Lisa Berry (lisa@id.ucsb.edu.) Your portfolio should be submitted as early as possible and no later than the quarter BEFORE you expect to graduate.*

Name: Eric Jones Email: ewj@ucsb.edu

Department: Physics Phone: (970) 402-1764

Name of Department Faculty Graduate Advisor: Mark Sherwin

REQUIREMENT 1

- Serve at least two quarters as a Teaching Assistant or Associate at UCSB

Course #	Employment Title	Quarter/Year
PHYS 20	Teaching Assistant	Fall 2015
PHYS 101	Teaching Assistant	Winter 2016

- Complete all TA Training activities required by your department

Departmental Faculty Graduate Advisor's signature verifying completion of the above two activities:

Mark Sherwin DocuSigned by: Mark Sherwin CABACA6D7CEB49E... 3/18/2020

Signature Date

- Attend the day-long campus-wide Teaching Assistant Orientation
- Receive a classroom videotaping and consultation

TA Development Program Coordinator's signature verifying completion of the above two activities:

3/19/20

Signature Date

REQUIREMENT 2

- Complete EITHER a CCUT-approved course in pedagogy OR attend a CCUT-approved program in teaching (SCWriP Summer Institute, Two quarters as video consultant fro TADP, Lead TA Institute, Summer Teaching Institute for Associates, or a Writing Program TAship. See website for details)

Course # and Name OR Teaching Program Name	Quarter/Year
PSYCH 227	Winter 2020

Instructor's signature verifying completion of Requirement 2 (or attach a copy of transcript, certificate, etc.):

Michael Miller: 3-18-2020

Signature Date

*If you will graduate in Summer Quarter, your portfolio must be submitted by the 5th week of Spring Quarter.

Submit as first page of CCUT Teaching Portfolio to: Lisa Berry, Co-Chair of CCUT, Instructional Consultation, 1130 Kerr Hall.

REQUIREMENT 3 (Complete one of the following)

CHECK ONE

☒ Option 3A: **DISCUSSION** of your own experiences using or implementing instructional technologies to enhance student learning. This 8-10 page discussion (double-spaced, 12 pt. font) must be supported by published research.

☐ Option 3B: **RESEARCH REVIEW** of existing research on effective instructional strategies using instructional technologies (~10 pages, double-spaced, 12-point font). Practical examples from candidate's own teaching experience and observations should be integrated into the research review.

☐ Option 3C: **INSTRUCTIONAL TECHNOLOGY PROJECT** demonstrating creative and substantive development of instructional materials utilizing computer-based or multi-media to enhance student learning. The project must be a significant aspect of a course.

☐ Option 3D: Completion of an **APPROVED COURSE** for Req. #3.

Course # Quarter/Year

Instructor's Signature Date

REQUIREMENT 4

CHECK ALL

☒ Taught course as an instructor of record with mentoring support of a faculty member.

☒ Included all necessary documentation in the CCUT Portfolio:

- A letter from mentor describing the nature and frequency of the mentoring (A Summer Teaching Institute for Associates (STIA) certificate may be offered in lieu of a mentor's letter).
- ESCI or other course ratings
- Open-ended student evaluations with discussion of your strengths and weaknesses

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REQUIREMENT 5

I have submitted all of the materials required for completion of the CCUT Teaching Portfolio and attest to their accuracy.

3/20/2020

Student's Signature Date

Release of CCUT Portfolio Contents

"I ☒ DO ☐ DO NOT release my CCUT portfolio for use as an example to other CCUT applicants if the Faculty Advisory Board so chooses." (List any sections you wish to have omitted in a separate page.)

"Further, I give permission for the above indicated parts of my proposal to be presented as examples in the following forms."

☒ As a hard copy ☒ On the CCUT website

"I ☒ DO ☐ DO NOT want my name attached to my portfolio if it is used as an example in the above forms."

3/20/2020

Student's Signature Date

Submit as first page of CCUT Teaching Portfolio to: Lisa Berry, Co-Chair of CCUT, Instructional Consultation, 1130 Kerr Hall.

1 Teaching Philosophy Statement

As an undergraduate at the Colorado School of Mines, where innovative physics education practices are prominently researched, I observed the development and implementation of pedagogical techniques firsthand. The realization that teaching practices could be deliberately altered caused me to start analyzing the teaching styles of my professors. Acting as a guinea pig, then, over the years I have identified the teaching styles that were most effective for me. Now, in my role as a teacher and mentor I try to embody the best of these virtues, while regularly reflecting on my teaching practices in order continue improving.

As a physics graduate student at UCSB I have served as a teaching assistant, graduate mentor for the Summer Institute in Mathematics and Science program, graduate mentor for the Undergraduate Diversity and Inclusion in Physics (UDIP) club, founder and organizer of the Programming Help Sessions, research mentor to two undergraduates, and instructor of record for an upper-level classical mechanics course. As I have been engaged in these positions, pedagogical contemplation along with trial-and-error have clarified my teaching philosophy, which I will convey in this portfolio. Broadly I seek to prioritize **accessibility, practicality, and mentorship**. In my teaching, these values ensure that students have the necessary resources to succeed independently, while also providing channels for direct one-on-one interactions. Over the course of my graduate career I have matured as a teacher and mentor, and my experiences will inform how I refine my teaching style in the future.

The first tenet of my teaching philosophy is accessibility. In the classroom, I work to ensure that the course is accessible by writing largely, speaking loudly, and using whiteboard space in a comprehensible manner. I always post my lecture notes online so that students can give me their full attention during class. Interpersonally, I strive to be approachable and light-hearted, so that students feel comfortable and enjoy talking with me. When I taught a course as instructor of record students would regularly ask questions during class and attend office hours, and one student from the class said that I "deserve[d] high praise for [my] friendliness and approachability." At UDIP, undergraduate students have confided in me and sought advice. Broadly, my temperament— in large part due to my focus on accessibility— has enhanced my ability to effectively communicate with students.

Second, I promote practical skills that will resonate with students and will endure long after memorized formulae and algorithms are forgotten. This mindset is very compatible with current active learning strategies. At least partially I emphasize practicality because I went to an engineering college, where the goal was always to achieve tangible outcomes. Whenever possible I "teach by example" by introducing new techniques as a means of solving problems, rather than formulating the techniques as an abstract truth to be memorized without context. I include real-world examples that illustrate physical concepts and build intuition. For example, students in my classical mechanics course will hopefully possess a sustained intuition for soap films, weighted dice, and the Earth-sun orbit, and whenever they wish to recall the details they can revisit my posted lecture notes. I am interested in teaching computational methods alongside physics courses so that students become comfortable plotting their often opaque analytic answers (e.g. in Mathematica). As part of the Programming Help Sessions, I expose physics students to essential programs like the typesetting language LaTeX and the programming language python, and I provide templates for curriculum vitae and research articles. I also provide guides for how to improve their computational efficiency (e.g. with streamlined bash environments) that, over time, will significantly improve their workflow. While theorems and algorithms will be forgotten by all but the most studious students, intuition and programming skills are broadly applicable and will help students as they advance through life.

Lastly, I develop personal connections with students by acting as a mentor. These connections cause students to be comfortable in my presence, which allows them to ask more questions, seek more advice, and generally allows them to adopt a better mindset for learning. To promote mentorship I advise the group Undergraduate Diversity and Inclusion in Physics (UDIP), and in association with UDIP I organize mentorship groups that unite undergraduates seeking advice with interested graduate physics students. In addition to leading one of these mentorship groups myself, I work closely with two undergraduates as a research mentor, for whom I use different methods of advising to address their different learning styles. In the classroom I predominantly focus on the relevant physics curriculum, but also broadcast the available resources that exist to help students succeed and maintain a healthy work-life balance (including my office hours, review sessions I host, and the physics study room). Being a mentor has facilitated my growth as a researcher and as a teacher.

By emphasizing accessibility, practicality, and mentorship, I provide students with the necessary resources to succeed independently, while also providing personal one-on-one attention whenever they seek it out. I amplify these qualities by presenting a stable yet playful demeanor, the full effect of which primes students to enter a suitable environment for learning. By participating in extracurricular activities— especially those that serve underrepresented groups in the undergraduate physics community— I am perceived as an approachable peer that is interested in their well-being, whether scholastically or interpersonally. While I have deduced much of my teaching philosophy from my participation in previous classes, while in graduate school I have made a dedicated effort to supplement my personal experiences with newly-learned pedagogical techniques. In the remainder of this portfolio, I will demonstrate how I have grown as an instructor throughout graduate school, specific approaches I have implemented based on my pedagogical training, and my future plans to integrate programming methods with physics courses.

2 Reflection on TA Training (Requirement 1)

By the time I entered graduate school I had worked as a grader and as a tutor in a learning center at my undergraduate institution. Accordingly, I was comfortable explaining concepts to students in one-on-one setting, but I had less experience leading an entire classroom of students either as a teaching assistant or as an instructor of record. Therefore, the initial teaching assistant training I received at UCSB was helpful when I worked as a TA during my first two quarters. Though this general training certainly provided general advice for effective teaching practices, the most glaring improvements to my teaching abilities occurred through self-reflection and through being videotaped. As I taught and mentored more— for SIMS, as part of UDIP, with undergraduate researchers, and while teaching the Programming Help Sessions— I became more comfortable while lecturing in front of a classroom. Now, the steady improvements to my teaching ability have been confirmed through my recent videotaping as an instructor of record; for example, in a letter from Mindy Collins analyzing one of one of my lectures, she stated that "[my] pacing was impeccable, as were [my] methodically clear explanations of material using everyday language" (the full letter is provided in Appendix B).

Admittedly, I do not recall many aspects of the TA training that I participated in as a first-year graduate student, but I clearly recall one lesson that I often thought about while teaching: Justin Pearson's tutorial on "how not to be a good TA." This clever and funny video featured Justin doing every possible incorrect TA behavior— he talked at the board, regularly called things "trivial," ignored questions from the audience, and had no coherent sense of boardwork. What all of these "bad" behaviors shared was that they were impractical: for example, talking at the board dampens volume, and poor boardwork is difficult to follow. Later on when I watched the videotaping of my first TA experience, I was shocked at how many "bad" behaviors I had accidentally fallen into! This video also clarified the way that I think about hierarchies of teaching ability: poor teachers will exhibit the bad behaviors displayed in Justin's video, and teachers that simply avoid these behaviors will be fine (in the sense that their lectures will be understandable if not stellar). To be a great teacher, in addition to "not being bad" you must also provide something special, whether in the form of exceptionally clear explanations, a novel take on the lecture material not available in the standard textbook, or the inclusion of technology-based teaching practices. Thinking about my past professors, this classification allowed me to identify which professors were fine (doing the bare minimum) versus which professors were exceptional.

I was first videotaped during my first quarter leading a discussion in a lower-division calculus-based kinematics course. Though I never met with the TA Development Program to analyze the video formally, in preparation for writing this portfolio I partially watched and independently analyzed my lecture performance. I was surprised at how many weaknesses were present five years ago, that were not present in the videotaping when I was instructor of record. First, I would often talk into the blackboard, which muffled the sound and made it difficult to hear me speak in the recording. Second, I was clearly nervous and regularly used filler words like "um" and "yeah." Third, my hands were too active— touching my beard, or fiddling with a piece of chalk that I was holding. Lastly, my handwriting and boardwork were cramped and, while legible, easily could have been neater. Despite these drawbacks, as a first year I did seem capable of fielding students' questions, and in my opinion my delivery of the lecture material was logical and understandable.

As I have developed as a teacher, I have remedied most of these faults. In Mindy Collins' letter, she observes that "there were almost no filler words." Additionally, she mentions that I am "very thorough in explaining each step and how the steps are related to each other." I now generally feel comfortable teaching, and this in turn makes me more calm and makes my lectures more understandable.

Finally, to some extent I have been able to contribute to the TA training of other graduate students. Before the Fall quarter of my second year I was invited to participate in an intradepartment TA training, where I worked with a group of 5 first-year graduate students for 4 hours discussing how to be an effective instructor. In this capacity I was able to pass on the lessons I had learned the previous year during my own TA training. Largely my suggestions to the new graduate students reflected the weaknesses I identified in myself after watching my videotaped TA section during my first year. Over time, my teaching abilities have improved by studying good teachers, deliberate reflection and analysis of my teaching methods, and plenty of trial-and-error.

I have valued my time as a TA. The responsibility I had as a TA forced me to learn how to command a classroom, and prepared me to teach as an instructor of record. Additionally, in the physics department the TA discussion sections are much more personal than the instructor's lectures: discussion sections are smaller, and are by design more interactive. I enjoy building connections with students, especially those that are genuinely passionate or curious. Lastly, I liked tutoring in the physics study room, where I was constantly challenged by homework problems from other courses— even if I wasn't sure of how to solve the problem, I would always attempt them and explain my thought process. Being a TA at UCSB as surely enriched my graduate experience.

3 Reflection on Taking a Teaching Course (Requirement 2)

I took the course PSYCH 227: Human Memory & Cognitive Processes in the Winter quarter of 2020, which was taught by Mike Miller. In this course I learned how theories of memory have developed over the last 100 years. Some of the experiments and findings are applicable to pedagogy, but the bulk of the course was spent trying to understand how human memory works (e.g. what types of memory exist? Where are memories stored?). Throughout the course I was exposed to quantitative psychology, which as a field was entirely new to me.

Several things that I learned in the class provided pedagogical insight. First, there is a canonical psychology experiment in which subjects are read a list of words, then immediately asked to recall as many of the words that they can. Subjects consistently remember items from be beginning of the list, and also from the end of the list, but fail to remember items in the middle. This U-shaped "serial position curve" led to one of the first memory models, in which there are three memory stores: sensory input, short-term memory, and long-term memory. In the serial position curve, as explained by this model, the remembered items from the beginning of the list are stored in long-term memory, and the items at the end of the list are still stored in short-term memory.

More recently, psychology research has been tasked with enumerating the different types of memory that exist. Psychology research generally advances by identifying dissociations in brain function, which are somewhat analogous to "gene knockouts" in genetics. For example, after a subject with epilepsy underwent experimental brain surgery to remove parts of their medial temporal lobe, they stopped being able to remember events (experiencing severe anterograde amnesia). Therefore, psychologists inferred that the medial temporal lobe is essential for remembering events. Other subjects suffering severe anterograde amnesia were capable of making new semantic memories (e.g., how the alternator in a car works) that they were able to recall later, but they were unable to recall how they learned the information in the first place. Therefore, psychologists inferred that semantic memories (i.e., general knowledge about a subject) and episodic memories (i.e., past experiences that a person can remember) are stored differently.

It is pedagogically useful to know how memories are stored, and that many different types of memory exist. For example, while teaching I might invoke the serial position curve to provide high-level overviews of the most important points at the beginning and end of a lecture. The serial position curve phenomenon provides a basis to the oft-quoted advice for giving a presentation or lecture: "tell them what you'll tell them, tell them, then tell them what you told them." Additionally, understanding that many types of memory exist—including episodic (events that occurred), semantic (general knowledge about the world), procedural (how to do a task), and priming (the ability to be "cued in" to an answer)— allows me to consider how students are learning and consolidating class materials. For example, if students remember a particular derivation I performed at a whiteboard, they will be using episodic memory. A deeper understanding of how to do physics using Hamiltonian mechanics would be stored as a semantic memory. The rote computation of a common integral accesses procedural memory. And when I ask them a question I have asked several times before, their quickened response would be a consequence of priming.

In teaching, interestingly, these types of memory are tied together. For example, being able to compute a rote calculation (procedural memory) might be important for a larger derivation that reflects something fundamental about the subject (semantic memory). Thinking about how I approached and solved a problem in class (episodic memory) might help students consolidate their own problem solving approaches (semantic memory). In an electronics lab, being able to put together a circuit (procedural memory) is as important as being able to derive the currents flowing through the circuit. It is important as a teacher to understand that these different types of memory exist, and that students might vary in their ability to store different types of memory. Being aware of the processes that underpin memory formation helps me better understand how students learn.

4 Discussion of Implementing Technology in Teaching (Requirement 3)

I am preparing my CCUT portfolio in the context of the ongoing COVID-19 pandemic, which has resulted in the transition of all UCSB classes to a virtual setting. My prior TA position (which involved showing elementary school children physics demonstrations) has been cancelled, and I am instead planning to TA for an upper-level physics course in complex variables. In this essay, I will review how to transition from one teaching paradigm to another, evidence for and implementations of active learning teaching methods, and how videoconferencing technologies like Zoom can facilitate active learning in virtual classrooms. Lastly, I will discuss how I intend to apply these best practices in my upcoming TA position next quarter.

4.1 Shifting teaching paradigms in physics education

At the Colorado School of Mines (CSM), my baccalaureate institution, the physics department was at the forefront of physics education research, and boasted innovative course formats that emphasize active learning and technological integration. In particular, the first two undergraduate physics courses in mechanics and electromagnetism— both courses were mandatory for all students— had transitioned into a hybrid format consisting of both lecture and a hands-on studio. The transition to this active learning style of teaching was chronicled by Kohl and Kuo [1]. (It happens that both of these professors taught me at CSM!) Their guidance for how to successfully implement to a new active learning-based curriculum from a traditional lecture-style curriculum should be applicable for attempts to convert traditional physics classrooms into virtual classrooms. The work required to virtualize every class continues to be a massive disruption to university teaching. Therefore, better understanding how to shift from one teaching style to another is valuable.

One of the key pieces of advice offered by Kohl and Kuo is that classes will not necessarily succeed immediately after overhauling a curriculum [1]. At CSM the curriculum was substantially revised each year for the first several years, but the accumulated improvements have generated an optimized curriculum that is undeniably effective. This improvement has been borne out in standardized test scores; in particular, in the Force Concept Inventory (a standardized test of first-semester physics knowledge) the CSM active learning curriculum produced an average gain of 0.5 points, compared with an average gain of 0.25 before the active learning curriculum was implemented. Similarly, following adoption of these active learning approaches, performance on exams increased and the number students that received D's, F's, or withdrew decreased.

In addition to hands-on experiments, this studio course features simulations like Physlets and PhET, which consist of physics animations and applets that are manipulable by the student. Integrating technology with traditional course material has become common in classical mechanics as well: in a review of contemporary approaches for teaching classical mechanics, José et al. argue that computing software (e.g. Mathematica, MATLAB, or Maple) have become an essential tool for aspiring physicists [2]. In particular, this review identifies undergraduate textbooks (e.g. *Classical Mechanics* by Taylor [3] or *Analytical mechanics* by Fowles and Cassiday [4]) that have end-of-chapter problems that require simulation to solve. In a similar vein, during the Programming Help Sessions I introduce students to bash, python, and LaTeX, which in my opinion are likewise essential tools for aspiring physicists.

Finally, Kohl and Kuo cation that the transition to active learning requires additional personnel in order to adequately serve the students [1]. These additional personnel lower the student-to-instructor ratio, which makes student-instructor interactions more accessible. At UCSB, assuming sufficient funding exists, I view this extra cost as a feature— high-achieving undergraduates relish the chance to gain teaching experience and a little extra income. As we prepare for virtual teaching during this pandemic, it is important to remember that the transition will be bumpy, and take time until an education comparable to in-person teaching is possible. To maximize the value of these virtual courses, it will be especially necessary to take advantage of active learning approaches to drive student engagement.

4.2 Best practices for virtual teaching

In response to the ongoing COVID-19 pandemic, universities worldwide have closed their campuses and are transitioning to online teaching. In order for virtual teaching to be a viable option, students must be guaranteed the ability to access the virtual course, i.e. they must have a computer and internet access. In response to the coronavirus crisis, the UCSB Food Security Taskforce has provided Chromebooks available for free rental for UCSB students [5]. Freely distributing laptops to college students has been shown to improve GPA and course completion rates, with benefits concentrated among low-income, minority, and female students [6, 7]. Publicly available internet resources are harder to come by for low-income students, especially as both university and local libraries close to minimize the spread of the virus. As highlighted in the *Quality Matters* Emergency Remote Instruction Checklist, it is important to "articulate quick and easy ways for learners to find appropriate academic or student services support offices and resources" [8]. Allowing students to rent computers for free ensures that courses remain accessible to everyone.

Though the coronavirus-induced transition to online-only courses by US universities has been sudden, online courses have been a prevalent alternative for more than 20 years; indeed, in 2013 11% of students were exclusively enrolled in online courses [9]. Thus, the experience that has been accumulated by these online-only universities should be leveraged to improve the quality of education for all future virtual classes. Unfortunately, existing studies have found that entirely virtual lectures result in student performance that is marginally worse than an equivalent lecture performed in-person; in one study online-only students performed 7.6% worse on exams than in-person students [10], while in a separate study online-only students received a course grade 4-5% worse than in-person students [11].

Thus, online-only teaching is an uphill battle. To provide students with a high quality education even in the face of virtual classrooms, it will be essential to augment traditional teaching styles with technology-based and active learning methodologies. Active learning methods have been consistently found to improve student's retention of material and problem solving abilities [12]. These active learning methods attempt to promote student engagement with the lecture material, collaborative learning, and problem-based learning (in which course material is motivated by a driving question that is introduced earlier) [12]. When applied to a large introduction physics course, active learning was found to increase student attendance and enjoyment of the material [13]. In this study, students were instructed to interact with their peers (student-student discussion) as well as work in small groups to solve problems several times each class.

4.3 Active learning with videoconferencing technology

The performance gains associated with in-person active learning are encouraging, but the application of active learning to virtual classrooms remains a daunting task. At UCSB, lectures and discussion sections next quarter will take place on Zoom, which is a videoconferencing program all UCSB students have access to. Using Zoom to deliver traditional lectures— in which the lecturer writes at a whiteboard while narrating their derivations— is still possible, but typically students mute their own video and audio feeds to conserve bandwidth, and so it is easy for students to become distracted or stop paying attention [14]. Thus, it will be essential to take advantage of technologies in Zoom to promote student participation in order to keep the students engaged and learning. This should be possible using built-in Zoom features like Screen Sharing, Breakout Rooms, and Video Recording, but it will require a concerted effort to effectively bring active learning to the virtual classroom [15, 16].

One challenge of videoconferencing is that only one speaker may intelligibly speak at a time [14]. Additionally, since students' cameras are usually off, it is difficult to check in with students while lecturing. Since it is difficult to receive visual feedback from students on Zoom, when I am lecturing during discussion sections as a TA next quarter I will regularly use Polls (available in Zoom) in the same way that like iClickers are used in in-person classes to receive feedback and evaluate student understanding.

Another way to address the "single intelligible speaker" issue while encouraging active learning is by using Breakout Rooms in Zoom [16]. This feature allows the class to be broken up into small groups of 3 or 4 students that talk among themselves, and the instructor is able to enter and exit each small group, or address the entire class. Currently in the UCSB physics department, active learning is commonly implemented by having students work through a list of discussion questions in small groups, while the TA and two or three undergraduate "learning assistants" wander around the room and work with the small groups one at a time. By posting these discussion questions online before the discussion section starts, and having students work in Breakout Rooms, this style of active learning should be able to be replicated in Zoom.

Another benefit of videoconferencing technologies is that they are easy to record, since everything is already entirely digital. In studying the "flipped classroom" teaching style, it was observed that students enjoyed being able to watch instructional videos multiple times, and felt more prepared for class when these videos were available [17]. Additionally, the Screen Share feature in Zoom allows students to efficiently share and discuss any computational work on their computers, which is especially useful for courses with a programming emphasis [18].

Videoconferencing technologies like Zoom allow students to ask questions of the lecturer in writing without fear of disrupting the class. Instructors can permit students to submit questions anonymously, which might cause students that are shy to speak up; indeed, research suggests that students are much more willing to engage in class if they are able to do so anonymously [19]. Since students working in small groups are isolated from the other small groups, students may feel more comfortable speaking up and sharing their questions or opinions. Lastly, students can submit questions to the instructor directly in Zoom without speaking out in class. One of the written comments I received as a TA several years ago was that “I felt that a few students always belted out answers to questions, making it harder to think about problems on our own ... if [I] could deter that from happening, I think the learning experience would be better overall.” Zoom should remedy this student’s concern by allowing students to answer questions silently and without spoiling the answer for other students.

Another active learning technique that is compatible with virtual classrooms is asking check-in questions like “what topic was the most confusing for you today and why?” that students answer and submit after each section [20]. Students can submit their answers on Gauchospace, and the instructor can use their responses both to check attendance and also to examine what aspects of the material should be revisited. These questions allow the instructor to check-in with students regularly, even in the absence of face-to-face communication. These regular check-ins will also accelerate the rate of improvement associated with transitioning to an online-only teaching style.

4.4 How I will implement virtual active learning next quarter

In general, active learning requires shifting attention from the lecturer to the student [12]. When I am employed as a TA next quarter, I will need to implement active learning approaches entirely virtually, which I will do by using technologies like Zoom and Gauchospace. My rough outline of what will be covered in each 50-minute discussion section follows.

I will begin each lecture with a 10 minute overview of the most critical material, which I will record and post online. During this short lecture, I will set up a webcam pointed at my face and write on a tablet that is Screen Shared and recorded. At the end of this lecture I will have the students answer a poll (e.g., which of the following four topics are you least confident in? Which are you most confident in?). Then, for 30 minutes the students will break into small groups using Breakout Rooms in Zoom, and work with each other to solve a series of discussion questions that were posted online before the discussion section. During this time, I (hopefully along with two undergraduate learning assistants) will bounce between groups, providing individualized instruction in each group. At the end, I will have one member from each group summarize one of the discussion problems to the entire class. Although this discussion section will be held entirely virtually, I hope that videoconferencing technology can be harnessed to provide high quality instruction.

To supplement these videoconferences, I will also create and monitor an online chat room for the class using Nectir. Nectir is an academic-focused Slack clone that is LaTeX compatible and increasingly used at UCSB. These chat rooms will emulate the inter-student interactions that occur in a physical classroom, and provide them a common forum in which to discuss class policies, how to solve homework problems, or questions about course material. I will have students ask me questions in Nectir that I answer in discussion section, and I will encourage students to communicate by Nectir while in the Zoom Breakout Rooms so that they can revisit their (nicely typeset) conversations at a later date. One of the most difficult parts of taking classes online will be social isolation, but an active chat room will provide some of the students an outlet to communicate.

As I implement this online instruction, I am sure that I will adapt to the new virtual environment. It will be a struggle to keep students engaged when they are not physically in the classroom, and ultimately this will depend on the commitment of the students themselves. By implementing active learning methods in a virtual platform, I hope to make the most of teaching online.

5 Reflection on my Technology in Teaching Discussion (Requirement 3)

Next quarter I was expecting to continue organizing the UCSB Physics Circus, in which I lead a group of undergraduate and graduate student volunteers to elementary schools in the Goleta and Santa Barbara areas performing physics demonstrations at elementary school science nights. Due to obvious coronavirus-related concerns, all of these science nights have been cancelled, along with my expected TA position. Instead, next quarter I will be employed as a TA for an upper-division complex variables course in the physics department, and the entire course will be entirely virtual. Therefore, I was glad to be able to research "best practices" for teaching virtually to fulfill the technology requirement of my CCUT portfolio.

Additionally, in the literature review I created for this discussion I learned how to transition a course into a new paradigm, and what to expect throughout this transition. I experienced first-hand the studio-style courses that were implemented at the Colorado School of Mines, and my subsequent proficiency in mechanics and electromagnetism are the beneficiaries of this new instructional style. I participated in these courses once all of the kinks had been ironed out, but in the research paper chronicling their development, they mention that it took several years until they observed an unequivocal improvement in student learning outcomes. As I dive into a similar transition teaching discussion sections entirely online, with limited time and few resources, it is encouraging to know that small sustained improvements are important. As has been true throughout graduate school, it is a marathon and not a sprint. I look forward to using Gauchospace to receive feedback from the students throughout the course, and I will do my best to improvise and adapt throughout the quarter.

As a graduate student I also tried to facilitate computer literacy among physics undergraduates by creating, designing, and teaching the Programming Help Sessions (PHS), a five-week curriculum that teaches undergraduate physics majors basic programming concepts from scratch. These sessions were predominantly attended by first- and second-year physics majors, and are taught once per quarter. As with most accessible extracurricular events, this program was especially helpful for underprivileged groups: since the undergraduate physics curriculum does not emphasize programming, the PHS enabled students to pursue computational research even if they had not learned how to program before attending UCSB. I taught these sessions three times (in Spring 2018, Fall 2018, and Spring 2019), and helped another graduate student run them in Winter 2019. My goal in running these sessions was to fill a void in the physics department, since the current major doesn't require any programming classes to graduate. Additionally, I wanted to provide undergraduates with practical computing skills that would benefit them as researchers or working professionals.

Finally, when I taught the upper-division physics course in classical mechanics as instructor of record in Summer 2019, I wish I had integrated software like Mathematica more heavily. I provided students with some Mathematica code to visualize some of the functions that we were working with, but I never spent class time modeling how to use the software myself. I know that some students appreciated these programs (I was able to see which students had downloaded the file on Gauchospace), but if I could teach the course again I would emphasize numerical methods throughout the course. I find it surprising that currently, physics majors are able to graduate without having ever programmed a forward Euler method to solve differential equations; in my opinion this should not be the case, and I would like to restructure the TA section so that students are exposed to basic numerical methods during their classical mechanics course.

6 Reflection on Teaching a Course (Requirement 4)

Teaching my own course was the most fulfilling aspect of the CCUT program for me. I was able to enact policies that I admired in previous professors that taught me, I enjoyed the freedom to emphasize certain aspects of the curriculum that I considered the most valuable, and getting to experience the enthusiasm of engaged students was entirely worth the difficulty of teaching a class. Still, after teaching this class I am anxious to teach again—I have identified several areas in which my teaching could have been more effective, and I am excited to implement these lessons in the future.

While teaching this course, I embodied the values of accessibility, practicality, and mentorship. To be accessible, I provided my all of my lecture notes online so that students were able to pay attention in class. Two sample pages of lecture notes are provided in Appendix D. In feedback from the class, one student said "great job posting the notes." Tengiz Bibilashvili, in his letter as a teaching mentor (provided in Appendix A), said that "summer quarter goes fast and detailed lecture notes help students stay focused on the material delivered in class." Additionally, I motivated the class with real-world problems (e.g. how weighted die roll compared to how fair die). Lastly, students were not afraid to ask me questions or approach me. For example, one student was comfortable talking to me about difficult life circumstances they were going through. In Mindy Colin's letter analyzing my teaching (provided in Appendix B), she says that students "ask questions ... without hesitation" and that students "find [me] approachable." By being a cheerful and helpful teacher, I was able to successfully teach students classical mechanics.

In hindsight, my most obvious weakness in teaching this course was that I didn't interact proactively enough with the teaching assistant. The TA and I regularly interacted through email, but I should have enforced weekly one-hour meetings. Partially, I think I was lulled into a false sense of security by having my TA adapt discussion section worksheets that

Tengiz Biblishavili developed for his class. However, since I didn't take enough control over what the TA covered, he would often select worksheet problems that were out-of-sync with what we were covering during lecture. As a result, the TAs discussion sections often covered material that wasn't practical for the students to learn.

The second difficulty with the TA section was that while these worksheets effectively probed students' understanding of tricky aspects of classical mechanics, they were geared towards an active learning paradigm for discussion section, in which a few "learning assistants" (strongly-performing undergraduates that had taken the course before) are employed for each section. Then, in theory students would with partners to complete these worksheets, while the TA and learning assistants wander the room engaging with students and answering their questions. Unfortunately, although I tried to receive funding for learning assistants, the department did not have the logistical support to employ them during the summer. Without these learning assistants, the student-instructor accessibility that is fundamental to active learning methods could not be implemented. Instead, while my TA still used these worksheets, he would tend to lecture rather than having the students work amongst themselves. In my ESCI scores for this class, the question that evaluated the effectiveness of the teaching assistant's discussion section was the only question that I received a below-average grade on.

While I realize that I should have exerted more oversight over the TA position, I now have an exciting vision to revamp and strengthen the TA section. Broadly, I am interested in adding a technology aspect of the course in which students numerically implement the concepts they learn in class during discussion section. First, the study of classical mechanics consists of solving for the equations of motion of physical systems, with the solutions being time-dependent trajectories. Traditionally these solutions are written analytically, but being able to visualize these trajectories by simulating them with software like Mathematica allows students to interact with the solutions. Beyond the improved visualization, increasing the amount that students practically interact with course material is a key part of active learning styles, which have been found to improve student comprehension and enjoyment of material.

Second, simulating ordinary differential equations provides a convenient on-ramp for the study of numerical methods. Once students are comfortable programming forward Euler solvers, the same mindset will enable them to succeed in computer science courses studying algorithms or data structures. Programming requires "thinking like a computer," which requires decomposing a problem into subunits, linking the subunits together coherently, and understanding the entire problem well enough to debug. Especially in this professional climate, familiarity with programming is essential for students' success, and I believe that classical mechanics is an ideal forum for them to learn.

In general, even though this was my first class teaching as instructor of record, based on student feedback I believe I did a good job. In Tengiz' letter, he says that I "did not make them feel that a class taught by a graduate student differed from a class given by a professor." My ESCI scores were almost exclusively "excellent" or "very good." For example, one student said that "Eric's preparation for lecture and willingness to provide additional sources when students expressed interest was excellent." Another stated that "Eric is a solid lecturer. Concepts are clear, as are course expectations." Teaching this class was the culmination of all of my previous teaching experiences. I appreciate the freedom that instructors have to steer their course, and also am awed by the responsibility they have to provide quality instruction for all students. In the future, I hope to revisit this course and improve my instruction of it.

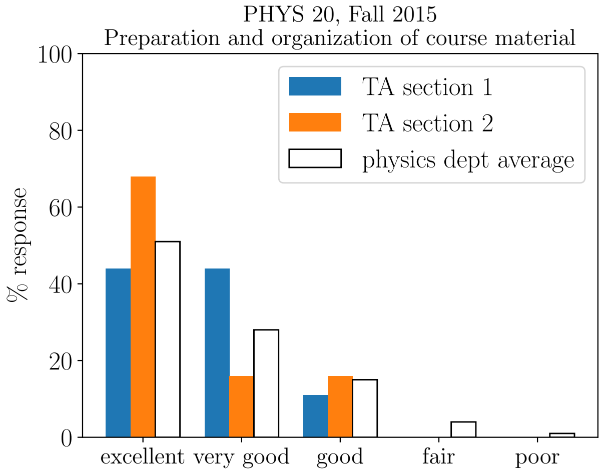
7 Summary of ESCI Results

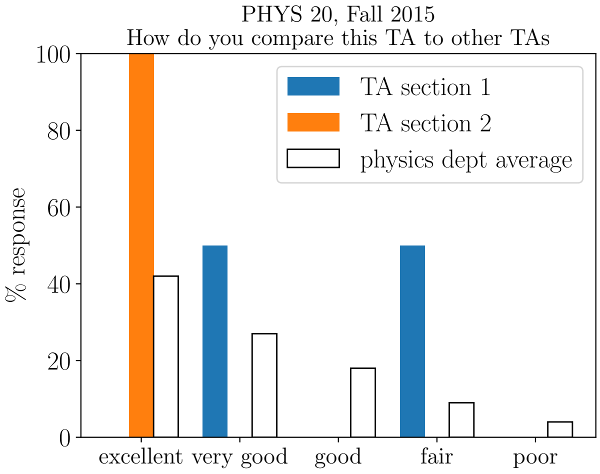
In graduate school I have taught two courses as a teaching assistant (Fall 2015 and Winter 2016), devised a curriculum for and led the extracurricular programming help sessions three times (Spring 2018, Fall 2018, and Spring 2019), and taught a course as instructor of record once (Summer 2019). Throughout these teaching experience, I have noticed obvious improvements in my confidence, my ability to effectively deliver content, and my ability to engage the class. My ESCI scores and feedback have quantitatively reflected this trajectory. Each quarter I read my ESCI feedback as soon as it was available, and used it to self-reflect and improve my teaching style. Having accumulated this experience, I am now confident that going forward I will be an effective instructor.

7.1 Teaching assistant for PHYS 20, Fall 2015

My first TA section was for PHYS 20, a freshman-level calculus-based kinematics course in the physics department. I was TA for two sections of this course that consisted of 30 and 47 students. I had worked as a mathematics tutor throughout high school and college, and so I felt comfortable answering questions and working one-on-one with students. However, leading a discussion section at the front of an entire class was new to me, and overwhelming at times. I recall that during my first lecture ever, I botched a trivial derivation of how to take the projection of one vector onto another vector— I was “off script” and hadn’t prepared this derivation beforehand, tried to do it on the fly, and failed. When I gave the same derivation for my second section, I performed the derivation properly. This pattern, in which my second discussion section was stronger than my first, continued to occur all quarter.

Despite these stumbling blocks, generally I felt that I performed adequately considering that it was my first TA experience. My ESCI scores for two questions follow; the first section I taught is in blue, and the second section that I taught is in orange. The physics department average scores are given by the hollow black bars.





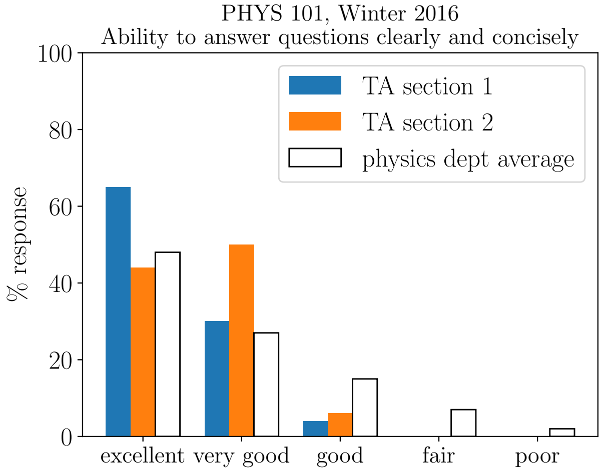
The students generally responded positively to my teaching for this course. This course was in the Fall, and it was for freshman physics majors, so the students didn't have many TAs to compare me to. My preparation and organization of course material were ranked on par or higher than the physics department TA average (mean score of 1.5 and 1.7 compared to a department-wide mean score of 1.8; here 1 is "excellent," 2 is "very good," and so on; lower scores are better). When comparing me to other TAs these students had, the difference between teaching the first and second sections is apparent: my first section thought I was either "very good" or "fair" with equal proportions, whereas once I was teaching the material for the second time the students unanimously found me "excellent."

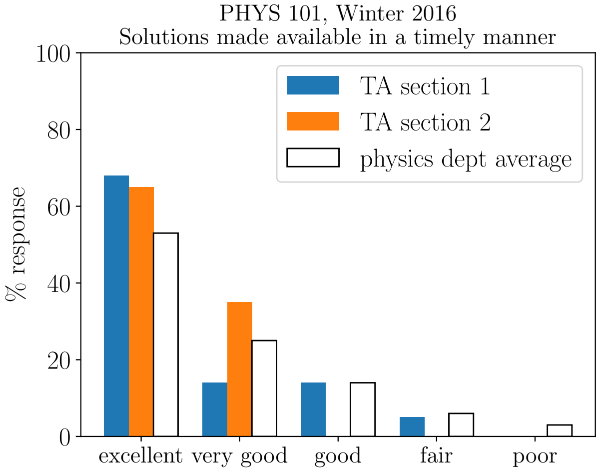
In written ESCI comments from my first section, the constructive comments informed me that I should "speak more clearly and ... encourage more people to participate;" that I "speak not very loudly;" and that I should "work on presence and confidence in front of the class." Additionally, I was told that I "make mistakes at times and ... could use a little practice with math." These comments were, admittedly, spot on, and I have since verified them by watching the videotaped lecture of my teaching for this class.

In some of the more positive written comments, students thought that "[my] teaching is very good and effective ... and greatly enhanced [their] learning experience," and several students said that I was "very good." My favorite response I have ever received was from one student who liked me, and said “E. Jones 4 life. Best TA to ever live. Best man to ever live.” For posterity, I have enshrined this piece of feedback in Appendix E.

7.2 Teaching assistant for PHYS 101, Winter 2016

I believe I substantially developed after this first TA experience. The second course I TAed for was for an upper-division complex variables course in the physics department. I taught two sections of 43 students each. This course largely consisted of mathematical concepts and techniques, and did not include very much physical reasoning. I am very sound at explaining math concepts, and find it more difficult to communicate physical intuition. I believe this is part of the reason that I was more comfortable teaching PHYS 101, and my improved confidence teaching was reflected in my ESCI scores. Scores for two ESCI questions follow.





In terms of my ability to answer questions clearly and concisely, students thought I was slightly above average the department mean (mean scores of 1.6 and 1.4, compared to department-wide mean of 1.9; lower scores are better). Students were especially impressed by my ability to create solutions and grade exams quickly (mean scores of 1.3 and 1.5, department-wide mean of 1.7). For this class I prided myself on creating clean solution sets and grading exams as quickly as I could, and so I appreciated that the ESCI scores reflected my effort.

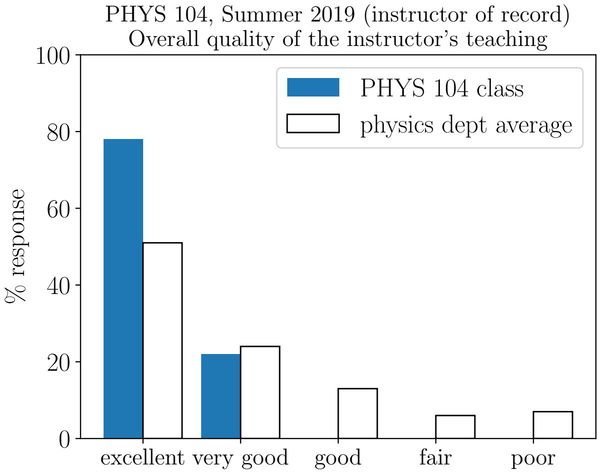
The written ESCI comments that I received for this course were overwhelmingly positive. Students found that "[my] discussion was helpful [and that I] did a great job;" and that I was "passionate about the subject material." One student said that I was "the most helpful, clear, prepared, and interest-sparking TA [they] had at UCSB." Another student found that "although [their] opinion of this class overall is less than perfect, the TAs performance is one of the few parts where I have no complaints ... I am particularly impressed by the speed of test grading." Finally, a student found that I "rank among the top of my TAs ... I think I could have skipped lecture and just gone to your session and have been fine in the class." I believe that, in all, I was able to effectively teach the majority of students.

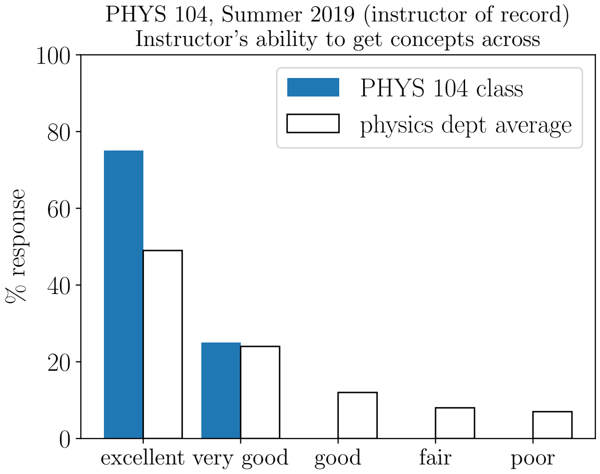
Some critiques that students had regarded the types of questions I worked through in class, and the way I structure the section. One student recommended that I "don't do basic problems during section time ... [instead] do more complicated problems similar to that of the HW/exam." However, since another student found that "the questions ... we did in class are great; they scale from easy to hard, so we can understand better," it is difficult to determine whether the difficulty level of my problems was appropriate. One of the ubiquitous difficulties in teaching is being accessible to both the strongest and weakest students, and I have not yet come to a conclusion of how to balance this conflict. Another student commented on the classroom environment, saying that "I felt that a few students always belted out answers to questions, making it harder to think about problems on our own ... if [I] could deter that from happening, I think the learning experience would be better overall." This discerning comment is one that I think about often, and I am regularly trying to figure out how to make my classroom inclusive and collaborative. The most concerning comment I received was a student saying that they felt "like it's hard to approach you (intimidating);" since accessibility is one of the key components of my teaching philosophy, I was a little surprised to receive this comment. Still, it has reminded me to always consider how others perceive me, and to continue working on leveling the playing field between instructor and student. Only one student said that I should "talk more loudly," compared to four students in my

PHYS 20 class, which is an improvement but still an indication that I should be aware of my volume.

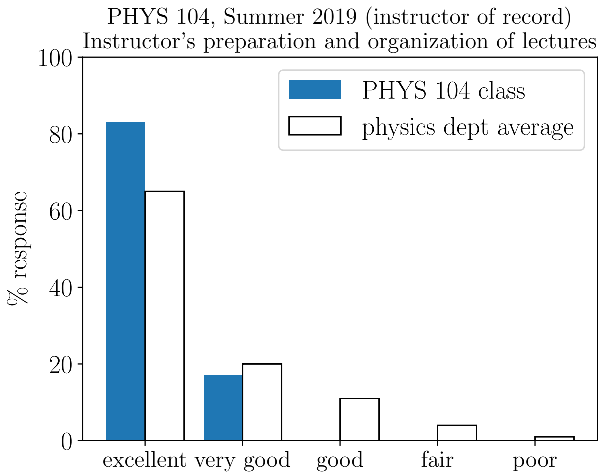
7.3 Instructor of record for PHYS 104, Summer 2019

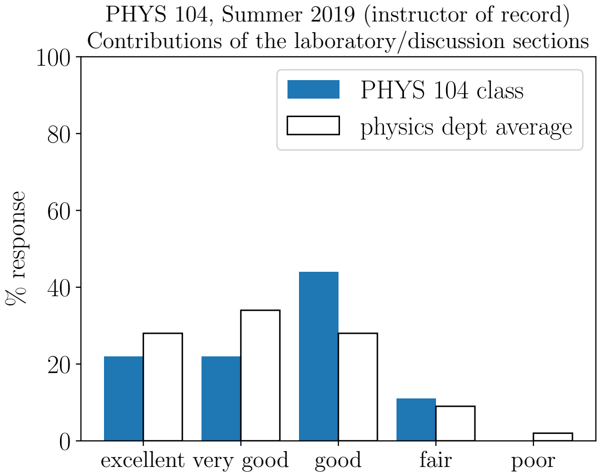
Finally, I taught as instructor of record for an upper-division classical mechanics course in the physics department for a class of 20 students. Before I taught this class, I created and ran the Programming Help Sessions (PHS, a 5-week extracurricular programming seminar for physics undergraduates) three times. Creating and presenting a curriculum for the PHS in part prepared me to teach PHYS 104. Additionally, I received mentorship from Tengiz Biblishavili, who is a phenomenal instructor that generously provided me with advice throughout the entire course.


PHYS 104, Summer 2019 (instructor of record)
Overall quality of the instructor's teaching


PHYS 104, Summer 2019 (instructor of record)
Instructor's ability to get concepts across

Based on the ESCI scores, students enjoyed my course. They found that I was an excellent or very good instructor, and I performed far about the department average (my course mean was 1.2, compared to a department mean of 1.9; lower scores are better). Additionally, they found that I was effective at getting concepts across (my course mean was 1.3, compared to a department mean of 2.0).





When I was teaching this course, to improve accessibility to the material I provided all of my lecture notes online. These lecture notes consolidated the most relevant material of the textbook, and were clearly written with all intermediate steps worked out. Lectures followed these notes almost entirely. The majority of my time preparing for this course was spent creating these notes, and I believe they imbued my course with a clear structure (two sample pages of notes are provided in Appendix D). I covered the material at the the pace I intended when I wrote the syllabus (provided in Appendix C), and didn't feel rushed at the end of the quarter. Therefore, I am glad my students found my preparation and organization excellent or very good, and above the department average (my course mean was 1.2, compared to a department mean of 1.6). My main failure during this class, as I mention in my teaching reflection in Section 6, was that I did not coordinate enough with my TA. The ESCI scores reflected this, finding that the discussion section was less effective than department average (my course mean was 2.4, compared to a department mean of 2.2). This was the only ESCI metric that I performed below average in.

The written comments for this course reflected this sentiment, with students commenting that "discussion section is not so helpful, [but] the lecture is very valuable." Students enjoyed my lecture notes, saying "great job posting the notes." One student, apparently unaware that I was creating the course from scratch, suggested that I "upload all HW and notes at start of quarter." Finally, one of the more encouraging comments I received was that I was an "amazing lecturer, always prepared with good examples to motivate thorough understanding and application/importance of material. Very accessible." This final comment, displayed in Appendix E, encapsulates why I enjoy teaching— I am thrilled to contribute to the learning experience of students, and enjoy being able to positively influence their lives.

8 Reflection on Requirement 5 (development via CCUT)

Participating in CCUT has been a very formative experience. Naturally, the required activities themselves— taking TA training, taking a course in pedagogy, writing a review on how technology is used in teaching, and teaching a course— have prepared me as a teacher. In addition to fulfilling all of the CCUT requirements, creating the CCUT portfolio has also prompted me to reflect on my teaching methods. In all, CCUT has provided structure to my accumulated teaching experiences through graduate school, and I appreciate that I had an opportunity to participate.

In making this portfolio, the first challenge was to identify the properties that best characterized my teaching philosophy. I settled on accessibility, practicality, and mentorship. I came to this conclusion by examining how I personally like to learn. I always want professors to provide their notes online, because I prefer to pay attention only to the professor while in class. I like professors that I feel like I can talk to. I avoided going to mathematics graduate school because I didn't like the idea of solving problems that were detached from reality. I enjoy being a mentor. I wove these ideas together into a coherent framework in my Teaching Philosophy Statement.

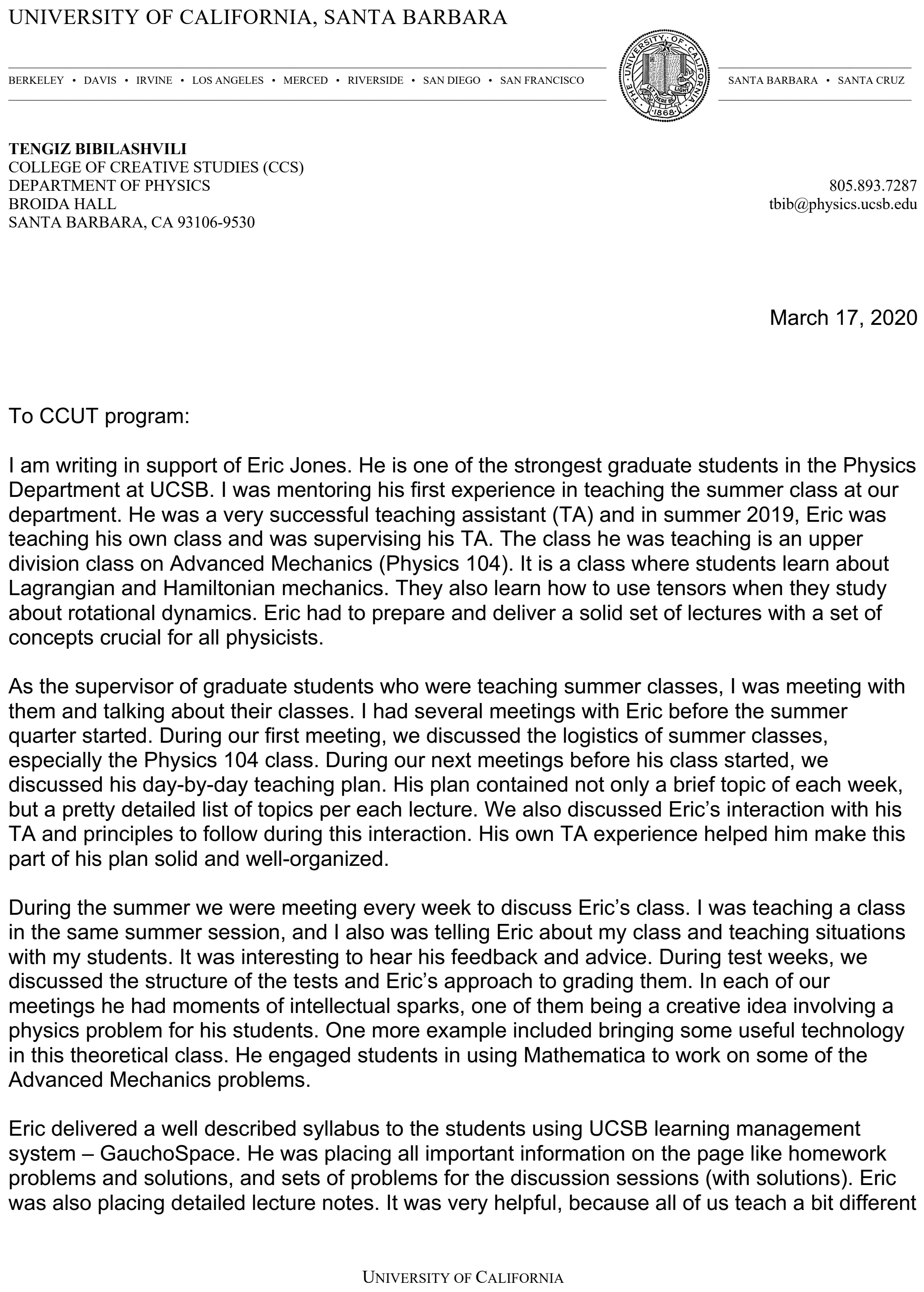
Once these themes were established, I found many examples of of them in my teaching. For example, in Mindy Colin's letter (Appendix B), my attitude is accessible and "makes [students] feel respected and comfortable that [I] will take them seriously regardless of their question or contribution." In choosing what topic to write a research technology review on, I was practical in choosing virtual teaching since I will be a TA in a virtual class next quarter. I have mentored undergraduates in several capacities through UDIP, research, the programming help sessions, graduate/undergraduate mentoring groups, and Physics Circus.

One particularly enjoyable aspect of creating this portfolio was revisiting past ESCI scores. I had not looked at my previous scores or comments for years, and had almost forgotten about the amusing “Eric Jones 4 life” comment. I also found it useful to plot my ESCI scores graphically. Being able to pick out patterns— like my improvement from the first to the second section of PHYS 20— provides quantitative detail to my teaching. Additionally, the progression of student comments over time are coincident with my self-perceived improvement in teaching ability.

I also enjoyed the video consultation. Mindy was very precise in her statements, and noticed lots of details about my lecture that I hadn’t noticed. She focused on how I used board space, the rate at which I spoke, the jokes I told, and how the class reacted to me. Comparing the videotape of my teaching in Summer 2019 with the videotape of my teaching in Fall 2015 is jarring: I have become significantly more calm and collected, fidget less, and am confident in my interactions with students. I no longer experience any sort of stage fright, and am at ease lecturing in front of a room. I wouldn’t have participated in the video consultation if not for CCUT, and I am glad to have the opportunity to directly observe my sharp improvement over time.

In the pedagogy course I took for CCUT, the instructor Mike Miller gave us a final exam with a list of short-answer but somewhat open-ended questions, and told us to “answer the questions thoroughly enough so that it’s clear you put some thought into them.” I really admired this approach to giving a final exam— it put the responsibility of learning on the students by having them reflect on a topic and answer to whatever extent they wished. This CCUT portfolio has operated in a similar way— by posing open-ended reflections it gives me the responsibility of evaluating my teaching. By codifying my teaching philosophy and reflecting on all of the teaching I have done in graduate school, I have determined the type of teacher I would like to be. I look forward to teaching a course again someday soon.

A Appendix: Teaching Mentor Letter



UNIVERSITY OF CALIFORNIA, SANTA BARBARA

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TENGIZ BIBILASHVILI
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BROIDA HALL
SANTA BARBARA, CA 93106-9530

805.893.7287
tbib@physics.ucsb.edu

March 17, 2020

To CCUT program:

I am writing in support of Eric Jones. He is one of the strongest graduate students in the Physics Department at UCSB. I was mentoring his first experience in teaching the summer class at our department. He was a very successful teaching assistant (TA) and in summer 2019, Eric was teaching his own class and was supervising his TA. The class he was teaching is an upper division class on Advanced Mechanics (Physics 104). It is a class where students learn about Lagrangian and Hamiltonian mechanics. They also learn how to use tensors when they study about rotational dynamics. Eric had to prepare and deliver a solid set of lectures with a set of concepts crucial for all physicists.

As the supervisor of graduate students who were teaching summer classes, I was meeting with them and talking about their classes. I had several meetings with Eric before the summer quarter started. During our first meeting, we discussed the logistics of summer classes, especially the Physics 104 class. During our next meetings before his class started, we discussed his day-by-day teaching plan. His plan contained not only a brief topic of each week, but a pretty detailed list of topics per each lecture. We also discussed Eric's interaction with his TA and principles to follow during this interaction. His own TA experience helped him make this part of his plan solid and well-organized.

During the summer we were meeting every week to discuss Eric's class. I was teaching a class in the same summer session, and I also was telling Eric about my class and teaching situations with my students. It was interesting to hear his feedback and advice. During test weeks, we discussed the structure of the tests and Eric's approach to grading them. In each of our meetings he had moments of intellectual sparks, one of them being a creative idea involving a physics problem for his students. One more example included bringing some useful technology in this theoretical class. He engaged students in using Mathematica to work on some of the Advanced Mechanics problems.

Eric delivered a well described syllabus to the students using UCSB learning management system – GauchoSpace. He was placing all important information on the page like homework problems and solutions, and sets of problems for the discussion sessions (with solutions). Eric was also placing detailed lecture notes. It was very helpful, because all of us teach a bit different from the book we use in our classes. Summer quarter goes fast and detailed lecture notes help students stay focused on the material delivered in class.

My evaluation of his summer teaching is that Eric did an outstanding job. I supervise grad students teaching in the summer for several consecutive years, and most of these students were facing some stressful situations where I had to help them. For example, they were afraid to not have enough time for the class and were asking me to work with them in making a plan to complete all topics on time. Graduate students often overestimate their undergraduates' knowledge and set up such tests that the average appears to be much lower than they would expect. Eric managed to give students solid experience and he did not make them feel that a class taught by a graduate student differed from a class given by a professor. Eric also was dealing with a case of cheating during a test and he managed this situation in the most professional way.

Eric Jones was involved in life of the department beyond regular expectations for a graduate student. In addition to research, he was contributing in computer science (CS) teaching, unrelated to a particular class. CS classes at UCSB give priority registration to the CS majors. As a result, many physics major students gain their computing experience by involvement in research projects or self-study. Eric was mentoring CS learning under our Undergraduate Diversity and Inclusion in Physics (UDIP) program. His work was acknowledged by the Physics department and by the campus wide Graduate Mentoring Awards.

Eric is a leader who loves bringing innovative tools in practice. He is currently working with the department leadership on a new set of computer science courses for our physics majors.

I am sure, Eric Jones is an intellectually sharp, young man with a strong sense of responsibility for work he is doing. He is raising the bar high and always tries to exceed expectations of his mentors. I see his potential to become an outstanding class instructor.

Tengiz Bibilashvili, LSOE
CCS Physics Program Coordinator

B Appendix: Video Consultation Letter

TA DEVELOPMENT PROGRAM
INSTRUCTIONAL DEVELOPMENT, UC SANTA BARBARA
1130 Kerr Hall 805.893.4289 http://oic.id.ucsb.edu/ta-development-program

TO: Eric Jones
FROM: Dr. Mindy Colin, Instructional Development
RE: Video Consultation, September 29, 2019

DISCUSSION
You explained at the beginning of our discussion that this was probably one of your better lectures because you felt like you were able to be a bit more interactive with the students because the content was more conceptual than the calculations typically done in this class. You were able to bring in some real-life examples and tell a few jokes, which students laughed at. You described your strengths as being able to know when you understand material well enough to explain it, and that your explanations are usually clear to students. You are also an approachable person and feel that students are comfortable around you, as evidenced by the calm and mutually respectful atmosphere of your classroom and the fact that your students tend to come to office hours. You indicated that a few students in this class came to you to talk through some personal issues, and you felt that you were a good listener in those cases.

You said you've been working on not using filler words during lecture and trying to stick to your script/notes instead of being distracted by tangents that you're not sure will end in the right place. We saw that your work has paid off in this video: there were almost no filler words and your lecture was right on-track. Your pacing was impeccable, as were your methodically clear explanations of material using everyday language. Your facial expressions light up a bit when you tell a joke or real-world example.

You use the board space very well and have it all planned out well in your notes, drawing lines between problems to make clear distinctions between concepts or examples. Your choice to post your lecture notes to GauchoSpace after class is a conscious pedagogical decision to provide support for students outside of class, as well as the opportunity for them to actively listen/observe complex lectures without feeling compelled to take detailed notes, thus splitting their attention.

I noticed that your explanations of material in this class follow a sort-of storyline in that you set the stage for a problem or calculation with a real example, then you take your time explaining how you approach the solution and where different variables might affect your approach or the way you calculate something. You are very thorough in explaining each step and how the steps are related to each other. When students ask questions, which they did without hesitation, you try to restate their question to make sure other students understand what is being asked, and you take time to think through how you are going to respond. This is probably one of the reasons that your students find you approachable because you don't just jump into an answer or shut the students down, which makes them feel respected and comfortable that you will take them seriously regardless of their question or contribution.

Lastly, we spoke about how to make the women in your classes feel more comfortable, since it is noticeable that there are only a few women in upper division Physics classes. I explained that the women aren’t necessarily worried about being bullied or shut-down by the men, though that plays a role, it might be more about them not wanting to stand out any more than they already do. I suggested that you talk to them politely and professionally when they come in or leave class so that they learn to trust you as someone who will recognize and accept their class contributions. Don’t try to only talk to them, or that might become creepy, but do make sure that they know you know their names and that you welcome their contributions and questions during class. This is also important for non-native English speakers and anybody who you notice acts a bit overly-insular. I would also suggest introducing students to each other on the first day of class and having students work together on problems, even briefly, during the first few days of class so that they feel comfortable around each other. Another thing that I didn’t mention during our discussion is possibly setting up a mobile-friendly homework ‘chat’ using Nectir so that students can ask each other (and you) questions about homework outside of class and outside of office hours.

Thank you for an enjoyable discussion and your enthusiasm for teaching. If you would like to arrange for another consultation (video, class visit, or just a discussion), please contact us at tavideo@id.ucsb.edu.

C Appendix: Example Syllabus

Physics 104: Advanced Mechanics

Summer B 2019

Instructor: Eric Jones
E-mail: ewj@physics.ucsb.edu
Time: MTW 9:30am-10:50am
Location: North Hall 1111

Course Website: On Gauchospace
Office Hours: 11am-noon W and 1-2pm F
Office Location: Broida Hall 6302

Discussion Section Time: Thursday 9:30am-10:50am
Location: Building 387, 1011
Teaching Assistant (TA): Kaikai Liu

Textbook: John Taylor, Classical Mechanics
Supplemental reading: Herbert Goldstein, Classical Mechanics

Administrative Assistance: Jean Dill, *Undergraduate Advisor*, Broida 3019C
E-mail: ugradstaffadvisor@physics.ucsb.edu

Homework

Problem sets are posted Fridays on the course website. *Homework is due the following Friday 5:00pm in the Phys 104 box in Broida.* It will consist of some end-of-chapter problems in Taylor, and other self-contained problems from other sources. **Your solutions should be written neatly and explained thoroughly.** Late homework will receive at most 75% of full credit, and will **only be accepted if permission is granted by email.** Graded homework will be returned in class the next Wednesday.

Discussion sections

Discussion sections will involve both TA-led practice problems, and student-led (groups of 3-4 students) discussion of concepts from lecture. Part of your course grade will be determined by your participation in discussion sections.

Exams and Important Dates

Midterm Exam: Aug 20 9:30-10:50pm, Tuesday, North Hall 1111
Final Exam: Sep 13 4-7pm, Friday, North Hall 1105

Last day to drop class: Aug 20, Tuesday
Last day to add class: Aug 16, Friday
Last day to change grading to P/NP: Sep 3, Tuesday
Start of discussion sections: Aug 8, Thursday

Grading Scheme

Homework	30%
Midterm	25%
Final	40%
Discussion Participation	5%
Extra credit: Essay on a chapter in Taylor (Ch. 12 or 16), details TBD	5%

Grading Scale (pre-curve)

A+	97 – 100	C+	76 – 78
A	90 – 97	C	70 – 76
A-	88 – 90	C-	68 – 70
B+	86 – 88	D+	66 – 68
B	80 – 86	D	60 – 66
B-	78 – 80	D-	58 – 60
		F	< 58

Tentative course outline

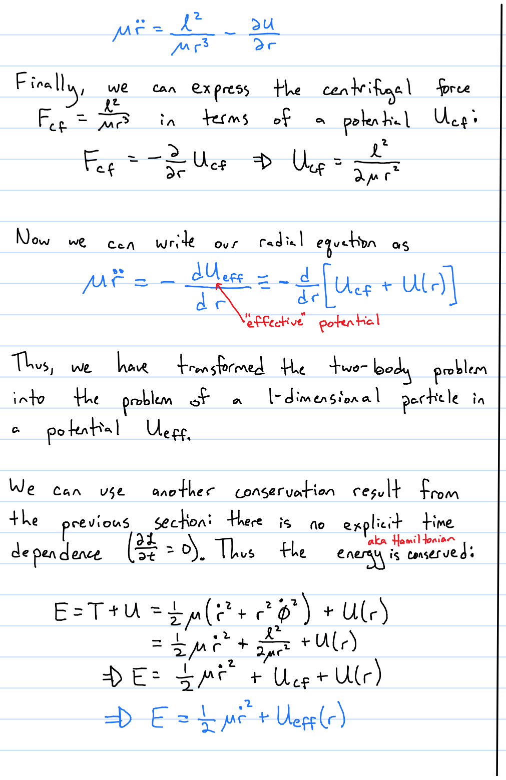
Date	**Topic**	**Reading Assignment**
Mon 8/5	Constraints and d'Alembert principle	Taylor Ch 7.1-7.4
Tues 8/6	Lagrange Mechanics	Taylor Ch 7.5-7.7
Wed 8/7	Calculus of variation	Taylor Ch 6.1-6.4
Mon 8/12 - Wed 8/14	Non-inertial reference frames	Taylor Ch 9.1-9.10
Mon 8/19	Review	
Tues 8/20	Midterm	
Wed 8/21 - Tues 8/27	Rigid body rotation	Taylor Ch 10.1-10.9
Wed 8/28 - Tues 9/3	Coupled oscillators	Taylor Ch 11.1-11.7
Wed 9/4 - Tues 9/10	Hamilton mechanics	Taylor Ch 13.1-13.7
Wed 9/11	Review	
TBD	Final Exam	

How to do well

If you did not take Phys 103 recently, you should review the material from that course. To be best prepared, read chapters 1 – 5, and 8 of the textbook Classical Mechanics by John Taylor.

Taylor will be used as the main textbook. However in some cases, to give you a broader overview and enhance your understanding, we may use a different approach. In lectures, we will go through the key ideas underlying new concepts of classical mechanics. We will also demonstrate the application of these concepts in form of examples. However, to further deepen your understanding it will be good to work through many problems. **Work and discuss these concepts and problems with your classmates. Study groups are encouraged.** It is important to carefully work through example problems on your own as well as in discussion with classmates. The homework and discussion sessions will help with that, but you should do more problems and have additional discussions. It is helpful to review the notes you have taken in lecture, and write out your own notes, explaining the material to yourself. Note sheets will be allowed for exams, so make sure to prepare them while you're working through the material and problems. Do not hesitate to seek help. Attend the discussion sections, and get involved.

D Appendix: Example Lecture Notes



$$\mu \ddot{r} = \frac{\ell^2}{\mu r^3} - \frac{\partial U}{\partial r}$$

Finally, we can express the centrifugal force $F_{cf} = \frac{\ell^2}{\mu r^3}$ in terms of a potential U_{cf}:

$$F_{cf} = -\frac{\partial}{\partial r} U_{cf} \Rightarrow U_{cf} = \frac{\ell^2}{2\mu r^2}$$

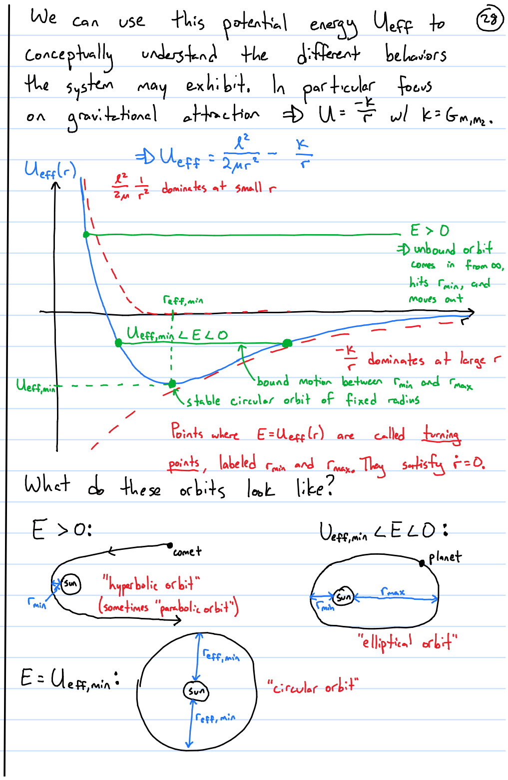
Now we can write our radial equation as

$$\mu \ddot{r} = -\frac{d\underset{\text{"effective" potential}}{U_{eff}}}{dr} \equiv -\frac{d}{dr}\left[U_{cf} + U(r)\right]$$

Thus, we have transformed the two-body problem into the problem of a 1-dimensional particle in a potential U_{eff}.

We can use another conservation result from the previous section: there is no explicit time dependence $\left(\frac{\partial \mathcal{L}}{\partial t} = 0\right)$. Thus the energy (aka Hamiltonian) is conserved:

$$E = T + U = \frac{1}{2}\mu\left(\dot{r}^2 + r^2\dot{\phi}^2\right) + U(r)$$
$$= \frac{1}{2}\mu\dot{r}^2 + \frac{\ell^2}{2\mu r^2} + U(r)$$
$$\Rightarrow E = \frac{1}{2}\mu\dot{r}^2 + U_{cf} + U(r)$$
$$\Rightarrow E = \frac{1}{2}\mu\dot{r}^2 + U_{eff}(r)$$



(28)

We can use this potential energy U_{eff} to conceptually understand the different behaviors the system may exhibit. In particular focus on gravitational attraction $\Rightarrow U = \frac{-k}{r}$ w/ $k = Gm_1m_2$.

$$\Rightarrow U_{eff} = \frac{\ell^2}{2\mu r^2} - \frac{k}{r}$$

Points where $E = U_{eff}(r)$ are called <u>turning points</u>, labeled r_{min} and r_{max}. They satisfy $\dot{r} = 0$.

What do these orbits look like?

$E > 0$:

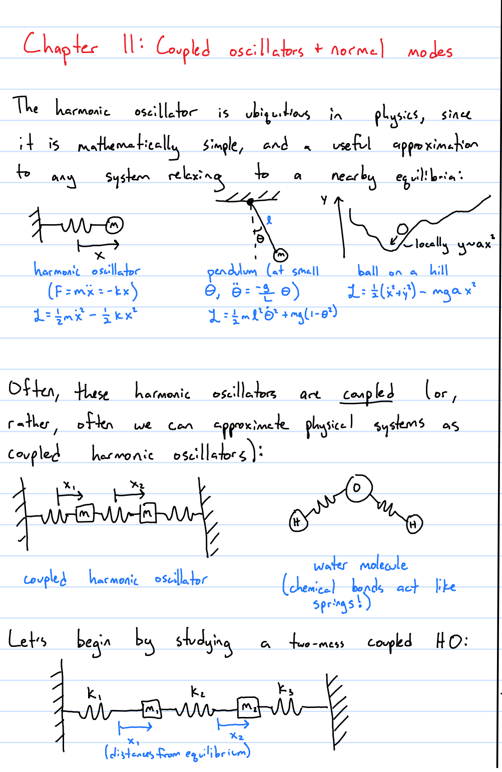
"hyperbolic orbit" (sometimes "parabolic orbit")

$U_{eff,min} < E < 0$:

"elliptical orbit"

$E = U_{eff,min}$:

"circular orbit"



Chapter 11: Coupled oscillators + normal modes

The harmonic oscillator is ubiquitous in physics, since it is mathematically simple, and a useful approximation to any system relaxing to a nearby equilibria:

harmonic oscillator ($F = m\ddot{x} = -kx$)
$\mathcal{L} = \frac{1}{2}m\dot{x}^2 - \frac{1}{2}kx^2$

pendulum (at small θ, $\ddot{\theta} = \frac{-g}{L}\theta$)
$\mathcal{L} = \frac{1}{2}m\ell^2\dot{\theta}^2 + mg(1-\theta^2)$

ball on a hill
$\mathcal{L} = \frac{1}{2}(\dot{x}^2+\dot{y}^2) - mgax^2$

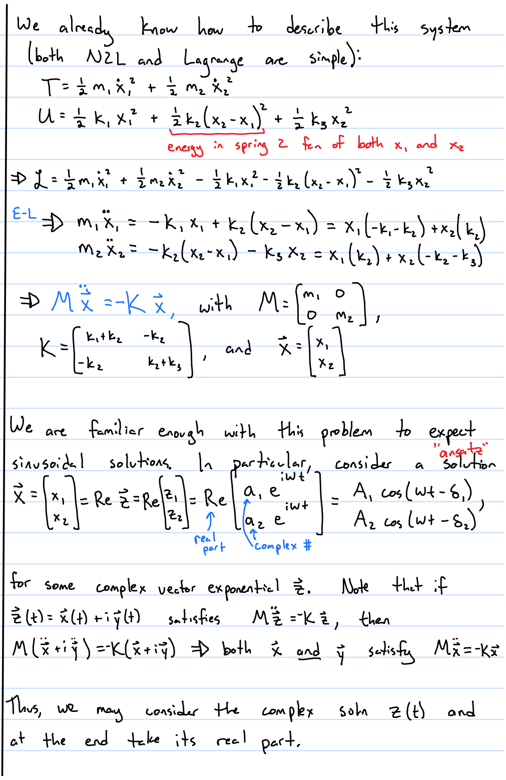
Often, these harmonic oscillators are <u>coupled</u> (or, rather, often we can approximate physical systems as coupled harmonic oscillators):

coupled harmonic oscillator

water molecule (chemical bonds act like springs!)

Let's begin by studying a two-mass coupled HO:

(distances from equilibrium)



We already know how to describe this system (both N2L and Lagrange are simple):

$$T = \frac{1}{2}m_1\dot{x}_1^2 + \frac{1}{2}m_2\dot{x}_2^2$$
$$U = \frac{1}{2}k_1x_1^2 + \underbrace{\frac{1}{2}k_2(x_2-x_1)^2}_{\text{energy in spring 2 fcn of both } x_1 \text{ and } x_2} + \frac{1}{2}k_3x_2^2$$

$$\Rightarrow \mathcal{L} = \frac{1}{2}m_1\dot{x}_1^2 + \frac{1}{2}m_2\dot{x}_2^2 - \frac{1}{2}k_1x_1^2 - \frac{1}{2}k_2(x_2-x_1)^2 - \frac{1}{2}k_3x_2^2$$

$$\overset{\text{E-L}}{\Rightarrow} m_1\ddot{x}_1 = -k_1x_1 + k_2(x_2-x_1) = x_1(-k_1-k_2) + x_2(k_2)$$
$$m_2\ddot{x}_2 = -k_2(x_2-x_1) - k_3x_2 = x_1(k_2) + x_2(-k_2-k_3)$$

$$\Rightarrow M\ddot{\vec{x}} = -K\vec{x}, \text{ with } M = \begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix},$$
$$K = \begin{bmatrix} k_1+k_2 & -k_2 \\ -k_2 & k_2+k_3 \end{bmatrix}, \text{ and } \vec{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

We are familiar enough with this problem to expect sinusoidal solutions. In particular, consider a "ansatz" solution

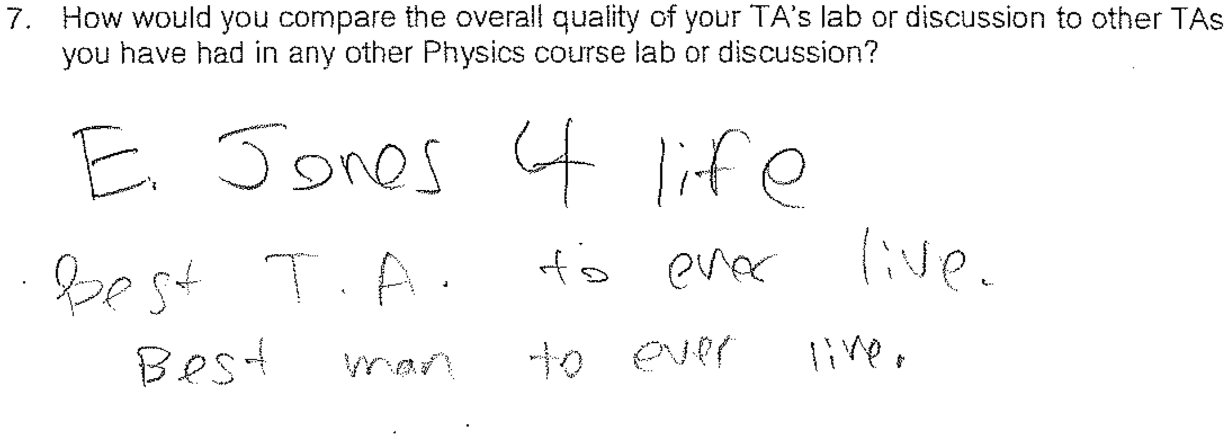
$$\vec{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \text{Re}\,\vec{z} = \text{Re}\begin{bmatrix} z_1 \\ z_2 \end{bmatrix} = \underset{\uparrow\,\text{real part}}{\text{Re}} \begin{bmatrix} \underset{\uparrow\,\text{complex \#}}{a_1} e^{i\omega t} \\ a_2 e^{i\omega t} \end{bmatrix} = \begin{matrix} A_1\cos(\omega t - \delta_1) \\ A_2\cos(\omega t - \delta_2) \end{matrix},$$

for some complex vector exponential $\vec{z}$. Note that if $\vec{z}(t) = \vec{x}(t) + i\vec{y}(t)$ satisfies $M\ddot{\vec{z}} = -K\vec{z}$, then $M(\ddot{\vec{x}} + i\ddot{\vec{y}}) = -K(\vec{x} + i\vec{y}) \Rightarrow$ both $\vec{x}$ <u>and</u> $\vec{y}$ satisfy $M\ddot{\vec{x}} = -K\vec{x}$

Thus, we may consider the complex soln $z(t)$ and at the end take its real part.

E Appendix: Sample Student Feedback

TA for PHYS 20, Fall 2015



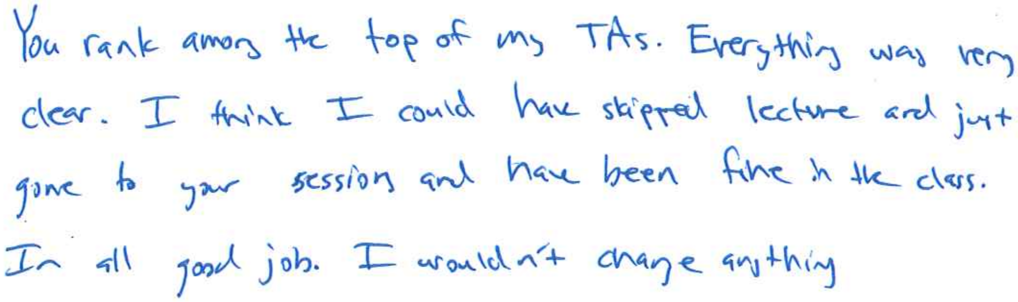
7. How would you compare the overall quality of your TA's lab or discussion to other TAs you have had in any other Physics course lab or discussion?

E. Jones 4 life

Best T.A. to ever live.

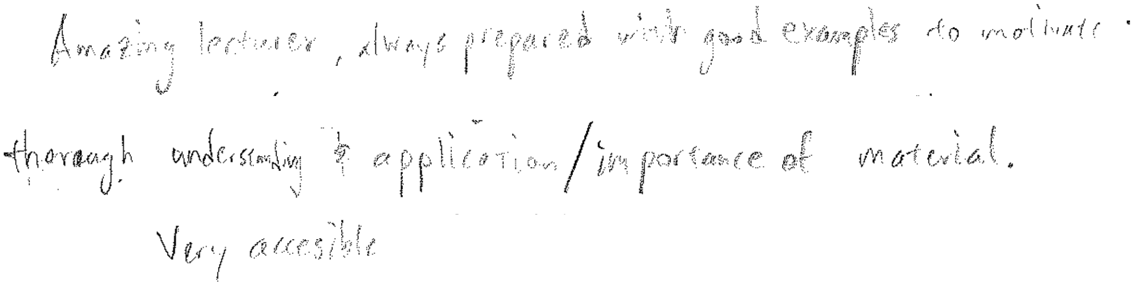
Best man to ever live.

TA for PHYS 101, Winter 2016



You rank among the top of my TAs. Everything was very clear. I think I could have skipped lecture and just gone to your session and have been fine in the class. In all good job. I wouldn't change anything

Instructor of record for PHYS 104, Summer 2019



Amazing lecturer, always prepared with good examples to motivate thorough understanding & application/importance of material.

Very accesible

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