Comprehensive Exam Process (Comps I and II)
A Guide for Students

(revised July 2026 by S.E. Parker)

Preface

This document is primarily intended to provide guidance for graduate students approaching their Comps II exam. Normally "approaching" means you are at the beginning of your third year of graduate school here at the University of Colorado. Students in their second year are encouraged to take the exam if they are ready. The exam consists of three parts. A formal paper demonstrates the ability to review and synthesize relevant published research on a selected topic in physics. An oral presentation demonstrates the ability to organize and present research at a scientific meeting. Finally, the oral part of the Comps II exam demonstrates the student's broad understanding of physics. The oral part of the exam in part assesses your ability to reason on problems you don't necessarily know the answers to immediately. The examiners will provide hints and guidance as appropriate.

Schedule Requirements for Comps I and Comps II

Comps I is typically completed by the end of a student's second year and requires successfully completing (with a B- or higher) five of the six following classes: Quantum Mechanics 1 and 2 (5250 and 5260); Electromagnetic Theory 1 and 2 (7310 and 7320); Theoretical Mechanics (5210), and Statistical Mechanics (7230). Students who have completed equivalent coursework may petition the Physics Graduate Committee to waive certain course requirements. This is done by filling out a Comps I waiver form, attaching the course syllabus, and sending it to the Graduate Program Professional (Jeanne Nijhowne as of 2025/2026). If the classes were not used to satisfy your undergraduate requirements, they may also be transferred and used towards the 30-credit physics course requirement.

Comps II is completed after Comps I. In some situations, the Comps II exam may be taken concurrently in the final semester of Comps I coursework. Comps II should be undertaken by graduate students who have found a Ph.D. thesis research adviser. Graduate students who are on track to not complete Comps II by the end of their sixth enrolled semester **must** petition the Associate Chair for Graduate Studies for an extension. In the absence of an extension, students who have not completed Comps II by the end of their sixth enrolled semester are considered to have failed Comps II and therefore may not remain in the program. The typical student trajectory should have the student ready to at least start the Comps II process by the beginning of their fifth enrolled semester, typically the fall beginning their third year. Early trajectories are welcomed and strongly encouraged.

Comps II Exam Overview

The Comprehensive Exam (Comps II) must be scheduled for a two-hour window and has three oral parts: a presentation (20 minutes, assuming no interruptions), a question period that specifically addresses the talk and paper (15-20 minutes), and a second question period covering general undergraduate physics (40 minutes).

The process begins with the submission of a "**Topic Proposal**" to the Chair of the **Comprehensive Exam Committee (CEC)**. The topic proposal form can be found on the Physics web site. Submit your topic proposal in pdf format. Prepare your proposal using any text editor and format you like, simply list and answer the questions. In the proposal you give a brief description of your proposed topic. Once approved, write a paper of professional quality that will also serve as the basis of your oral presentation. The entire Comps II process, from start to finish, is designed to take three to four months. It should be completed before the end of your sixth semester, and therefore it is wise to plan ahead and not to wait until the last minute to submit your proposal. Submitting your proposal and securing the three-faculty member **Oral Exam Committee (OEC)** early in the fall semester works very much in your favor. Many exams are taking place and finding faculty to serve on OECs becomes more difficult later in the academic year. Scheduling an exam can be challenging and takes time. Starting early helps reduce uncertainty and avoids the risk of your exam being pushed back until the next fall semester and delaying your academic progress.

The Comps II Process

The Comps II process is comprised of five action items for which you are responsible, plus an additional one if you do not pass all three parts of the exam. The following tasks and their timing are explained in further detail below:

1. Submit Topic Proposal to CEC Chair
2. Coordinate with your OEC to schedule an exam date and time
3. Notify the CEC Chair and the Graduate Program Professional of exam date
4. Compose and submit the final Comps II paper to the OEC and CEC Chair at least two weeks prior to the exam
5. Take oral exam
6. Retake/redo exam parts of exam if necessary.

Timing

A successful Comps II process normally takes 3.5 - 4 months to complete, assuming there are no issues. Exams must be completed by the end of the academic year, which is typically in early to mid-May. This is a hard deadline. The precise date will be included in a letter sent to all third-year students early in the fall. Scheduling can be difficult in early May because many faculty have research and professional service obligations once classes are over. **Your Topic Proposal Form must be submitted by**

the end of the second week in February. Early submission is highly encouraged and works in your favor.

Submit the Topic Proposal as a pdf the CEC Chair. It usually takes two weeks to assign an OEC. The OEC reviews your proposed topic and the OEC Chair will contact you within two weeks to inform you if it is approved and provide any feedback. If it is not approved, you should a revise the proposal, taking the committee's comments into consideration.

Once assigned an OEC and your topic is approved, it becomes your responsibility to schedule an exam date. You should begin scheduling soon because scheduling can be difficult. Once you set a date and time, please send this information to the CEC Chair and the Graduate Program Professional. Your research advisor is encouraged to attend the exam but does not grade the exam and must remain silent during the examination period.

While scheduling with your research advisor and OEC, you should be composing your Comps II paper. It is due to OEC members no later than two weeks before the oral exam. **Please send email reminders to your OEC members** a week before, two days before, one day before, and the morning of your oral exam. **You are responsible to include the link to the score sheet in each reminder**:
https://cuboulder.qualtrics.com/jfe/form/SV_1S1eq9mCAYK2jqd.
Many busy faculty utilize calendar invites. Please use them!

The Topic Proposal

The Topic Proposal is a paragraph or less than one page description on what you are proposing to write your paper on. The paper covers a contemporary topic in physics. Here, "physics" can be interpreted very broadly, going outside the core physics disciplines.

The proposed topic must be entirely outside your field of research. More topic proposals have been rejected by the CEC for reasons of topic overlap than any other reason. If you are doing thesis research on high-Tc superconductivity, for example, you should probably not propose to write about graphene, because both are topics belonging to condensed matter physics. You cannot count on committee members to have the expertise to make a clear distinction of what is and what is not part of your subfield. Therefore, it is safest to keep a far distance for your own field. For example, a condensed matter student writing about X-ray laser physics, would probably safe.

The proposal should address a *contemporary* topic in physics. Contemporary means that it is of current or recent interest and activity, most likely as evidenced by

literature, within the last ten to twenty years. However, we do not mean to discourage topics of continuing but slowly advancing fields, if there is progress to report. Your topic description should be concrete, specific, and place clear limitations on the scope of the proposed paper. Recent fashionable topics such as "quantum computing" or "graphene" are terribly broad, for example. In the first case, you might limit the topic to "Quantum computing with neutral Rydberg atoms" and for the second, it might be: "Ultra high-speed optical modulation based on graphene." Citations to specific literature should help you to be specific about your plans for the paper's content.

While your topic should not be too broad, it should also not be too technical. It should be basic enough to be of interest to a broad audience of physicists. The core of the topic should be heavy on basic physics. An emphasis on engineering, applications, or societal issues should be avoided. The Topic Proposal should include a few physics journal references. In addition to giving credit where credit is due, providing references establishes credibility and helps to better define the proposed paper content. Here is a summary list of Topic Proposal characteristics:

- Physics topic outside of your physics research sub-discipline
- Short. Less than one page
- Concrete and specific, defining the scope of the future paper
- Include a small number of citations to physics journal articles

Suggestions for Selecting a Topic

If you are having difficulty choosing a topic, try going through recent issues of Physics Today, Physical Review Letters, Science, Nature, and similar such journals covering physics and related fields. Journal publishers also often maintain web sites with the latest and greatest news in science. Attend colloquia and seminars. Pick something you may have never heard about but sounds interesting. One purpose of the Comps II paper writing exercise is to help you maintain some breadth in physics, because much of the remainder of your time here focuses on one very tiny portion of physics (even if it is the most important in the world!). One very common error students make is to review many subtopics within a field with a lack of depth. It is better to explain the fundamental physics of one subtopic well. It is this depth of understanding that the OEC is looking for in the paper and presentation (not the topic proposal). The topic should be narrow enough so that a comprehensive review of many facets is not needed and the fundamentals can be covered in a 10-12 page paper and a 20-minute talk.

Topic Proposal Format

As in nearly any professional composition, the Topic Proposal should list its title, authorship (that's your name as you like to have it appear in print) and date. Make sure to include a short list of physics journal references. It must be sent by email to the CEC Chair as a pdf document.

Topic Proposal Acceptance/Revision

Your OEC will review your Topic Proposal and the OEC Chair will provide feedback and let you know when it is approved. If you do not hear back from the OEC Chair contact them two weeks after your OEC was assigned. If feedback is provided by the OEC, please use this as guidance to improve your paper and talk.

Writing the Comps II Paper

The Comps II paper is a review of a research topic including its history, importance, and current challenges. The paper does not require you to carry out any new research. It must explain the fundamental physics in a way that is understandable to a first-year graduate student, like the intent of the CU physics department colloquia. In this way, the paper is quite different than a refereed journal article. It should not be too technical or comprehensive. The level of the paper should be like that found in feature articles that focuses on a current research topic in
Physics Today. See: https://physicstoday.aip.org/issue-archive
Use a conventional physics journal article format and not that used in *Physics Today*. You may use the format of one of the physics journals in your own research area.

The paper must be your own work. AI or other human generation that is not your own work is considered plagiarism. Use of AI is allowed for basic grammar correction. The paper must be a professional, publication-quality document of 2500-3000 words (10 - 12 pages). It will contain an abstract, figures and/or tables that are properly referenced, and will have sources well cited. Any figure or table must have both a caption explaining it and be mentioned in the text as well. The paper must draw on multiple original sources. The paper must be typeset in 12-point font, and double-spaced. Your OEC will be interested in understanding "the physics" of your chosen outside research topic. OEC faculty examiners are typically not all experts on the topic. It is critically important to keep the reader (or reviewer) in mind when writing a paper. Likewise, to keep the audience in mind when preparing a talk. That would be your OEC in this case.

Writing Assistance

The Physics Department has technical writing courses. The instructor teaching those classes is available to provide technical writing assistance. We urge you to seek this person's advice and help. Whether English is your second language, or you are simply concerned about your technical writing ability, outside expertise can be of enormous value. We also encourage you to seek advice from your research advisor about form and content of your paper. It is in everyone's best interests that you can write well.

Paper Submission

The final paper in pdf format should be emailed to the OEC **at least two weeks before the oral exam**. Also provide a copy of the paper by email to the CEC Chair.

Scheduling the Comps II Exam

The exam should be completed within three months after the exam committee is appointed. Exams should not be scheduled during breaks. The candidate is responsible for organizing the time and place of the oral examination (with assistance from professional staff to find a room, if necessary), and making sure all AV equipment is working. The candidate must ensure that all members of the exam committee are available *for a full two hours*, in order that there is adequate time for the exam and the OEC (plus the research advisor) deliberation afterwards. The score sheet is electronic, and you should include the link in any communication you have with your committee reminding the members of the exam's time and place.

The Exam Format

The exam will consist of the student's 20-minute oral presentation, followed by 15-20 minutes of questions on your talk and paper. Then there is 40 minutes of questioning on general physics. Consider crafting backup slides for more technical aspects that you might expect to be asked about but that can't fit in a 20-minute talk.

Public Attendance

The Comps II oral exam is **not** open to the public (or your guests, colleagues, etc.).

The Oral Presentation

The examination begins with a 20-minute talk on your paper's topic. You are expected to use a computer projector, and it is your responsibility to stay within the time limit. The time limit will be enforced by the OEC Chair, with allowances made if there are delays due to questioning. The presentation should be at the same level as our physics colloquia. Namely, it should be understandable to a first-year physics graduate student. A physicist in the same general research field but outside the particular topic should be able learn something new from the talk. Often, students err on the side of making the talk too technical without "explaining the physics". The committee will expect to hear the underlying fundamentals and even OEC members who are experts may drill deep to ensure your understanding is firm. The talk should have good organization, use figures well, and be presented clearly. You should be very well prepared and comfortable with the material. You should be prepared enough to not read directly from a script. The OEC should only ask clarifying questions during your presentation. However, expect and be prepared to handle questions during your talk. You will not be penalized for the additional time needed.

The Question-and-Answer Session

After the talk concludes, the exam committee will ask you questions related to your talk and paper for 15 to 20 minutes. These questions may clarify the material presented, as well as probe further into your understanding of the topic. The committee may also ask questions regarding the paper.

The rest of the exam covers general physics and typically last 40 minutes. Realize that the transition from the questions on the topic and general physics may be gradual and this is managed by the OEC Chair. This part of the Comps II exam is required to demonstrate the skills and knowledge in physics to qualify for Ph.D. candidacy. You are expected to demonstrate in the exam a mastery of undergraduate physics, defined broadly. The exam will test both conceptual understanding and problem-solving. Questions may be drawn from basic undergraduate physics. If you are unsure of topical coverage, see the CU's undergraduate physics course requirements. Topics include classical mechanics, electromagnetism including circuits and EM waves, special relativity, quantum mechanics, and thermal physics. You are expected to be able to use basic mathematical techniques such as series expansions and solving differential equations. Special topics such as solid-state, nuclear, particle, atomic, or plasma physics can appear, but specialized knowledge is not expected of you.

Expectations

About 90% of students pass the exam the first time. That is the good news. The bad news is that a sizable fraction (maybe 30%) of students do not perform well on answering questions (as measured by mastery knowledge of undergraduate physics). It is typically the general physics questions, but there can also be problems with a lack of basic understanding of the topic. Of this 30%, there is an inevitable variability in the exam outcome. With that said, you should prepare well (by practicing) and take the oral physics questioning part very seriously so that your exam goes smoothly and you avoid the variability of outcome issue completely (approximately 70% of students sail through smoothly because they are very well prepared).

You are not expected to answer every problem well to pass. But you are expected to demonstrate some knowledge of undergraduate physics. It is very important to understand what is being asked. If you are unsure, you may ask clarifying questions. It is also OK, after some thought, to say "I'm a little stuck here… and not sure where to go next." This will not immediately lead to failure. The score of a pass is 50% (see Exam Scoring below), so it is in your best interests to keep your composure and power through it.

Concluding the Exam

After the oral exam ends, you will be excused from the room, so remove all your belongings. You should leave the exam area as you will not be given the results of the

exam orally. You will be informed of the outcome of the exam by an email from the OEC Chair.

Exam Scoring and Results

Each Oral Exam Committee member will assign points to the three parts of the examination as follows: Paper 0 - 3; Presentation 0 - 3; Questions 0 - 4. The OEC will discuss the result and conclude whether the candidate has passed or failed: candidates may pass at the PhD candidacy level, the Master's level, or fail parts of the exam. A passing score at the PhD level for each part of the exam is 50% or better. A student who continues in the Ph.D. program will obtain a Master's degree after passing all three parts. Student's not continuing in the Ph.D. program are required to have passed two of the three areas to obtain a Master's degree. Exceptions require approval from the Graduate Chair.

Retaking the Exam on a Partial Pass

The first thing to understand is that a partial pass on a Comps II exam is a setback, but **not**, on its own, a reason to give up your Ph.D. ambitions. Most students do pass the exam the second time and learn something by doing so. If you do not pass the entire exam, you will be informed of the areas that need improvement. Candidates with a partial pass should meet with their research adviser to discuss the outcome and develop a plan for moving forward. The OEC Chair and the CEC Chair will provide guidance. Students who receive a partial pass on the first attempt may request a new committee for the second attempt. Even without the student's request, a new examination committee may be assigned by the CEC Chair.

Normally Comps II will be completed by the end of your third year. You are allowed one retake if you do not pass a portion of your exam on the first try. You fail Comps II if you do not make a first attempt by the end of the second semester of your third year. Unless and extension is granted, you fail Comps II if you have not retaken the failed portion(s) of the exam within one year. In the case of a failed retake, you are permitted to complete the semester for which you are enrolled.

Guidelines for Receiving a Master's Degree (MS)

The Comps II exam is used as the Master's Exam in the Physics Department. Once you have successfully completed Comps II, and you have completed or are in the process of completing all 30 course credits, you are eligible to receive a Master's in Science (MS) degree. You will need to apply to the Graduate School through myCUInfo by the Master's deadline set by the Graduate School. Check the Registrar's calendar for dates. If you miss the deadline, you will need to apply for the following semester. You should apply for an MS only after you have successfully completed all parts of Comps II if you intend to stay in the Ph.D. program. Your OEC is considered you Master's exam

committee in the Physics Department. The OEC Chair is recorded as Chair on you Master's Exam Report.

If you plan on taking the Comps II Exam to obtain a Master's degree only and not stay in the Ph.D. program, contact the CEC chair.

Additional Important Rules

Taking the Exam During Summer Session

Comps II exams cannot take place during the summer due to university policy. Please contact the Graduate Program Professional if you have questions regarding taking the exam outside the fall/spring academic semesters.

Recourse, Requests for Exemptions, and Similar

It is the CEC's responsibility to administer the Comps II exam and to follow the policies that have been put into place by the Physics Department. If you have questions or concerns regarding the policies and procedures, it is appropriate to contact the CEC chair. Please understand that Comps II is independent of your research obligation to your research group. While your research advisor is urged to participate in the exam and is often included on email communications, your research advisor is not on the OEC and has little control over the timing and outcome. Thus, you will need to manage your travel and other research commitments that may potentially conflict with your Comps II exam preparation. The Graduate Committee, not the CEC, considers petitions for exceptions to the rules established by the department.

Suggested Reading

The following reading and references may be helpful preparing for the Comps II paper and presentation.

The Mayfield Handbook of Technical & Scientific Writing, Leslie C. Perelman, et al, Mountain View, CA: Mayfield, (1998).

The Craft of Research, Wayne C. Booth, et al, Chicago, IL: U of Chicago Press (2003).

Keys for Writers, Ann Raimes, fourth edition, Houghton Mifflin, (2004).

The Science of Scientific Writing, George D. Gopen and Judith A. Swan, *American Scientist* Volume 78, 550-558 (Nov-Dec 1990).