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

(revised August 2025 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.

Schedule requirements for Comps I and Comps II

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 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 syllabi, 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 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 at least have the student ready to 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 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 (henceforth CEC)**. The topic proposal form can be found on the physics web site. You submit your topic proposal in pdf format. You may 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, you 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 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 nominally 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-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. Working back, this means that it is very dangerous to send in a

proposal to the CEC after early February: there will be no margin for issues such as having your proposal rejected. **An early start is highly encouraged.**

Submit the Topic Proposal as a pdf to the Chair of the CEC. It usually takes two weeks to assign an OEC. The OEC reviews your proposed topic and the OEC chair will contact you in less than two weeks to inform you if it is approved and provide any feedback. If it is not accepted, 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. Include the link to the score sheet 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, say, within the last ten or 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 narrow. A single calculation or experiment will often lose the bigger picture. The core of the topic should be heavy on real physics; 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!)

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. It is in your own best interests to take any comments from the OEC seriously.

Writing the Paper

The Comps II paper is a review of a research topic including its history, importance, ongoing efforts, outstanding issues, and likely future directions. It need not be comprehensive or cover every detail. 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 should be a formal, publication-quality document of 2500-3000 words (12 - 15 pages). It should contain an abstract, figures and/or tables that are properly referenced, and citations. The paper's writing quality, organization, typesetting, and figures must be professional. The general level of the paper should be that of a serious review article, such as a feature article in *Physics Today* on current research or a contribution to *Annual Reviews*. The paper must draw on many original sources; a "book report" or a paper that relies largely on a single source is not acceptable. The paper should be **your own** writing, but it is not expected and not appropriate to involve new research. The paper should be typeset in 12-point font, and double-spaced. The paper should explain the connection of your topic to fundamental principles of physics. It does not need to cover every technical detail or recent result that would be more typical for a scientific review article. The OEC will be more interested in understanding "the physics" of your chosen topic.

For style guidance, go to the website of one of the physics journal publishers (preferably one that you might actually use to submit manuscripts for publication in your research). You may use the style format for paper submissions to that journal, except figures and tables should be included with the text near their first mention rather than at the end as expected by some publishers.

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 interest that you can compose a competent work.

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 Exam

The exam should be completed within three months after the exam committee is appointed. 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.

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 you giving a 20-minute talk on the paper 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 the student questions related to their talk and paper for 15 to 20 minutes. These questions may clarify the material presented, as well as probe further int the student's understanding of their topic. The committee may also ask questions regarding the paper.

The rest of the examination 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 the full range of basic physics fields: classical mechanics including wave motion and Lagrangian and Hamiltonian dynamics; electromagnetism including circuits and EM waves; special relativity; nonrelativistic quantum mechanics including perturbation theory and scattering; optics; statistical physics and thermodynamics. 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.

Concluding the Exam

After the oral exam ends, you will be excused from the room: 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.

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. 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.

Who May Chair a Master's Exam?

The person who is recorded as Chair on your Master's Exam Report form must be rostered in the Grad School. If you are unsure whether a particular faculty member is rostered, check with the Graduate Program Assistant. All tenure/tenure track physics faculty are already rostered.

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 of help for students 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).