Physics PhD Program - Evaluation of Students

Summary

The PhD evaluation process is based on five learning objectives (see page 2). Incoming students will meet with an advising committee (the Core-Advising Committee) that will work with each student to develop an appropriate path to meeting the learning objectives in a timely fashion. This includes an individualized schedule for taking the core courses of the PhD program.

An important step in fulfillment of Learning Objective 1 ("Analyze Physical Systems"), is the successful completion of core physics classes. Students are required to have a 3.0 GPA in 8/9 core physics courses. Students should aim to complete the core courses within the first two years in the program. Retaking courses is allowed. The Core-Advising Committee is responsible for advising and monitoring student's progress through this requirement.

The Preliminary Oral Examination acts as a gateway to PhD candidacy (as mandated by the graduate school). Before scheduling this exam, the student completes a writing project. The Preliminary Oral Examination includes two parts: (1) a thesis proposal presentation, and follow-up questions related to the thesis proposal, (2) a student-prepared lecture (self-learned material) on an assigned topic, followed by questions. An appropriate topic for the student-prepared lecture would go beyond what is discussed in graduate courses but be familiar to experts in the student's research field.

Ethics and inclusion are part of the learning objectives. Appropriate ways of satisfying these requirements will be identified early by the Core-Advising Committee. The publication requirement for graduation will be agreed upon at the Program of Study Meeting.

Progress towards the completion of the program will also be monitored through yearly student self-reflection letters, and yearly advisor recommendation letters. These letters will be discussed when the thesis committee meets with the student and that advisor at the required annual progress meetings.

Note to students who began the PhD program prior to Fall 2020

The evaluation process described in this document applies to students who enter the PhD program in Fall 2020 and onward. Students who entered the PhD program prior to Fall 2020 are are being evaluated by an older system. These students who are evaluated under the older system have the option of switching to the new system. Students must make a written request to switch (send your request to the Department Chair). Switching can only be done once. When a student switches, the following equivalencies will be applied:

Old system	Equivalent accomplishment in the new system
・Passed the old comprehensive exam	・Passed the GPA requirement for core courses
・Passed the old Preliminary Oral Exam	・Passed the writing project and the new Preliminary Oral Exam
・Passed the Research Seminar and completing CITI ethics training	・Passed the ethics training requirement

Learning Objectives for the Physics PhD

OSU Graduate School PhD Learning Outcomes
(https://gradschool.oregonstate.edu/faculty/program-assessment**):**

a) produce and defend an original significant contribution to knowledge; and
b) demonstrate mastery of subject material; and
c) be able to conduct scholarly activities in an ethical manner.

In addition, and as a clarification to the OSU Graduate School Learning Outcomes, upon completing the requirements for a PhD in physics from Oregon State University, Physics graduates will be able to:

Analyze Physical Systems
Apply physical laws and principles to formulate and produce solutions to questions that arise from a broad range of physical phenomena; master quantitative techniques (exact techniques and various levels of approximation including order-of-magnitude estimates); and devise and adopt ways of making meaning of their results.

Learn Physics Expertly
Learn and apply new concepts, methodologies, and techniques by identifying and engaging with various resources including, e.g., research literature and books, both individually and in collaboration with peers and other experts.

Create and Share Novel Physical Insight
Design and conduct original research within a chosen specialty and disseminate the results through effective presentations in professional settings and in the scientific literature. Research expectations include: familiarity with primary literature, identification of central issues and knowledge gaps, ability to develop original questions, ability to identify and mitigate obstacles in research, ability to engage in productive discussions and work synergistically within a group or collaboration, and ability to write effective scientific publications that include citations and clear descriptions of methods and results.

Communicate with Learners
Design and facilitate physics learning experiences at an appropriate level of sophistication for a broad range of audiences (e.g. colleagues, students, and the general public).

Do Physics Ethically and Inclusively
Conduct themselves ethically and inclusively in all professional settings, in accordance with the American Physical Society code of ethics (https://www.aps.org/policy/statements/ethics.cfm), as well as proactively identify areas where ethical and/or discrimination issues may arise and articulate strategies for dealing with them.

Linking Learning Objectives to Evaluation Instruments

Learning Objective: Analyze Physical Systems

Importance: Familiarity with basic physics is expected from a PhD in Physics. Problem solving techniques are necessary for research, industry, and teaching jobs.

Primary Assessment Tool

- Core course minimum GPA requirement. Assessed at meetings with Core-Advising Committee.

Additional Assessment Tools

- Lecture presentation about an assigned, self-taught topic.
- Thesis Proposal
- Student Self-Evaluation
- Advisor Evaluation
- Thesis Manuscript
- Thesis Defense

Learning Objective: Learn Physics Expertly

Importance: It is a crucial skill for a physics PhD to be able to learn new skills on their own and/or through collaboration with peers, outside of the classroom environment.

Primary Assessment Tool

- Lecture presentation about an assigned, self-taught topic. Assessed at the Preliminary Oral Examination.

Additional Assessment Tools

- Courses
- Thesis Proposal
- Student Self-Evaluation
- Advisor Evaluation
- Thesis Manuscript
- Thesis Defense

Learning Objective: Create and Share Novel Physical Insight

Importance: Being able to design, conduct, and disseminate original research is the hallmark of a PhD. Typical employment of PhDs in academia, industry, and government requires such skills.

Assessment Tools

This is a complex learning objective that requires a multi-layered assessment strategy assessed throughout the PhD.

- Writing project
- Thesis Proposal
- Student Self-Evaluation

- Advisor Evaluation
- Thesis Manuscript
- **Final Oral Examination** (Thesis Defense)

Learning Objective: Communicate with learners

Importance: The ability to teach physics is fundamental for a physics PhD. Teaching here has broad meaning, including classroom teaching, training, and doing outreach.

Primary Assessment Tool

- Lecture presentation about an assigned, self-taught topic. Assessed at the Preliminary Oral Examination.

Additional Assessment Tools

- Courses
- Thesis Defense

Learning Objective: Ethics and Inclusion

Importance: Being able to perform the duties of a physicist in an ethical manner is key for the reliability and reproducibility of results and the reputation of the profession. Inclusiveness is a shared value in physics. Advancement of the understanding of nature will be more efficient if everyone is allowed to participate on equal footing.

Primary Assessment Tools

- Ethics training, Inclusion training.
- Student Self-Evaluation
- Advisor Evaluation

Description of each evaluation instrument

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Core-course GPA

The core courses are defined to be the courses that are required to be completed by all Physics Ph.D. students. Currently this consists of the following 9 courses:

- Mathematical Methods
- Dynamics
- Quantum Mechanics 1, 2, and 3
- Electromagnetic Theory 1, and 2
- Statistical Thermophysics 1, and 2

A grade point average (GPA) will be calculated from the highest 8 grades from the 9 core classes. This top-8, core-class GPA must be greater than or equal to 3.0. Retaking a course should be discussed with the Core-Advising Committee. If a student retakes a course, the second grade will count (this is OSU's policy for retaking classes). Students should strive to complete the core course GPA requirement as early as possible in the program, following the individual plan agreed with the Core-Advising Committee. A student who does not take bridge courses is expected to complete the core courses in the first two years of the program. (Bridge courses are courses that a student uses to form a bridge from their undergraduate training to the core graduate courses).

The Graduate Course Group will periodically review the learning outcomes of each core course (and revise if necessary), so that the core courses are optimized to serve the program learning outcome of "Analyze Physical Systems".

Pedagogical Training

The Core-Advising Committee will meet with students at the beginning of Year 1 to help students identify appropriate pedagogical training. This will typically be a formal course offered in the first year of the graduate program. The student must participate in and pass the training.

Ethics Training

The student must take the CITI online training modules and pass the online tests as part of the ethics component of the Research Seminar. Research groups will regularly discuss the ethical conduct of research.

Inclusion Training

The core-advising committee will meet with students at the beginning of Year 1 to help students identify appropriate inclusion training. For example, it may be a course about inclusion. The student must participate in and pass the training. Research groups and teaching teams will regularly discuss the inclusive conduct of professional work.

Student self-evaluation and advisor evaluation

Before the first program-of-study meeting, and before every annual meeting thereafter, the advisor will write an evaluation of the student, and the student will write a self-evaluation. (The Preliminary Oral Examination and the Thesis Defense count as annual meetings). The evaluations are a list of things the student has done, with emphasis on what was done since the last annual meeting, to make progress towards the learning outcomes. The evaluations monitor progress toward learning outcomes, and provide an opportunity for the student and advisor to gain clarity and guidance. The cumulative portfolio of evaluations will also be useful for the student when writing job applications, and useful for the advisor when writing letters of recommendation.

We recommend that the student and advisor write their self-evaluation/evaluation independently. The evaluations must be shared with the graduate committee at least 48 hours before the annual meeting. The advisor is encouraged to share their evaluation with the student (before and/or after the annual meeting) to facilitate feedback/guidance on progress towards the learning objectives.

A suggested template for evaluations is provided here.

Analyze Physical Systems:

- Briefly describe physical systems that the student analyzed in the last year in the context of their research project.

Learn Physics Expertly:

- Briefly describe concepts that the student learned outside the classroom environment. Describe how the learning occurred.

Create and Share Novel Physical Insight:

- Discuss any knowledge gaps in the research field that the student has identified. (Sometimes we find a knowledge gap, then do a literature search and discover that the gap has been filled. This is a success is worth recording in the evaluation.)
- Discuss trouble shooting that the student performed in the course of research.
- What are the most important/significant discussions the student had about the research in the last year. Who participated in the discussion?
- What collaborations has the student engaged in? What role?
- What writing and presentations has the student done in the context of research?

- What is the publication requirement for a PhD from this research group?

Ethics & Inclusion:

- Discuss what you have done in the past year to ensure that your professional work (research and teaching) is done ethically and inclusively. What problems are you still facing in conducting your professional life ethically and inclusively?

Publication requirement

The publication requirement can vary between subfields. This requirement will be defined by the advisor in the first evaluation letter (see above). The publication requirement can subsequently be amended with the consensus of the committee. The advisor's publication requirement must clarify the role of co-authorship. The agreed-upon publication requirement must be met before the **Final Oral Examination**.

Writing project

Scientific writing is one of the important skills to be developed in the course of Ph.D. studies. The goal of the writing project is to develop skills in clear written communication that prepares the student for writing peer-reviewed research papers and the Ph.D. thesis. The writing project should be completed before scheduling the Preliminary Oral Examination and be one of the following:

- Thesis proposal
- Conference proceedings paper
- Letter or Article written for a journal (i.e. "a paper")
- Literature review (e.g. to serve as an introduction for a thesis)
- MS Project report

The writing must be done during the student's time in the graduate program at OSU, and the writing must be done by the student independently. The advisor's feedback on the manuscript should be incorporated in the document, but all editing must be done by the student.

The structure of the document depends on the type of the document chosen (see above). However, most document types are expected to follow the structure of scientific publications and have (i) an abstract, (ii) an introduction to discuss the motivation for the research, the status of the field and the gaps of knowledge, (iii) proposed methodology or relevant theoretical framework, and (iv) preliminary or anticipated results. The main discussion should be followed by (v) conclusions and (vi) references. The literature review document is be expected to have an overview of various methodologies and literature results and how they inform the research to be done by the student towards their Ph.D.

There is no page requirement for the writing project. However, a typical format for a full-sized conference proceedings paper (5-10 one-and-a-half spaced pages which includes figures and references) provides a reasonable target.

The quality of the document will be evaluated by the committee and feedback to the student will be provided within 1 week of submission. If revisions are necessary, these revisions will have to be incorporated before the Preliminary Oral Examination can be scheduled.

Preliminary Oral Examination:

The Preliminary Oral Examination consists of two parts. The student may choose the sequence of these two parts. The total time allocated for the exam is 2 hours.

Part I. Thesis proposal

The thesis proposal consists of a 30-minute talk followed by questions. The talk may include results from the student's preliminary research, but the main emphasis should be the proposed research. The structure of the talk should be as follows: introduction (to introduce the committee to the field, identify gaps in knowledge and provide context for the proposed research), preliminary results (which helped shape the proposal and demonstrate core competencies of the student researcher), and proposed research. The proposed research part should focus on research questions to be answered, proposed methodology, risks associated with the methodology (what can go wrong?). Risk mitigation should be discussed. A timeline for achieving research milestones should also be provided.

The follow-up questions from the committee will evaluate the student's understanding of research goals, knowledge of the methodology, suitability of methodology, and the literature context for the proposed research.

Part II. Presentation on a self-taught topic

4 weeks before the scheduled date of the Preliminary Oral Examination, the student's advisor will email the thesis committee members with a list of suggested topics. The committee will communicate via email (or otherwise) to select one topic.

3 weeks before the scheduled date of the Preliminary Oral Examination, the committee will communicate the topic to the student. The student will prepare a 25-minute presentation/lecture on the topic, which will be given during the Preliminary Oral Examination.

The student will be questioned by the committee during and after the presentation. The committee may ask clarifying questions during the presentation. Questions that go beyond clarification will be reserved for after the presentation.

The topic should be selected in such a way that it is relevant to the student's proposed research topic, yet it is general enough that experts in the student's research field should be knowledgeable about it. The topic should be beyond what is discussed in graduate courses.

The student should prepare the presentation as for a classroom setting, including quantitative statements and a detailed derivation of the presented conclusion(s). When preparing this presentation, the student is free to use any learning tool, including the advice of peers, colleagues, department members, and the student's supervisor. However, interactions with colleagues/experts must be kept at a professional level such that the student maintains ownership of the finished product. For example, when the student discusses the topic with their advisor, the interaction would look like a student visiting office hours for a class.

Example topics that could be assigned to a student doing research in astrophysics:

- Solutions of the Riemann problem (for a numerically oriented student)
- Apparent superluminal motion in astrophysics
- The Jeans limit and its relevance in structure formation

Example topics that could be assigned to a student doing research in condensed matter:

- The phenomenology of type-I and type-II superconductivity

- What are dislocations, and how do they affect ductility?

Thesis and Final Oral Examination (thesis defense)
The members of the thesis committee who are Physics faculty will review any thesis material that hasn't been peer reviewed. A written report from each professor will be given to student.

Proposed timeline

Table 1 and 2 outline example timelines for assessing a PhD student. There is some flexibility in the timeline that can be adjusted to each student's individual needs. Each student's timeline must be discussed with and approved by the Core Advising Committee.

Table 1. An example timeline for assessments for a student not taking bridge courses.

Year 1	Core grad class grades	Pedagogy training	Ethics training	Inclusivity training	
Year 2	Core grad class grades	Student self-evaluation	Advisor evaluation		
Year 3	Writing project	Student self-evaluation	Advisor evaluation	Preliminary Oral Examination: Thesis proposal	Preliminary Oral Examination: Lecture from self-learning
Year 4		Student self-evaluation	Advisor evaluation		
Year 5	Publication requirement	Student self-evaluation	Advisor evaluation	Review of written thesis	Thesis Defense

Table 2. An example timeline for assessments for a student who takes bridge courses.

Year 1	Bridge class grades	Pedagogy training	Ethics training	Inclusivity training	
Year 2	Core grad class grades	Student self-evaluation	Advisor evaluation		
Year 3	Core grad class grades	Student self-evaluation	Advisor evaluation		
Year 4	Writing project	Student self-evaluation	Advisor evaluation	Preliminary Oral Examination: Thesis proposal	Preliminary Oral Examination: Lecture from self-learning
Year 5		Student self-evaluation	Advisor evaluation		
Year 6	Publication requirement	Student self-evaluation	Advisor evaluation	Review of written thesis	Thesis Defense