



Michigan Technological University
Physics

INFORMATION FOR GRADUATE STUDENTS
DEPARTMENT OF PHYSICS

MS in Physics
MS in Applied Physics
Ph.D. in Physics
Ph.D. in Applied Physics

MICHIGAN TECHNOLOGICAL UNIVERSITY

2023-2024

INFORMATION FOR GRADUATE STUDENTS

Table of Contents

I. Facilities and General Information	1
A. Department Structure	1
B. Keys, Desk, Computers, and Research Space Assignments	2
C. Email, Mail Service, Photocopier, Supplies, and Printers	2
D. Graduate Student Workload Expectations	3
E. Work Obligation of Teaching Assistants (GTA)	3
F. Work Obligation of Research Assistants (GRA)	3
G. Safety	4
H. Absence Policy	5
I. Colloquium	6
J. Academic Integrity	6
K. International Students	6
L. Stipend, Tuition, and Health Care	7
M. Physics Learning Center	8
N. Accommodation Policies for Americans with Disabilities	8
O. Grievance Procedure	8
P. Paternity Leave Policy	9
II. Advisors	9
A. Course-Work Advisor	9
B. Research Advisors – The Selection Process	10
C. Individual Development Plan (IDP)	11
D. Advisory Committee	11
E. Policy for Changing Academic Advisor	12
F. Student Progress Feedback	13
G. Academic Probation	13
III. Graduate Degree Requirements	14
Graduate Course Schedule	15
Responsible Conduct of Research Training (RCR)	16
A. Master of Science in Physics	17
1. Thesis Option	17
2. Report Option	17
3. Coursework Option	18
4. Master's Form Submission Schedule	18
B. Master of Science in Applied Physics	19
Curriculum Design	19
Application Elective Courses	20
1. Thesis Option	21
2. Report Option	21
3. Coursework Option	22
C. Doctor of Philosophy in Physics	22

1. Residency	22
2. Coursework	22
3. Qualifying Examination	22
4. Research Proposal Examination and Petition to Enter Candidacy	24
5. Doctoral Dissertation and Final Oral Examination	25
D. Doctor of Philosophy in Applied Physics	26
1. Advisors and Advisory Committee	27
2. Coursework	27
3. Qualifying Examination	28
4. Research Proposal Examination and Petition to Enter Candidacy	31
5. Doctoral Dissertation and Final Oral Examination	31
E. Graduate Certificates	33
F. Student Responsibilities	33
IV. Time Line to Degree	34
V. Illustrative Time Line for Academically Prepared Physics Ph.D. Graduate Students	36
Appendix A: Annual Graduate Student Progress Report Form	37
Appendix B: Rubrics & Evaluation Form	39

INFORMATION FOR GRADUATE STUDENTS DEPARTMENT OF PHYSICS

The following information has been compiled to assist graduate students with their adjustment to Graduate School and to outline the requirements and procedures for obtaining an advanced degree in the department of physics. The information supplied herein is more specific than that in the Graduate School website as it applies to our programs: M.S. in physics and applied physics, and Ph.D. in physics and applied physics. Students should familiarize themselves with this handbook and the general regulations of the Graduate School as found in their *Policies and Procedures* web pages <https://www.mtu.edu/gradschool/policies-procedures/>, which covers policies and procedures, degree requirements, necessary forms, and more. The Graduate School website <http://www.mtu.edu/gradschool/resources-for/students/> also contains a wealth of information for current students. Convenient links to many of these resources are also available on the physics department website <https://www.mtu.edu/physics/graduate/information/>

I. Facilities and General Information

A. Department Structure

The physics department is a community of scholars and professional staff working together to further the mission of the department and the University. Major academic responsibilities in the department are handled by the Department Chair and several important faculty committees.

Department Chair: Dr. Ravi Pandey / Interim Dean of the College of Sciences and Arts
Dr. Jacek Borysow / Interim Department Chair of Physics

Physics Graduate Studies Committee: Dr. Ranjit Pati, Chair

Applied Physics Graduate Studies Committee: Dr. Yoke Khin Yap, Chair

Atmospheric Science Graduate Studies Committee: Dr. Raymond Shaw, Chair

Qualifying Exam Committee: Dr. Issei Nakamura, Chair

Department Staff:

Megan Johnson -	Office Assistant / Graduate Program Coordinator
Jesse Nordeng -	Machinist & Safety Coordinator
William Slough -	Laboratory Coordinator
Claire Wiitanen -	Office Manager / Budget Coordinator

Graduate Student Government Representatives: Nithin Allwayin & Jester Itliong

B. Keys, Desk, Computers, and Research Space Assignments

Each graduate student in residence is provided a desk for personal use in an office and after-hours access to that office. A student's *HuskyCard* identification card is used for after-hours access to Fisher Hall via the south entrance at US41 by the large lecture halls. Office and teaching laboratory keys are ordered by the Office Manager. Students working on research projects may be issued keys to project laboratories upon approval of the faculty member responsible for that laboratory. Requests for new keys, replacements for lost keys, or swipe-card access to restricted areas should be made to the Department Coordinator. Keys must not be passed on to anyone else or duplicated under ANY circumstances. Lending or duplication of keys is grounds for dismissal. Lost keys need to be reported to supervisors as soon as they are noticed to be missing. A \$100 fee is assessed for any key lost/replaced or not returned to public safety when no longer needed.

Graduate students are provided computer access through computer labs in several common areas (Fisher Hall 331) and offices. Computers for research use are provided by research advisors. Questions and problems with computers should be directed to the Information Technology (IT) help desk, found on the first floor in the library or via email at it-help@mtu.edu. The IT staff will supply you with your username and password; change your password the first time you log into your account.

Students should pay particular attention to Michigan Tech computer use policies regarding copyrights, privacy, passwords, and hacking. These can be found on the IT website <http://www.mtu.edu/it/security/security-resources-tools/online-security-privacy/>

C. E-Mail, Mail Service, Photocopier, Supplies, Printers

E-Mail is the department's primary communication tool with graduate students regarding issues such as financial support, graduate program obligations and responsibilities, and semester timelines and deadlines, to name a few. You are expected to be responsive to departmental e-mails at all times.

Mail is delivered daily to physics around 1:30 p.m. Student mailboxes are located in the main office, Fisher Hall 118. It is advisable to check your mailbox daily for mail and messages.

Photocopiers, laser printers, and office supplies are available for physics graduate students to use for research and teaching purposes only. Departmental resources are limited, so efficiencies such as double-sided printing and copying are appreciated. Please see one of the office assistants for office supplies and your photocopier access code. Also note that there are important national laws regarding photocopying copyrighted materials. If you have a question about copyright law please inquire in the library or see <https://www.mtu.edu/library/research/copyright/>.

D. Graduate Student Workload Expectations

Students who are enrolled are expected to work on their research or coursework according to the [General Requirements of Credit Expectations](#).

1. In summary, these guidelines state: "One credit should average 3.5 hours of a student's time per week for one semester. One hour in class and 2.5 hours in individual study is a typical division." The 3.5 hours commitment per credit holds as well for students enrolled in research credits. Thus an *average* graduate student enrolled in 9 credits of research should spend *on average* $9 \times 3.5 = 31.5$ hours per week on their research.
2. Students who are supported by a GRA, GTA, GTI, GADI, etc. are expected to perform work for the University at the rate of 20 hours per week (for a full appointment). This 20 hours per week is *IN ADDITION* to the amount of time a student spends working on their coursework or research for the credits in which they are enrolled. These graduate appointments are considered to be part-time jobs which provide some financial assistance to students so that they can pursue their degrees on a full-time basis.

The sum of #1 and #2 above is more than 40 hours per week, but less than 60 hours per week; however, the most successful students are those who focus their attention on achieving the intended outcomes for their courses and research.

E. Work Obligation of Teaching Assistants (GTA)

Graduate teaching assistants should expect to devote 20 hours per week to their teaching obligations including office hours set aside to help individual students. Office hours should be a minimum of two (2) hours per week and should be posted on the syllabus and outside the office door. Students employed by the department of physics as teaching assistants are reminded that they serve as representatives of the department - this should be reflected in their comportment. Teaching assistants are required to follow all applicable employee policies. Their immediate supervisor is the laboratory coordinator.

F. Work Obligation of Research Assistants (GRA)

On average, students supported by graduate research assistantships are expected to work 40 hours per week (including approved coursework) for the research project from which the stipend and tuition is paid. Since all support monies are derived from government or industry contracts and grants, it is the student's responsibility to perform assigned research tasks in a timely manner. It should be noted that most contracts require formal progress reports on the research performed. The immediate supervisor of research assistants is their research advisor.

G. Safety

There are several safety policies and procedures in effect at Michigan Tech that particularly apply to graduate students such as those concerning general safety and hazardous waste. Annual online safety training is mandatory for ALL employees and will be communicated to you via email when assigned. Additional safety policies and training required to use the machine shop, any research or teaching laboratories, or chemicals will be communicated and assigned by respective physics personnel. Please consult your research advisor regarding all applicable safety policies and procedures before beginning work. Questions can also be directed to the safety coordinator.

For safety purposes, visitors are not permitted in research and instructional labs unless written permission has been granted by the Department Chair; this includes spouses and children. There have been incidents in other departments where unauthorized visitors, including children, have had accidents causing themselves harm. This rule is designed to prevent this type of tragedy.

For your reference, the Michigan Tech safety manual is available on line at:
<http://www.mtu.edu/ehs/documents/safety-manual/>

H. Absence Policy

Since students are enrolled in one of the graduate courses each semester, details of the requested leave (timing during a semester, length of leave, and similar) must comply with Michigan Tech policies for student absences

(<https://www.mtu.edu/deanofstudents/academic-policies/attendance/>) in general.

Furthermore:

(i) Students supported by research grants or fellowships need approval from the research advisor for a leave of absence in accordance with the requirements of the appropriate funding agencies.

(ii) Students supported by a teaching assistantship (GTA) or employed hourly as a department grader or lab assistant need prior approval from the department's lab coordinator and the research advisor for a leave of absence.

Please note that as per Michigan Tech academic policy, instructors (research/academic advisors) retain the discretion to excuse student absences for reasons other than those described in the above link about Michigan Tech academic policies.

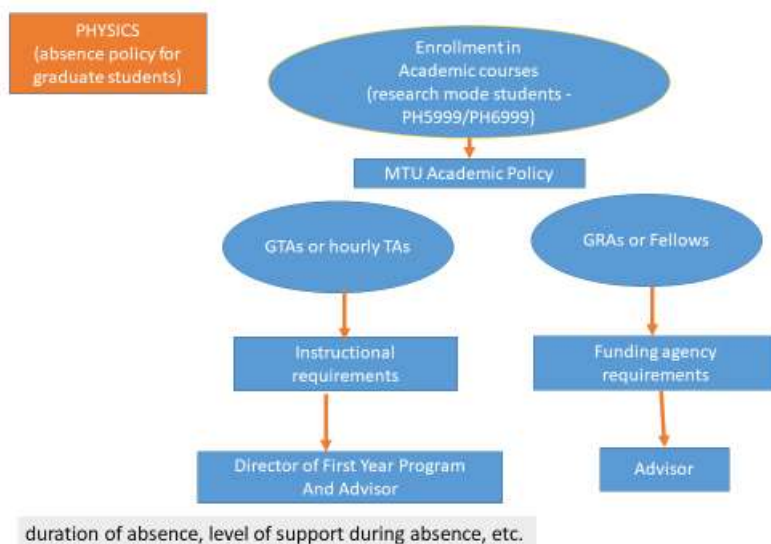
For unforeseen circumstances when a prolonged absence is needed, the Michigan Tech policy will be followed:

<https://www.mtu.edu/gradschool/policies-procedures/academic/student-policies//> .

All absences shall be officially requested by filing the Absence Request Form available at: <https://www.mtu.edu/physics/graduate/pdfs/physics-gradstudent-absence-request-fields.pdf>

Additionally, prior written approval is required for international travel:

<https://www.mtu.edu/fso/forms/travel/>



I. Colloquium

The department organizes a colloquium series held on Thursdays at 4:00 p.m. in Fisher Hall 139. Its purpose is to broaden the education of each student by bringing to campus leaders in various areas of physics. Attendance is required of all students seeking graduate degrees from our department and is explicitly stated in the course descriptions for the department's graduate research courses: PH5010, PH5999, and PH6999. In addition to being an important educational experience, attendance at colloquia is also a professional courtesy to your colleagues and to the invited speakers. Students habitually missing department colloquia will face appropriate actions.

- a. First Year Students – exempt from presentations
- b. Second Year Students – poster presentation is required
- c. All Other Students (On/Off Campus) – must present an oral presentation, unless they would be defending their thesis/dissertations in the Spring or Summer semesters

This provides opportunities for constructive feedback, practice in giving professional presentations, and increases awareness of the exciting research being done in the department. Additional details of this activity will be emailed to you later.

J. Academic Integrity

The University and the physics department expect all students to maintain the highest level of academic and scientific integrity in all aspects of their studies, from class work to exams to research. If you are unsure of or have specific questions about assignments, projects, examinations, etc., please ask your instructor.

A detailed booklet describing Michigan Tech's academic integrity policy and procedures, including definitions of plagiarism, cheating, fabrication, and facilitating academic dishonesty, is available from the Dean of Students office, or on the web at: <http://www.admin.mtu.edu/usenate/policies/p109-1.htm> All graduate students should carefully read this policy. Students must also view the orientation module on academic integrity at <https://www.mtu.edu/gradschool/resources-for/admitted/orientation/online-orientation/>

Further information on Scientific Misconduct Procedures may be found at <https://www.mtu.edu/research/administration/integrity-compliance/misconduct/>

K. International Students

Upon arrival on campus all international students must register with the Office of International Programs and Services (IPS) located in room 200 of the Administration

Building. All matters concerning employment practice, visa renewals, and related matters are handled through this office <http://www.mtu.edu/international/students/current/f1-students/>

All international students whose native language is not English must take an English Language Assessment. The assessment takes place in the Michigan Tech Testing Center, Center for Teaching and Learning, Van Pelt and Opie Library 226. Visit the Testing Center to schedule a time to take the assessment or contact them at 906-487-1001, techttesting-l@mtu.edu. More details can be found at <http://www.mtu.edu/ctl/for-graduate-teaching-assistants/language-assessment/>

Additionally, all first-time international students must attend the International Graduate Student Communication and Cultural Center (IGSC3). Students' language skills and their cultural competency will be assessed, and students will be coached on an as-needed basis so they can provide better service to our undergraduates and faculty while serving as graduate teaching assistants. Additional information can be found here <https://www.mtu.edu/ctl/for-graduate-teaching-assistants/igsc3/>

In order to be visa compliant, international students must register as full-time students. Questions regarding, I-20 Forms and full-time status may be directed to the Graduate School.

L. Stipend, Tuition, and Health Care

Graduate teaching assistants (GTAs) and graduate research assistants (GRAs) are paid a stipend set by the Graduate School and, in some cases, their research advisor. Stipend payments are issued bi-weekly and generally increase as you progress toward your degree and submit the required M- and D- forms. Supported graduate students must be enrolled for nine (9) credits each semester during the academic year and one (1) credit in the summer, with tuition paid directly by the department or research grant. Tuition charges in excess of these values will be your responsibility, along with student voted fees and late registration fees.

Limited summer teaching appointments are available to graduate students making satisfactory progress toward their degree but are dependent upon availability of funds.

Graduate students are required to enroll in the Michigan Tech graduate student health insurance program or provide proof of comparable insurance coverage. Financially supported students receive partial support toward their health insurance cost. More information about health insurance and health care can be found at <http://www.mtu.edu/hr/students/insurance/>. Questions regarding health insurance coverage can be addressed to the physics department representative(s) to the Graduate Student Government (listed on page 1) or to Human Resources.

M. Physics Learning Center

The Physics Learning Center (PLC) was established primarily for the enhancement of undergraduate learning in our general physics classes. It is staffed by a team of undergraduate coaches from several disciplines and is currently located in Fisher Hall 128. The PLC's operations and policies are monitored by a student head coach and PLC faculty coordinator, Dr. Robert Weidman.

Graduate students wishing to use the PLC shall honor policy by giving use of the room to PLC instruction as first priority and using the room quietly when instruction is taking place. Please make sure the door is always locked unless occupied by PLC coaches, physics graduate students, or faculty. See the PLC faculty coordinator, Dr. Weidman, if you have any questions.

N. Accommodation Policies for Americans with Disabilities

Michigan Tech complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disability Act of 1990 (ADA) (<http://www.mtu.edu/equity/access-disability/>). If any student has a disability and needs a reasonable accommodation for equal access to education or services at Michigan Tech, please contact the Dean of Students Office (906-487-2212 or deanofstudents@mtu.edu), Coordinator for Student Disability Services (906-487-1494), or visit <https://www.mtu.edu/deanofstudents/disability/>. For other concerns about discrimination, contact one's advisor, Department Chair, or the Affirmative Action Office (906-487-3310 or equity@mtu.edu).

O. Grievance Procedure

Graduate students with concerns or complaints about the behavior of other faculty members, staffs, or students in professional situations should consult with the program director and department chair to address the issue. However, questions of plagiarism should be taken to the Dean of the graduate school, and sexual discrimination and sexual harassment issues should be taken to the University Title IX Coordinator (<https://www.mtu.edu/title-ix/assault-harassment/>). These procedures are designed to protect the rights and privacy of both faculty and students and to equitably adjudicate conflicts among faculty and students. Students have the right to fair and equal treatment by faculty members, staff, and fellow students. If the issue raised by the students cannot be resolved by the program director and Department Chair of physics or in the case of conflict, student should consult the Dean of the graduate school or the Ombudsperson in the campus (<http://www.mtu.edu/ombuds/>).

P. Paternity Leave Policy

The Graduate School Graduate Student Parental Leave Policy provides assistance to students during a pregnancy, postpartum, during an adoption process, or following a foster care placement. This policy makes it possible for students to receive time extensions for the completion of courses, exams, and other degree requirements (including the overall time to completion of the degree). This policy also makes it possible for students to be released from their teaching or research responsibilities for an excused absence period. (<https://www.mtu.edu/gradschool/policies-procedures/academic/parental-leave/>)

II. Advisors

Advisors help students structure a program of study that addresses their needs and satisfies degree requirements. New students are initially assigned the respective Chair of the physics, applied physics, or atmospheric sciences Graduate Studies Committee as their advisor to facilitate a student's selection of a research advisor. Once a research advisor is selected, an Advisory Committee is formed for each student. The Advisory Committee prepares a program of course study and research work that will lead to the desired graduate degree. It is up to the student and their advisor to fill out, get signed, and submit the appropriate forms to the department or Graduate School at the appropriate times (see this link for current forms and instructions) <https://www.mtu.edu/gradschool/policies-procedures/forms-deadlines/>

A. Course-Work Advisor

Graduate Studies Committee Chairs (see page one) currently serve as coursework advisors for all entering physics, applied physics, and atmospheric sciences graduate students. Entering students prepare their fall-semester course schedules in consultation with the respective Chair during orientation before the start of the first semester. During the third week of classes in the fall, first-year students need to meet with the Chair to prepare a course schedule for spring semester and subsequently register for classes. During the spring semester, continuing students can register for both the summer and next fall semesters.

A first-year student with a graduate teaching assistantship (GTA) typically takes three (3) courses each semester. Course loads are substantially reduced in subsequent years when the bulk of the student's effort is devoted to research. The University requires that full-time graduate students receiving stipends register for nine (9) credit hours per semester. To be considered full time during the summer semester, students must register for a minimum of one (1) credit or one (1) course. Please consult with your advisor and with the Graduate Studies Committee Chair for updates regarding rules for support and full-time status, especially during the summer and in the semesters approaching graduation. Once students finish required courses, the qualifying examination, and the research proposal examination, they may submit the Graduate School's Petition to Enter Candidacy

<http://www.mtu.edu/gradschool/policies-procedures/forms-deadlines/> Students must still maintain full-time status but are eligible for a lower research tuition rate. Students should check with the Graduate School in advance for the most up-to-date requirements.

Courses may be taken outside of physics **ONLY with PRIOR written approval** of the student's research advisor, respective Graduate Studies Committee Chair, and Department Coordinator. Permission Forms are available on our web site <https://www.mtu.edu/physics/graduate/information/>

Typically, such approval requires that students are taking required physics courses during the same semester. In general, approval will be granted for taking only one (1) non-physics course per semester. Graduate research assistants (GRAs) are expected to work full-time on their research and studies. Graduate students supported financially by the physics department may not be on the payroll of other departments. If this procedure is not followed, you will be billed for the tuition charges incurred.

B. Research Advisors - The Selection Process

The process described below is intended to assist all first-year students in becoming familiar with research interests of the faculty prior to selecting a research advisor. Ambitious students may select a research advisor outside of this process if desired. While it is hoped that the student/advisor relationship will prove satisfactory for all concerned, in those instances where expectations are not met, it is possible for a student to change research advisors in consultation with the respective Graduate Studies Committee Chair. After a student selects a research advisor the Advisor and Committee Recommendation Form should be completed online, printed, signed, and filed with the department and Graduate School

<http://www.mtu.edu/gradschool/policies-procedures/timelines/index.html>

For most students, the process of selecting a permanent faculty research advisor should begin in the first year of residence when all new students are required to take PH5010 Journal Club. Each member of the research faculty will present a brief description of research activities in a series of 20-25-minute presentations scheduled throughout the spring semester. All first-year students are required to attend all of these faculty research talks - attendance will be taken. Students are expected to follow up with individual interviews with those faculty members whose projects are of interest to discuss specific research projects and availability of funding.

Upon completion of the research presentations and after suitable time for follow up interviews, each student should meet with their first choice of research advisor and request that they assume the role as their research advisor. The proposed research advisor and student may agree to a trial period to see how the working relationship develops. Students having difficulty finding a research advisor, or students wishing to change research

advisors, should consult with the respective Graduate Studies Committee Chair as soon as possible. First-year students unable to find a research advisor must notify the respective Graduate Studies Committee Chair before the eighth week of spring semester so that the process can be facilitated.

Students may want to consider the following when choosing advisors:

- 1) interests in research area
- 2) current research group size
- 3) track record of advisor-papers, funding, student graduation, and job success.

Please be aware that the availability of any particular research project is governed by the availability of funds to support that research.

C. Individual Development Plan

All new graduate students are encouraged to prepare an Individual Development Plan (IDP) once they have identified a research advisor. IDPs help to keep students on track and are also needed for applying for the finishing fellowship.

<https://www.mtu.edu/gradschool/resources-for/students/professional/idp/>

D. Advisory Committee

Each student accepted into the physics, applied physics, or atmospheric sciences graduate program in the department of physics is required to have an Advisory Committee consisting of his or her graduate faculty advisor and two other departmental faculty members. The applied physics Graduate Studies Committee Chair will remain the advisor for students pursuing the MS-coursework option.

After passing the Qualifying Exam and prior to the Research Proposal Exam, Ph.D. students, in consultation with the research advisor and with the approval of the Graduate Committee/Department Chair, should select their Advisory Committee members and file the form <http://www.mtu.edu/gradschool/policies-procedures/timelines/index.html> with the department and Graduate School. The primary purpose of the Advisory Committee is to guide and monitor the research work of the student. A graduate faculty member external to physics is required for the final dissertation defense but may be invited to participate on the Advisory Committee sooner.

E. Policy for Changing Academic Advisor

i) Procedures

This policy applies to those graduate students enrolled in physics, applied physics and atmospheric sciences (with home department in physics) programs at Michigan Tech. Before initiating the process to change your graduate advisor, please consider all the options listed on the Graduate School website for how to address difficulties in the student-advisor relationship.

As a rule, students are encouraged to practice effective communication and openly discuss with their current advisor any possible significant changes (e.g., research project, advisor, funding, qualifying exams, publications, impact on immigration status, etc.). If there are compelling reasons for changing an advisor during the graduate study, the student or the advisor can initiate the process to change an advisor in consultation with the Program Director and Department Chair. If the student or advisor feels that there may be a conflict of interest on the part of the Program Director or Department Chair, contact the Assistant Dean of the Graduate school to determine additional steps to resolve the situation.

ii) Financial Supports

If the student is under research support from the advisor, the support is not transferred to the new advisor. However, if the student is under TA support from the department, the support will be transferred to the new advisor depending upon the satisfactory progress of the student required by the department for receiving the funding support. If the student is receiving external funding support directly through fellowships such as from NSF or DOE, any fellowship-specific guidelines will be followed; if unspecified, the student will maintain the funding independent of the advisor, pending approval of the funding agency.

iii) Coursework and Degree Requirements

The student's course credits will be transferred to the new program if a program change is pursued. It is the responsibility of the student, however, to fulfill the degree requirements of the new program. For example, a student changing from physics (or applied physics) to atmospheric sciences needs to fulfill the degree requirements for the atmospheric sciences program (e.g., a core class in physics might not represent a core class in atmospheric physics, and might just count as an elective), including the qualifying exam. A student who is changing from physics to applied physics or vice versa needs to satisfy the degree requirements including the number of qualifying examinations of the respective programs. If the student stays in the same program and pursues a change of advisor, his/her finished coursework, qualifying exams, research proposal examination, and published papers will be counted toward the degree. There is an exception to the rule in the case of applied physics. Since the oral component of the qualifying examination in applied physics is specific to the project and advisor, the change of advisor requires the student to retake the oral component of the qualifying examination. If the new advisor

feels that retake of the oral component is not necessary, the new advisor in consultation with the applied physics program director can waive the retake requirement for the oral component of the qualifying exam.

Once you change the advisor, please fill out an updated Advisor Form for approval by the Graduate School.

F. Student Progress Feedback

The Annual Student Progress Evaluation Form (see Appendix A) verifies that students are making timely progress toward degree completion and provides students with guidance and feedback. Annual Student Progress Evaluation Forms are also a factor in determining students' future funding in the program. With the exception of certain students on leave, any student not making satisfactory progress toward the degree will not be considered in good standing and could lose funding. Satisfactory Progress will be indicated on the form by a designation of "Satisfactory" from the program director. A designation of "Serious Concerns" will be accompanied by an explanation of any actions the students must undertake in order to return to satisfactory status (the student's status will then be reviewed again the following semester).

G. Academic Probation

Graduate students receiving grades below 'B' in any course must meet with the program Director of Graduate Studies during the following semester to review their status. The Program Director consults with the Department Chair as well as the advisor of the student, and with their approval, may place a student on probation or may recommend a student's withdrawal or dismissal from the Program. Students receiving anything less than a designation of "Satisfactory" on their Annual Student Progress Evaluation Forms must also discuss required actions to remediate their status with the Program Director of Graduate Studies. Failure to take appropriate steps by the end of subsequent semester may result in a student's being placed on probation or in a recommendation of withdrawal or dismissal. During academic probation, students are expected to enroll full-time. Probationary status is reviewed at the end of each semester by the Program Director and Chair to determine whether the student should be removed from or remain on academic probation or be asked to withdraw from the program.

III. Graduate Degree Requirements

The focus of the Graduate Program in the department of physics is on the PhD in physics and applied physics. The Interdisciplinary atmospheric sciences graduate program is also represented by physics faculty advisors of those graduate students. Students are generally admitted into the department's Graduate Program based on an assessment of their ability to succeed as doctoral students. Most students in pursuit of a Ph.D., who when admitted into the Graduate Program do not already possess an M.S. degree or its equivalent, can readily obtain a Master of Science in physics degree according to **Coursework Option** outlined below. Students wishing to terminate their graduate study with a Master's degree are strongly encouraged to pursue the thesis option. The project option is available to students under special circumstances.

Graduate Course Schedule

Graduate courses expected to be offered by the department of physics, and a tentative schedule under semesters, are as follows:

		F23	S24	F24	S25	F25	S26	F26	S27
PH4210	Electricity and Magnetism I	X		X		X		X	
PH4292	Light and Photonic Materials	X		X		X		X	
PH4390	Computational Methods in Physics	X		X		X		X	
PH4395	Computer Simulation in Physics*				X				X
PH4510	Intro to Solid State Physics	X		X		X		X	
PH4610	Stellar Astrophysics		X						X
PH4620	Galactic Astrophysics				X				
PH4630	Particle Astrophysics						X		
PH5010	Graduate Journal Club		X		X		X		X
PH5090	Special Topics in Physics*		*						
PH5110	Classical Mechanics				X				X
PH5151	Quantum Optical Materials		X		X		X		X
PH5210	Electrodynamics I	X		X		X		X	
PH5211	Electrodynamics II*				*				*
PH5310	Statistical Mechanics		X				X		
PH5320	Mathematical Physics	X		X		X		X	
PH5395	Computer Simulation in Physics				X				X
PH5396	Statistics, Data Mining & Machine Learning in Astronomy		X				X		
PH5410	Quantum Mechanics I	X		X		X		X	
PH5411	Quantum Mechanics II		X				X		
PH5510	Theory of Solids		X				X		
PH5520	Materials Physics				X				X
PH5530	Special Topics in Nanotechnology				X				X
PH5640	Atmospheric Physics	X		X		X		X	
PH5680	Atmospheric Fluid Dynamics		X				X		

*offered on demand

Other 4000-level physics or related courses may also be of interest. In addition, the department offers PH5999 full time Master's Research and PH6999 Doctoral Research with separate sections assigned to each faculty advisor.

Certain courses in physics are considered foundational for all students seeking M.S. or Ph.D. degrees in physics, irrespective of intended research specialty. Coursework is not limited to preparation for specific research work but has been selected to provide a general physics education to act as a foundation for future study and a career in physics. A grade of 'B' or better is officially required by all M.S. and Ph.D. graduate students in the following core courses. A minimum of nine (9) credits must be enrolled (PH5010 is compulsory) for all graduate students (except for those in the MS and accelerated MS in applied physics programs).

	<u>Core Courses</u>	(credits)
PH5010	Graduate Journal Club	(1)
PH5110	Classical Mechanics	(2)
PH5210	Electrodynamics I	(3)
PH5310	Statistical Mechanics	(3)
PH5320	Mathematical Physics	(3)
PH5410	Quantum Mechanics I	(3)

In addition, a grade of 'B' or better is required in at least two (2) of the following courses:

	<u>Disciplinary Electives</u>
PH4395	Computer Simulation in Physics
PH4610	Stellar Astrophysics
PH4620	Galactic Astrophysics
PH4630	Particle Astrophysics
PH5211	Electrodynamics II
PH5390	Scientific Computing
PH5411	Quantum Mechanics II
PH5510	Theory of Solids
PH5520	Materials Physics
PH5610	High Energy Astrophysics
PH5640	Atmospheric Physics
PH5680	Atmospheric Fluid Dynamics

Exemptions from taking any of the required courses on the basis of prior graduate work are to be determined by the Graduate Studies Committee Chair in consultation with the Department Chair.

Responsible Conduct of Research Training (RCR)

Responsible Conduct of Research (RCR) Training is an important aspect of being an effective scholar and is mandatory whether a Master's or Doctoral degree candidate. Basic training must be completed within the first two (2) semesters or a registration hold will be placed on the

student's account. Advanced training (advanced RCR) must be completed by the end of the third semester. Students may not enter candidacy or graduate if RCR training is not complete. <https://www.mtu.edu/gradschool/resources-for/students/academic/rcr/>

A. *Master of Science in Physics*

1. Thesis Option

Students intending to terminate their graduate study at the Master's level are encouraged to pursue the Thesis Option. In addition to the coursework requirement outlined above, a minimum of 20 course credits is required. The remaining credits (not less than six (6)) of the total 30 required by the Graduate School are taken as Graduate Research (PH5999). University policy requires that at least two thirds of the coursework be completed in residence at Michigan Tech.

Students should select an advisor during their second semester and file an Advisor and Committee Recommendation Form with the Graduate School; file a Degree Schedule for approval the semester prior to the final defense; and submit the Degree Completion Form in the semester of planned degree completion. (See submission schedule on page 12.)

No later than two (2) weeks prior to the proposed oral examination date the student, in consultation with the research advisor, schedule your defense by completing a scheduling request on [MyMichiganTech](#) to schedule the exam time and place. A title and abstract should be submitted to the office assistant one (1) week before the oral examination so that announcements can be sent to the department and University community. The Advisory Committee completes an Evaluation of Graduate Learning Objectives and Assessment of Final Defense for departmental record.

2. Report Option

In addition to the coursework requirements, a minimum of three (3) credits in PH5999 (research) is required. Remaining credits of the 30-total required by the Graduate School may include additional course or research credits (up to a maximum of six (6) research credits) as approved by the physics Graduate Studies Committee Chair and the student's Advisory Committee. A minimum of 12 credits must be at the 5000-6000 level and a maximum of 12 credits can be at the 3000-4000 level. A student following the report option is expected to present written and oral reports at the conclusion of the research project. The Advisory Committee completes an Evaluation of Graduate Learning Objectives for departmental record.

3. Coursework Option

This option is designed for students pursuing the Ph.D. in physics who, when accepted to the graduate program, do not already possess an M.S. degree in physics or its equivalent. Students with advanced preparation in pursuit of the Ph.D. in physics might skip the MS degree altogether upon the recommendation of their Advisory Committee. Please be aware that the following degree requirements are much more stringent than the minimum requirements dictated by the Graduate School for **Coursework Option**.

The coursework requirement for the Master of Science in physics is a grade of 'B' or better in graduate courses approved by the student's Advisory Committee totaling 30 credit hours, including the core course and disciplinary elective requirements listed above under the Thesis Option. In addition, six (6) credits of graduate research (PH5999 or PH6999) must be earned. A thesis is not required; however, the research serves both as the beginning of the doctoral research and the basis of the Research Proposal Examination described below.

The student, in consultation with the Graduate Studies Committee, will file all necessary forms (M Forms) for a Master's degree in physics under **Coursework Option**. The Advisory Committee completes an Evaluation of Graduate Learning Objectives for departmental record. **All first-year students are encouraged to enroll for PH5001** for research, instead of PH5999 or PH6999, to ensure that they have sufficient course credits.

4. Master's Form Submission Schedule

Form:	Term Due:
Advisor and Committee Recommendation Form	Second Semester
Degree Schedule	Semester PRIOR to Defense
Degree Completion Form	Semester of Planned Degree Completion
Verification of Final Degree Requirements	TWO WEEKS after oral exam or at end of final exam week of final semester

Current versions of all tracking forms are available online at:

<https://www.mtu.edu/gradschool/policies-procedures/timelines/dissertation/>

Note to International Students: Visa requirements for international students often change. International students should stay well informed of current visa requirements through International Programs & Services (IPS) or the Graduate School related to timelines and possible changes of status after graduation.

B. Master of Science in Applied Physics

Exciting research is now being done in new interdisciplinary branches of physics, including physics at nanoscale, biomedical, atmospheric, photonics, and optoelectronics. Most of the physics faculty have established research programs in these “frontier” areas of applied physics. The current M.S. in physics program at Michigan Technological University does not allow M.S.-seeking graduate students adequate flexibility to meet the demands of such frontier areas. The M.S. applied physics program will provide the necessary framework to allow faculty to tailor core courses for their students that are more closely aligned to their specialized research areas. The new program will also attract physics undergraduate students from more diverse backgrounds to pursue graduate-level study in applied physics at Michigan Tech and provide better job opportunities for our graduates in areas of contemporary technological interest.

The student, in consultation with their Advisory Committee will file all necessary Progress to Degree Forms (see submission schedule on page 16).

Curriculum Design

The curriculum structure of the proposed M.S. applied physics program is similar to our current M.S. physics program but, as noted above, offers students additional flexibility through tailoring their respective core courses as a foundation for work in a more specialized applied physics program. For example, students in biophysics could be better prepared with a core course on molecular biology, and students in physics at nanoscale may need core courses in advanced solid-state theory (e.g., quantum tunneling, quantum confinement phenomena) and device engineering.

The next table lists the course requirements for the applied program, which are in addition to the Graduate School’s requirements. A minimum of 30 credits is required for the program.

Degree	Course Requirements Beyond Those of the Graduate School
M.S. in Applied Physics Thesis option Report option Coursework option	<p><u>Core Courses:</u> <i>Minimum of 10 PH credits at the 4000-level or higher, including a minimum of 6 credits from the following list:</i></p> <p>PH5010 Journal Club (1 credit; required) PH5110 Classical Mechanics (2 credits) PH5210 Electrodynamics I (3 credits) PH5310 Statistical Mechanics (3 credits) PH5320 Mathematical Physics (3 credits) PH5410 Quantum Mechanics I (3 credits)</p> <p><u>Application Electives</u> <i>Minimum 10 credits at the 4000-level and higher (including at least one course at the 5000-level or higher) from an Application Elective list; with approval of advisor.</i></p>

	<p><i>Additional courses may be required by the student's advisory committee under plans A and B.</i></p> <p><u>Research</u></p> <p><i>PH5999 Master's Research</i></p> <p>Minimum 6 credits for thesis degree (Thesis option)</p> <p>Minimum 3 credits for report degree (Report option)</p> <p>No research for coursework degree (Coursework option)</p>
--	--

Application elective course lists, shown below, will be updated annually. New lists may be created by the applied physics Graduate Studies Committee, depending on faculty interests and available course offerings.

Application Elective Courses

(I) Atmospheric Physics:

- PH 5640 - Atmospheric Physics
- PH 5680 - Atmospheric Fluid Dynamics
- PH 5320 - Mathematical Physics
- ATM 5010 - Research Methods in Atmospheric Science
- ATM 5519 - Atmospheric Biogeochemistry
- ATM 5515/CE5515/CH5515 - Atmospheric Chemistry
- ATM 5512 - Applied Boundary Layer Meteorology
- GE 5800 - Mathematical Modeling of Earth Systems
- CEE 4501 - Environmental Engineering Chemical Processes
- CEE 4504 - Air Quality Engineering and Science
- EE 5540 - Statistical Optics (no longer listed?)
- FW 5340 - Population Genetics and Applied Forest Genetics
- GE 4250 - Fundamentals of Remote Sensing
- GE 5800 - Earth Systems Science II

(II) Physics at Nanoscale

- PH 5410 - Quantum Mechanics I
- PH 5520 - Materials Physics
- PH 5530 - Selected Topics in Nanotech
- PH 4510 - Introduction to Solid State Physics
- EE 5471 - Microfabrication Laboratory
- EE 5460 - Solid State Devices
- MEEM 5130 - Nanoscale Science and Technology
- MSE 6200 - Advanced Topics in Materials Characterization
- PH 5530 - Selected Topics in Nanotech (theory and experiment both)
- PH 4390 - Computational Methods in Physics
- PH 5510 - Theory of Solids

(III) Photonics

- BE 5250 - Biomedical Optics

EET 5261 - Optical System Design and Testing
EE 5410 - Engineering Electromagnetics
EE 5526 - Microwave Engineering
EE 5528 - Antenna Engineering
EE 5490 - Solar Photovoltaic Science and Engineering
PH 5410 - Quantum Mechanics I
PH 5320 - Mathematical Physics
PH 5510 - Theory of Solids

(IV) Biophysics

PH 4999 - Molecular Biology for Physicists and Engineers
BE 5250 - Biomedical Optics
BE 5550 - Biostatistics for Health Science Research
BE 5880 - Principles and Analysis of Cellular Processes
BL 5010 - Cellular Imaging and Confocal Microscope
BL 5035 - Bioimaging
BL 5370 - Special Topics in Microbiology
BL 5360 - Special Topics in Biochemistry
BMB 6020 - Theoretical Molecular Biology (now called "advanced molecular biology")

1. Thesis Option

In addition to the coursework requirements described above, a minimum of 20 course credits and a minimum of six (6) credits in PH5999 (research) are required. Remaining credits of the 30-total required by the Graduate School may include additional course or research credits (up to a maximum of ten research credits) as approved by the applied physics Graduate Studies Committee Chair and the student's Advisory Committee. A minimum of 12 credits must be at the 5000-6000 level and a maximum of 12 credits may be at the 3000-4000 level. Requirements of this option also include a written Master's thesis and a final oral examination based on the student's thesis.

2. Report Option

In addition to the coursework requirements described above, a minimum of three (3) credits in PH5999 (research) is required. Remaining credits of the 30-total required by the Graduate School may include additional course or research credits (up to a maximum of six (6) research credits) as approved by the applied physics Graduate Studies Committee Chair and the student's Advisory Committee. A minimum of 12 credits must be at the 5000-6000 level and a maximum of 12 credits may be at the 3000-4000 level. A student following the report option is expected to present written and oral reports at the conclusion of the research project.

3. Coursework Option

Students will be required to take 30 course credits including the core course and disciplinary elective requirements listed above, and as approved by the applied physics Graduate Studies Committee Chair. A minimum of 18 credits must be at the 5000-6000 level and a maximum of 12 credits may be at the 3000-4000 level.

C. Doctor of Philosophy in Physics

All Junior graduate students are encouraged to apply for coursework MS degrees while working towards a PhD degree. (See page 16 for forms/timeline)

1. Residency

A minimum of two-thirds of the required non-research coursework credits required for the degree through Michigan Tech. PhD students must take at least 20 credits beyond the Master's or 50 credits beyond the Bachelor's through Michigan Tech. Research credits used to satisfy degree requirements must be taken through Michigan Tech and must be supervised by a member of Michigan Tech's graduate faculty. Courses which meet the "through Michigan Tech" requirement are defined as courses listed in the Michigan Tech course catalog and taught by Michigan Tech faculty. For certain circumstance, the directors of our Graduate Study Programs may offer a waiver on these requirements. See the Graduate School Website for details;

<https://www.mtu.edu/gradschool/policies-procedures/requirements/phd/>.

2. Coursework

A minimum of 30 course and/or research credits beyond the Master's degree, or a minimum of 60 course and/or research credits beyond the Bachelor's degree are required for the Ph.D. degree.

The core course and disciplinary elective requirements are detailed above. Additional coursework is determined by the student's Advisory Committee and early discussions with the committee in this regard are recommended.

Once students have a research advisor they may enroll in Doctoral Research (PH6999).

After all required courses are completed, and no later than the semester prior to the final oral examination, the Degree Schedule Form should be completed, reviewed by the Chair of the Graduate Studies Committee, and filed with the Graduate School.

3. Qualifying Examination

Students accepted into the physics Ph.D. program must take a written Qualifying Examination authored and administered by the Qualifying Examination Committee which covers three (3) areas: Classical Mechanics (including introductory special relativity), Electricity and Magnetism, and Quantum Mechanics. Each of these exams are scheduled in separate two-hour periods. Sample examinations are available in the shared physics Qualifying Exams google drive. Request access to the drive from the Graduate Program Coordinator.

Questions regarding the qualifying exam policies may be directed to the Chair of the Qualifying Examination Committee (listed on page one).

Problems in the areas of Classical Mechanics, Electricity and Magnetism, and Quantum Mechanics may be solved using techniques taught at the advanced undergraduate level. Representative materials for these subjects are listed on the next page.

Classical Mechanics

Text: *Classical Dynamics of Particles & Systems*, J.B. Marion and S.T. Thornton, 3rd edition, Harcourt Brace Jovanovich, Inc., 1988. Chapters 1-14.

Text: *Analytical Mechanics*, G.R. Fowles and G.L. Cassiday, 7th edition, Harcourt Brace & Company, 2005. Chapters 1-11.

Text: *Classical Mechanics*, J. Taylor. University Science Books, 2005. Chapters 1-11, 13, 15.

Electricity and Magnetism

Text: *Introduction to Electrodynamics*, 3rd ed. D. J. Griffiths, Prentice Hall. Chapters 1-11.

Text: *Electromagnetism*, G. L. Pollack and D. R. Stump. Addison Wesley, 2002.

Chapters 1-11, 13-15.

Quantum Mechanics

Text: *Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles*, R. Eisberg and R. Resnick, 2nd edition, John Wiley & Sons, 1985. Chapters 1-10.

Text: *Quantum Mechanics, An Accessible Approach*, R. Scherrer, Pearson Addison Wesley, 2006. Chapters 1-10.

The Qualifying Examination will be given twice each year during the second and third weeks of the fall and spring semesters. Typical fall and spring schedules follow. Be sure to confirm exam times and exam rooms in advance with the department coordinator.

Fall Semester:

Week 2	Thursday	7:00 – 9:00 p.m.	classical mechanics
Week 2	Saturday	3:00 – 5:00 p.m.	electricity and magnetism
Week 3	Thursday	7:00 – 9:00 p.m.	quantum mechanics

Spring Semester:

Week 2	Thursday	7:00 – 9:00 p.m.	classical mechanics
Week 2	Saturday	2:00 – 4:00 p.m.	electricity and magnetism
Week 3	Thursday	7:00 – 9:00 p.m.	quantum mechanics

All work must be done in exam (blue) books that will be provided. When solving Electricity and Magnetism problems, a consistent set of units must be used; the system of units being used should be stated at the beginning of the problem. No handbooks or calculators are allowed. Any needed mathematical information will be provided.

Students are encouraged to take the Qualifying Examination the first time it is given following their arrival on campus and may do so without penalty. The main purpose of this “free shot” is to acquaint new students with the exam subject matter and format. The free shot is not typically deferred to a future semester and does not count as one (1) of the two (2) official attempts that students are allowed to pass the exam. Any of the three (3) exams passed on the free shot need not be retaken in future attempts; passing all three exams on the free shot fully satisfies the Qualifying Examination requirement. Students who elect to take the free shot but do not pass the exam in its entirety are required to take their first attempt as described in the following paragraph.

Students who enter the Ph.D. program during the summer or fall semester will take the Qualifying Exam free shot in their first fall semester, the first official attempt will be in their first spring semester, and their second official attempt will be in their second fall semester. Students who enter the Ph.D. program during the spring semester will take the Qualifying Exam free shot in their first spring semester, the first official attempt will be in their first fall semester, and their second official attempt will be in their second spring semester. Students are allowed two (2) official attempts to pass the Qualifying Examination. Passing scores in each of the three (3) exams are required to fulfill the qualifying requirement.

Students are usually informed of the outcome of the written exams within three (3) weeks of the last-scheduled examination date, the outcome being either a PASS or a FAIL for each exam. Any of the three (3) exams not passed during the first attempt must be retaken the next time the Qualifying Examination is given. If after the second attempt students have not passed all three (3) exams, the Qualifying Examination Committee will recommend that those students be dismissed from the Ph.D. program, except as noted below.

After the second attempt, if a student has passed all areas except one (1), an *ad hoc* committee may be formed consisting of the Qualifying Examination Committee and Graduate Studies Committee Chairs and the student's research advisor. This *ad hoc* committee will determine whether it is appropriate to continue the failed exam to allow

the student an opportunity to demonstrate his/her knowledge in the subject matter using an alternate format. If a continuation is warranted, it may consist of an oral exam, the requirement that the student take a specified course and earn the grade of 'B' or better, or some similar activity that can be evaluated. The continuation activity cannot consist of a third attempt of the Qualifying Examination. The successful completion of the continuation activity will result in a PASS for the failed exam.

After passing all exams, the Report on Qualifying Examination is signed by the student's advisor, the Qualifying Examination and Graduate Studies Committee Chairs, and filed with the physics office assistant.

4. Research Proposal Examination and Petition to Enter Candidacy

The Research Proposal Examination is taken after the Qualifying Examination has been passed. It is administered by the student's Advisory Committee for the purpose of reviewing and evaluating the student's proposed plan for research. Once a student has identified a research problem in consultation with their research advisor, has become familiar with the related literature, and has devised a plan for research, the Research Proposal Examination should be scheduled. A paper describing the proposed research, not exceeding 15 pages in total length, should be distributed to the Advisory Committee one (1) week prior to the scheduled exam. The student should prepare a 30-minute talk outlining both the problem and the proposed research methods. The remainder of the exam will be devoted to questions and answers related to the proposed research. Although no special form is needed for scheduling this examination, please consult the physics office assistant to schedule a room, advertise the talk to the department and University community, and prepare the Report on Research Proposal Examination. The Advisory Committee will be given the Evaluation of Graduate Learning Objectives (GLO) to complete during the Examination. Both Report and Evaluation Forms are retained for departmental records.

Upon successful completion of the Research Proposal Examination, the student completes the Petition to Enter Candidacy and submits it to the Graduate School.

5. Doctoral Dissertation and Final Oral Examination

The final examination may be scheduled any time after a period of two (2) academic semesters following the successful completion of the Research Proposal Examination and upon completion of the dissertation in satisfactory form. It is the responsibility of the student to be aware of the most current policies and rules regarding graduation (check with the Graduate School and their website). Two (2) weeks prior to the final examination a completed draft of the dissertation, prepared in accordance with the manual "Instructions Concerning the Preparation of Theses and Dissertations", must be submitted to the Graduate School along with completing a scheduling request on MyMichiganTech. The student is responsible for obtaining all necessary signatures on said form, as well as

scheduling a room for the defense with help from an office assistant as needed. The dissertation is also distributed to the Advisory Committee at this time.

One (1) week before the oral examination, the student submits a defense title and abstract to the office assistant so that announcements can be sent to the department and University community.

The day of the defense, the student completes the Report on Final Oral Examination for subsequent approval; the Advisory Committee completes the Evaluation of Graduate Learning Objectives and Assessment of Final Defense for departmental record. Following the oral defense, the Ph.D. candidate incorporates all corrections and suggestions of the Advisory Committee into the final dissertation.

Students can familiarize themselves with the deadlines, dissertation submission policies, and necessary graduation forms via the Graduate School's website

<https://www.mtu.edu/gradschool/policies-procedures/timelines/dissertation/>

Note to International Students: Visa requirements for international students often change. International students should stay well informed of current visa requirements through International Programs & Services (IPS) or the Graduate School related to timelines and possible changes of status after graduation.

D. Doctor of Philosophy in Applied Physics

All Junior graduate students are encouraged to apply for coursework MS degrees while working towards a PhD degree. (See page 16 for forms/timeline)

The study of physics has generally been focused on foundational disciplinary areas including high-energy physics, atomic and molecular physics, astrophysics, and nuclear physics. Over the past two (2) decades new branches of physics have gained increasing attention particularly in those interface areas where traditional physics intersects with other applied disciplines. These include biophysics, chemical physics, physics at the nanoscale condensed matters, materials physics, optics/photonics, plasmonics, optoelectronics, etc. In order to fill such a void in the interdisciplinary program in physics at the doctoral level, a new Ph.D. in applied physics program was introduced in the 2016 fall semester. The applied physics program will broaden the scope of the previous Ph.D. in Engineering physics program to include emerging areas.

Degree requirements for the Ph.D. in applied physics are similar to those for the Ph.D. in physics. Differences are explained below.

1. Advisors and Advisory Committee

Students will initially be assigned the applied physics Graduate Studies Committee Chair as their advisor to prepare an initial course of study during orientation before the student's first semester begins. By the end of the second semester in residency the student selects a research advisor who will serve to guide and direct a subsequent course of study and research, and to chair the student's Advisory Committee. By the end of the fourth academic semester, the full Advisory Committee should be formed whose purpose is to assist and monitor the research work of the student. In addition to the research advisor, the Advisory Committee must consist of three (3) other members, including at least one (1) member of the physics graduate faculty. If desired, Committee members can be graduate faculty from another cognate department. The Advisory Committee, chosen by the research advisor and the student with approval of the Graduate Studies Committee Chair will ultimately serve on the student's examining committees. The student submits an Advisor and Committee Recommendation Form to the Graduate School.

2. Coursework

A grade of 'B' or better is required for a minimum of nine (9) credits (PH5010 is compulsory) enrolled in the following core courses:

Core Courses (credits)

PH5010	Graduate Journal Club	(1)
PH5110	Classical Mechanics	(2)
PH5210	Electrodynamics I	(3)
PH5310	Statistical Mechanics	(3)
PH5320	Mathematical Physics	(3)
PH5410	Quantum Mechanics I	(3)

Exemptions from taking any of the required core courses on the basis of prior graduate work are to be determined by the applied physics Graduate Studies Committee Chair in consultation with the Department Chair.

In addition, a grade of 'B' or better is required in at least three courses at the 4000 level or higher, and at least one course at the 5000 level or higher, in the student's chosen area of specialization and as approved by the student's Advisory Committee. Additional courses may also be required by the student's Advisory Committee. Early discussions with the Committee in this regard are highly recommended. Typical courses could include:

EE4254	Image Processing
EE5340	Statistical Optics
EE5410	Engineering Electromagnetics
EE5430	Electronic Materials

EE5440	Laser Types, Laser Design, Modeling Techniques, and Nonlinear Optics
EE5460	Solid State Devices
EE5520	Fourier Optics
EE6410	Advanced Engineering Electromagnetics
EE6420	Interaction of Electromagnetic Waves and Materials
EE6450	Theory of Devices
EE6470	Thin Films
MSE4530	Scanning Electron Microscopy and X-ray Microanalysis
MSE4700	Electronic Properties of Materials
MSE4710	Materials Science/Electronic Devices
MSE5100/5110	Thermodynamics and Kinetics I & II
MSE5140	Mechanical Behavior of Materials
MSE5550	Transmission Electron Microscopy
MSE6100	Computational Materials Science and Engineering
MSE6110	Advanced Topics in Materials Processing
MSE6200	Advanced Topics in Materials Characterization
MSE6400	Advanced Topics in Mechanical Behavior of Materials
PH5211	Electrodynamics II
PH5411	Quantum Mechanics II
PH5510	Theory of Solids
PH5520	Materials Physics
PH5640	Atmospheric Physics
PH5680	Atmospheric Fluid Dynamics

Courses may also be chosen from the list of application electives for the Master of Science in applied physics. Required courses will be listed and verified at least one (1) semester before the final oral defense is scheduled on the Degree Schedule Form.

3. Qualifying Examination

Students accepted into the applied physics Ph.D. program must take a written Qualifying Examination authored and administered by the Qualifying Examination Committee which comprises a physics component and an application component.

The physics component covers two (2) of the three (3) following areas, to be chosen in advance by the student: Classical Mechanics (including introductory special relativity), Electricity and Magnetism, and Quantum Mechanics. Each of these exams are scheduled in separate two-hour periods. Sample examinations are available on a shared google drive. Please request access from the office assistant if you do not have access.

Questions regarding the qualifying exam policies may be directed to the Chair of the Qualifying Examination Committee (listed on page one).

Problems in the areas of Classical Mechanics, Electricity and Magnetism, and Quantum Mechanics may be solved using techniques taught at the advanced undergraduate level. Representative materials for these subjects are listed below:

Classical Mechanics

Text: *Classical Dynamics of Particles & Systems*, J.B. Marion and S.T. Thornton, 3rd edition, Harcourt Brace Jovanovich, Inc., 1988. Chapters 1-14.

Text: *Analytical Mechanics*, G.R. Fowles and G.L. Cassiday, 7th edition, Harcourt Brace & Company, 2005. Chapters 1-11.

Text: *Classical Mechanics*, J. Taylor. University Science Books, 2005. Chapters 1-11, 13, 15.

Electricity and Magnetism

Text: *Introduction to Electrodynamics*, 3rd ed. D. J. Griffiths, Prentice Hall. Chapters 1-11.

Text: *Electromagnetism*, G. L. Pollack and D. R. Stump. Addison Wesley, 2002. Chapters 1-11, 13-15.

Quantum Mechanics

Text: *Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles*, R. Eisberg and R. Resnick, 2nd edition, John Wiley & Sons, 1985. Chapters 1-10.

Text: *Quantum Mechanics, An Accessible Approach*, R. Scherrer, Pearson Addison Wesley, 2006. Chapters 1-10.

The Qualifying Examination will be given twice each year during the second and third weeks of the fall and spring semesters. Typical fall and spring schedules follow. Be sure to confirm exam times and exam rooms in advance with the department coordinator.

Fall Semester:

Week 2	Thursday	7:00 – 9:00 p.m.	classical mechanics
Week 2	Saturday	3:00 – 5:00 p.m.	electricity and magnetism
Week 3	Thursday	7:00 – 9:00 p.m.	quantum mechanics

Spring Semester:

Week 2	Thursday	7:00 – 9:00 p.m.	classical mechanics
Week 2	Saturday	2:00 – 4:00 p.m.	electricity and magnetism
Week 3	Thursday	7:00 – 9:00 p.m.	quantum mechanics

All work must be done in exam (blue) books that will be provided. When solving Electricity and Magnetism problems, a consistent set of units must be used; the system of units being used should be stated at the beginning of the problem. No handbooks or calculators are allowed. Any needed mathematical information will be provided.

Students are encouraged to take the Qualifying Examination the first time it is given following their arrival on campus and may do so without penalty. The main purpose of this “free shot” is to acquaint new students with the exam subject matter and format. The free shot is not typically deferred to a future semester and does not count as one (1) of the two (2) official attempts that students are allowed to pass the exam. Any of the exams passed on the free shot need not be retaken in future attempts; passing all exams on the free shot fully satisfies the physics component of the Qualifying Examination requirement. Students who elect to take the free shot but do not pass the exam in its entirety, are required to take their first attempt as described in the following paragraph.

Students who enter the Ph.D. program during the summer or fall semester will take the Qualifying Exam free shot in their first fall semester, the first official attempt will be in their first spring semester, and their second official attempt will be in their second fall semester. Students who enter the Ph.D. program during the spring semester will take the Qualifying Exam free shot in their first spring semester, the first official attempt will be in their first fall semester, and their second official attempt will be in their second spring semester. Applied physics Ph.D. students are allowed two (2) official attempts to pass the physics component of the Qualifying Examination and must **pre-select two (2) of the three exams (3) they will take PRIOR to the first examination date**. They may not change their selection if a second attempt is necessary. Passing scores in each of the two (2) pre-selected exams are required to pass the physics component of the exam.

Students are usually informed of the outcome of the written exam within three (3) weeks of the last-scheduled examination date, the outcomes being either a pass or a fail for each exam. Any of the three (3) exams not passed during the first attempt must be retaken the next time the physics portion of the Qualifying Examination is given. If after the second attempt students have not passed all three (3) exams, the Qualifying Examination Committee will recommend that those students be dismissed from the Ph.D. program, except as noted below.

After the second attempt, if a student has passed all exams except one (1), an *ad hoc* committee may be formed consisting of the Qualifying Examination Committee and Graduate Studies Committee Chairs, and the student's research advisor. This *ad hoc* committee will determine whether it is appropriate to continue the failed exam to allow the student an opportunity to demonstrate his/her knowledge in the subject area using an alternate format. If a continuation is warranted, it may consist of an oral exam, the requirement that the student take a specified course and earn the grade of 'B' or better, or some similar activity that can be evaluated. The continuation activity cannot consist of a third attempt of the physics component of the Qualifying Examination. The successful completion of the continuation activity will result in a PASS for the failed physics component exam.

The student's Advisory Committee formats the application component of the Qualifying Examination that is two (2) to three (3) hours in length and appropriate to the student's chosen area of applied physics interest, focusing on fundamentals related to but not on the student's current research. The application component should be completed by the end of the student's spring semester of the second year.

After passing both physics and applied exam components, the Report on Qualifying Examination is signed by the student's advisor, the Qualifying Examination and Graduate Studies Committee Chairs, and filed with the physics office assistant.

4. Research Proposal Examination and Petition to Enter Candidacy

The Research Proposal Examination is taken after the Qualifying Examination has been passed. It is administered by the student's Advisory Committee for the purpose of reviewing and evaluating the student's proposed plan for research. Once a student has identified a research problem in consultation with their research advisor, has become familiar with the related literature, and has devised a plan for research, the Research Proposal Examination should be scheduled. A paper describing the proposed research, not exceeding 15 pages in total length, should be distributed to the Advisory Committee one (1) week prior to the scheduled exam. The student should prepare a 30-minute talk outlining both the problem and the proposed research methods. The remainder of the exam will be devoted to questions and answers related to the proposed research. Although no special form is needed for scheduling this examination, please consult the physics office assistant to schedule a room, advertise the talk to the department and University community, and prepare the Report on Research Proposal Examination. The Advisory Committee will be given the Evaluation of Graduate Learning Objectives (GLO) to complete during the Examination. Both Report and Evaluation Forms are retained for departmental records.

Upon successful completion of the Research Proposal Examination, the student completes the Petition to Enter Candidacy and submits it to the Graduate School.

5. Doctoral Dissertation and Final Oral Examination

The final examination may be scheduled any time after a period of two (2) academic semesters following the successful completion of the Research Proposal Examination and upon completion of the dissertation in satisfactory form. It is the responsibility of the student to be aware of the most current policies and rules regarding graduation (check with the Graduate School and their website). Two (2) weeks prior to the final examination a completed draft of the dissertation, prepared in accordance with the manual "Instructions Concerning the Preparation of Theses and Dissertations", must be submitted to the Graduate School along with a completing a scheduling request on MyMichiganTech. The student is responsible for obtaining all necessary signatures on said form, as well as scheduling a room for the defense with help from an office assistant as needed. The

dissertation is also distributed to the examining committee at this time. The examining committee consists of the three (3) members of the student's Advisory Committee and a fourth member chosen from a cognate department or program.

One (1) week before the oral examination, the student submits a defense title and abstract to the office assistant so that announcements can be sent to the Department and University community.

The day of the defense, the student completes the Report on Final Oral Examination for subsequent approval; the Advisory Committee completes the Evaluation of Graduate Learning Objectives and Assessment of Final Defense for departmental record. Following the oral defense, the Ph.D. candidate incorporates all corrections and suggestions of the Advisory Committee into the final dissertation.

Students can familiarize themselves with the deadlines, dissertation submission policies, and necessary graduation forms via the Graduate School's website

<https://www.mtu.edu/gradschool/policies-procedures/timelines/dissertation/> .

Note to International Students: Visa requirements for international students often change. International students should stay well informed of current visa requirements through International Programs & Services (IPS) or the Graduate School related to timelines and possible changes of status after graduation.

E. Graduate Certificates

Graduate certificates can be obtained concurrently with a graduate degree or as a separate graduate program. A graduate certificate requires fewer credits and is more limited in scope than a Master's degree. You may be interested in a graduate certificate if you have a specific skill set, you'd like to enhance. Many of our students seeking certificates use them to further their career, find a new job, or meet state or national licensing requirements. The department of physics offers the following graduate certificates:

Big Data Statistics in Astrophysics Certificate:

<https://www.mtu.edu/gradschool/programs/certificates/big-data-statistics-astrophysics/>

Advanced Computational Physics Certificate:

<https://www.mtu.edu/gradschool/programs/certificates/computational-physics/>

Frontiers in Materials Physics Certificate:

<https://www.mtu.edu/gradschool/programs/certificates/materials-physics/>

Frontiers in Optics, and Photonics Certificate:

<https://www.mtu.edu/gradschool/programs/certificates/optics-photonics/>

F. Student Responsibilities

It is the responsibility of each physics, applied physics, and atmospheric sciences/physics graduate student to be familiar with the physics department policies as outlined in this handbook, and with Graduate School policies as outlined in the Graduate School Website; <https://www.mtu.edu/gradschool/policies-procedures/>. It is the responsibility of each graduate student to be sure that Master's or Doctoral Forms are completed and authorized in a timely fashion, and are filed with the physics office assistant or Graduate School as prescribed.

IV. Time Line to Degree

What:	When:
Advisor and Committee Recommendation Form	BY END OF FIRST ACADEMIC YEAR naming research advisor
Responsible Conduct of Research (RCR)	BASIC by end of first academic year ADVANCED by end of third semester
Report on Qualifying Examination	WITHIN FIRST TWO YEARS in PhD program Submit advisory committee approved form to physics Prepare the Individual Development Plan (IDP)
Advisor and Committee Recommendation Form	SEMESTER FOLLOWING passing qualifying exams naming advisory committee
Degree Schedule*	SEMESTER COURSEWORK IS COMPLETE or SEMESTER BEFORE petition to enter candidacy
Report on Research Proposal Examination*	UPON PASSING ORAL RESEARCH PROPOSAL EXAM Submit advisory committee approved form to physics
Petition to Enter Candidacy* * These three forms are often submitted at the same time	ONE WEEK PRIOR to the first day of classes in the semester student plans to enter candidacy
Schedule your Final Oral Examination (defense)	TWO WEEKS PRIOR TO ORAL DEFENSE Complete a scheduling request on MyMichiganTech. Submit with draft copy of dissertation to graduate school & advisory committee
Report on Final Oral Examination	DAY OF DEFENSE Complete for advisory committee signatures following oral defense
Approval of Dissertation, Thesis, Report	COMPLETE ALL REVISIONS, ask your advisor to submit the Approval form via google forms

	WITHIN ONE WEEK submit dissertation, thesis, report to Digital Commons & ProQuest
Workspace Cleanout Form	BEFORE GRADUATING/LEAVING
Survey of Earned Doctorate; Exit Survey	BEFORE COMPLETING DEGREE

Current versions of all tracking forms are available online at:

<https://www.mtu.edu/gradschool/policies-procedures/timelines/dissertation/>

V. Illustrative Time Line for Academically Prepared Ph.D. Graduate Students

Year 1 - Assuming fall semester acceptance

- September: Qualifying Examination (free shot allowed only in acceptance semester)
- 2-3 physics courses each semester (9 credits)
- Explore research experience with a research advisor, if possible
- Prepare an Individual Development Plan
- Funding via a teaching assistantship
- 20 hours of work/week, typically in introductory physics labs
- January: Qualifying Examination
- Spring of First Year – research experience with a research advisor
- Summer of First Year - begin research
If funded by a GRA, ~40 hrs./week; if GTA, ~20 hrs./week

Year 2 - One/Two courses each semester; MS/PhD research

- September- Retake un-passed Qualifying Exams
- Divide remaining time between research and teaching (if still on GTA)
- Prepare the [Individual Development Plan \(IDP\)](#)

Year 3 - Little coursework. Divide time between research and teaching (if still on GTA)

- Research Proposal Exam

Years 4 & 5 - Finish Dissertation Research

- Write dissertation (no more than six months)
- Submit one/two co-authored manuscripts for publication in a refereed journal, in collaboration with your research advisor
- During years three-to-five, you should have attended and presented talks and/or posters at a few national meetings
- Final dissertation defense
- Latter part of year five make plans for the rest of your life (job searching, etc.)

Note that with a GRA you are being paid to do your dissertation research.

With a GTA, you have a job in addition to your dissertation research.

Note also that some teaching experience is valuable for most jobs.

Appendix A

The following have read the above progress report and have been involved in discussions with the student.

Satisfactory Progress (if No, please explain)

Yes _____ No _____

Advisor Signature

Date

Recommended actions: Yes _____ No _____

Explanation of progress status and recommendations (from Advisor, program assistant, and program director):

Student Signature

Date

Program Director Signature

Date

Recommended Practice towards your PhD degree

Please rate your own progress by writing 1 to 5 next the following practices (1 = Not in my practice at all, and 5 = being performed regularly).

This list is created by referring to the following article: Lucy Taylor, "Twenty things I wish I'd known when I started my PhD," Nature, November 6, 2018, (<https://www.nature.com/articles/d41586-018-07332-x>)

1. Do you regularly discuss, review, update your academic and research goals with your supervisor?
3. Do you conduct regular literature reviews?
4. Do you regularly write down all your research activities and records? This includes discussion notes, research method and procedures, among other things.
6. Do you organize your workspace, files/folders, notes, research samples, etc.?
7. Have you start writing pieces of your thesis, including what you learnt from your literature review?
8. Do you have the habits to let your supervisor know when you don't understand something?
9. Do you socialize with other students and people around you? You need to have life outside work.
10. Do you present your research regularly, including lab-group meetings, conferences?
Presenting is a good way to get feedback.
11. Have you always aim to publish your research by designing your research accordingly?
12. The nature of research is that outcomes are often beyond what you expect. If this is happening, do you discuss this with friends, supervisor, and your thesis committee?
13. In case you are in the process of writing your thesis chapters, do you back up your work in your computers? Pieces of chapters can be written even during the first year of your study.
14. In case you are in the process of writing your thesis chapters, do you send your drafts to your supervisor for early feedback?

Appendix B

Rubrics and Evaluation Forms (PhD and MS)

GLOs for PhD	Departmental Objective	Unsatisfactory	Marginal / Progressing	Satisfactory	Very Good/ Excellent
1 - Demonstrates mastery of the subject matter	Synthesizes existing knowledge in a professional manner	e.g. Does not understand basic concepts or conventions. Misinterprets or misuses sources.	Displays a basic understanding of the field.	Displays a solid understanding of the field. Adequate exploration of interesting issues and connections.	Demonstrates thorough mastery as well as creativity in drawing on multiple sources. Synthetic and interdisciplinary. Demonstrates a deep understanding of relevant literatures
2 - Demonstrates advanced research skills	Proficient in application of existing methodologies and techniques	e.g. Misapplies or uses non-standard techniques without adequate rationalization.	Applies standard techniques. Does not recognize limitations of data / techniques were applicable.	Uses appropriate, theory, methods and techniques. Appropriately explains limitations of data / techniques were applicable.	Suggests and utilizes improvements to standard methods and techniques. Limitations are thoroughly and competently discussed.
	Critically analyzes and evaluate their own findings and those of others	e.g. Does not recognize improbable results.	Relies on others to suggest data that are relevant to solving a problem. Literature review is adequate but not critical.	Identifies weaknesses in own work but discussion is not comprehensive.	Provides critical evaluation of previous works. Identifies and corrects weaknesses or flaws in referenced work. Identifies and discusses shortcomings in own work.
3 - Make an original and substantial contribution to the discipline	Think originally & independently to develop concepts & methodologies	e.g. No independent research. Question or problem is trivial, weak, unoriginal, or previously solved.	Demonstrates competence but is not very original or significant. Displays little creativity, imagination, or insight.	Argument is strong, comprehensive, and coherent. Has some original ideas, insights, and observations.	Has a compelling question or problem. Project is original, ambitious, creative, and thoughtful. Asks or addresses new / important questions.
4 - Demonstrates professional skills	Displays effective written communication skills	e.g. Writing is disorganized, has frequent spelling and grammatical errors. Illustrations poorly selected or illegible.	Writing is adequate. Structure and organization are weak, but sufficient. Illustrations legible, technically correct, and appropriate.	Well written and organized.	Concise, elegant, engaging. Technical content and graphic design of illustrations well planned / executed.
	Displays effective oral communication skills	e.g. Disorganized or unable to articulate an argument. Does not grasp intent of questions.	Clear and coherent, partially understands or addresses questions, responses may have some gaps in logic or inconsistencies.	Clear & coherent. Engages appropriate audiences. Grasps intent.	Compelling, persuasive, and accessible to multiple audiences. Articulate addresses questions.
	Professional conduct in the discipline	Plagiarism is found in written reports.	Absence of plagiarism in oral and written reports.	Absence of plagiarism, appropriate referencing and attribution, etc. in oral and written reports.	Absence of plagiarism, appropriate referencing and attribution with professional discussion, etc. in oral and written reports.

GLOs for MS (Thesis and Report Options)	Departmental Objective	Unsatisfactory	Marginal / Progressing	Satisfactory	Very Good/ Excellent
1 - Demonstrates proficiency of the subject matter	Synthesizes existing knowledge	e.g. Does not understand basic concepts or conventions. Misinterprets or misuses sources.	Displays a basic understanding of the field.	Displays understanding of the field. Adequate exploration of interesting issues and connections.	Demonstrates proficiency in drawing on multiple sources. Synthetic and interdisciplinary. Demonstrates understanding of relevant literatures
2 - Demonstrates research skills	Applying existing methodologies and techniques	e.g. Misapplies or uses non-standard techniques without adequate rationalization.	Applies standard techniques. Does not recognize limitations of data / techniques were applicable.	Uses appropriate, theory, methods and techniques. Appropriately explains limitations of data / techniques were applicable.	Suggests and utilizes improvements to standard methods and techniques. Limitations are discussed.
	Analyzes and evaluate their own findings and those of others	e.g. Does not recognize improbable results.	Relies on others to suggest data that are relevant to solving a problem. Literature review is adequate but not critical.	Identifies weaknesses in own work but discussion is not comprehensive.	Provides evaluation of previous works. Identifies and corrects weaknesses or flaws in referenced work. Identifies and discusses shortcomings in own work.
3 - Make a contribution to the discipline	Develop concepts & methodologies	e.g. No independent research. Question or problem is trivial, weak, unoriginal, or previously solved.	Demonstrates competence but is not very significant. Displays little insight.	Argument is strong. Demonstrate some ideas, insights, and observations.	Has a good question or problem to solve. Project is well planned. Asks or addresses important questions.
4 - Demonstrates professional skills	Displays effective written communication skills	e.g. Writing is disorganized, has frequent spelling and grammatical errors. Illustrations poorly selected or illegible.	Writing is adequate. Structure and organization are weak, but sufficient. Illustrations legible, technically correct, and appropriate.	Well written and organized.	Concise and engaging. Technical content and graphic design of illustrations well planned.
	Displays effective oral communication skills	e.g. Disorganized or unable to articulate an argument. Does not grasp intent of questions.	Clear, partially understands or addresses questions, responses may have some gaps in logic or inconsistencies.	Clear presentation. Engages appropriate audiences. Grasps intent.	Convincing and accessible to multiple audiences. Articulately addresses questions.
	Professional conduct in the discipline	Plagiarism is found in written reports.	Absence of plagiarism in oral and written reports.	Absence of plagiarism, appropriate referencing and attribution, etc. in oral and written reports.	Absence of plagiarism, appropriate referencing and attribution with professional discussion, etc. in oral and written reports.

GLOs for MS (coursework option)	Departmental Objective	Unsatisfactory	Marginal / Progressing	Satisfactory	Very Good/ Excellent
1 - Demonstrates proficiency in physics courses	Synthesizes existing physics knowledge	e.g. Does not understand basic concepts or conventions. Misinterprets or misuses sources.	Displays a basic understanding of the field.	Displays understanding of the field. Adequate exploration of interesting issues and connections.	Demonstrates proficiency in drawing on multiple sources. Synthetic and interdisciplinary. Demonstrates understanding of relevant literatures
2 - Demonstrates proficiency in courses offer by other departments	Synthesizes existing knowledge beyond physics	e.g. Does not understand basic concepts or conventions. Misinterprets or misuses sources.	Displays a basic understanding of the field.	Displays understanding of the field. Adequate exploration of interesting issues and connections.	Demonstrates proficiency in drawing on multiple sources. Synthetic and interdisciplinary. Demonstrates understanding of relevant literatures
1. 3- Demonstrates interest to apply coursework knowledge to research activities	Interest to apply coursework knowledge to research activities	e.g. Does not attend physics colloquium, physics seminars or enroll in PH5010 (graduate journal club)	Attend physics colloquium, physics seminars or enroll in PH5010 (graduate journal club)	Actively attend physics colloquium, physics seminars or PH5010 (graduate journal club)	Actively attend physics colloquium, physics seminars or PH5010 (graduate journal club). Enroll in research credit (PH5999).
4 - Demonstrates professional skills	Displays effective written communication skills	e.g. Writing is disorganized, has frequent spelling and grammatical errors. Illustrations poorly selected or illegible.	Writing is adequate. Structure and organization are weak, but sufficient. Illustrations legible, technically correct, and appropriate.	Well written and organized.	Concise and engaging. Technical content and graphic design of illustrations well planned.
	Professional conduct in the discipline	Plagiarism is found in written reports.	Absence of plagiarism in oral and written reports.	Absence of plagiarism, appropriate referencing and attribution, etc. in oral and written reports.	Absence of plagiarism, appropriate referencing and attribution with professional discussion, etc. in oral and written reports.

Evaluation of PhD Graduate Learning Objectives (GLOs)

Student: _____ Advisor (s) _____

Presentation type: Progress Presentation/Preliminary exam/Thesis defense

Committee/Faculty could make decisions by referring to the suggested rubric. Please elaborate your rating on the space next to each GLO or on the space at the bottom of the form.

GLO 1: Demonstrate mastery of the subject matter

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

GLO 2: Demonstrate advanced research skills

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

GLO 3: Make an original and substantial contribution to the discipline

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

Goal 4: Demonstrate professional skills

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

Comments: _____

Evaluation of MS (Thesis/Report Options) Graduate Learning Objectives (GLOs)

Student: _____ **Advisor (s)** _____

Presentation type: Progress Presentation/Thesis or Report defense

Committee/Faculty could make decisions by referring to the suggested rubric. Please elaborate your rating on the space next to each GLO or on the space at the bottom of the form.

GLO 1: Demonstrate proficiency of the subject matter

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

GLO 2: Demonstrate research skills

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

GLO 3: Make a contribution to the discipline

- Unsatisfactory (1)
- Marginal/Progressing (2)

- Satisfactory (3)
- Very Good (4)
- Excellent (5)

Goal 4: Demonstrate professional skills

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

Comments: _____

Evaluation of MS (Coursework option) Graduate Learning Objectives (GLOs)

Student: _____ **Advisor (s)** _____

Committee/Faculty could make decisions by referring to the suggested rubric. Please elaborate your rating on the space next to each GLO or on the space at the bottom of the form.

GLO 1: Demonstrate proficiency in physics courses

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

GLO 2: Demonstrate proficiency in courses offer by other departments

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

GLO 3: Demonstrate interest to apply coursework knowledge to research activities

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

Goal 4: Demonstrate professional skills

- Unsatisfactory (1)
- Marginal/Progressing (2)
- Satisfactory (3)
- Very Good (4)
- Excellent (5)

Comments: _____

