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

2016-2017

INFORMATION FOR GRADUATE STUDENTS
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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 Catalog 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 the Graduate School's *Academics* web pages http://www.mtu.edu/gradschool/administration/academics/, which covers policies and procedures, degree requirements, necessary forms, and more. The Graduate School website http://www.mtu.edu/gradschool/resources-for/current/ also contains a wealth of information for current students. Convenient links to many of these resources are also available on the physics department website http://www.mtu.edu/physics/resources/graduate/

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
Physics Graduate Studies Committee: Dr. Jacek Borysow, Chair
Applied Physics Graduate Studies Committee: Dr. Yoke Khin Yap, Chair
Qualifying Exam Committee: Dr. Ranjit Pati, Chair
Department Staff:
Andrea Lappi - Department Coordinator
Kimberly Oldt - Office Assistant 4
Jesse Nordeng - Machinist & Safety Coordinator
Douglas Wilken - Laboratory Associate
William Slough - Laboratory Coordinator

Graduate Student Government Representatives – Binita Hona, Aeshah Muqri

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 *Tech Express* identification card and assigned M-number grant after-hours admission to Fisher Hall via the south entrance at US41 by the large lecture halls. Office and teaching laboratory keys are ordered by the department coordinator. 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.

All graduate students are provided computer access through computer labs in several common areas (Fisher Hall 330) 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. Please read the policies for using physics computers as well as using any Michigan Tech computer facilities as soon as you begin using the computers. Computer use policies are available on our website at http://www.phy.mtu.edu/basiccomputing/policy.html .

Students should pay particular attention to Michigan Tech computer use policies regarding copyrights, privacy, passwords, and hacking. These can be found through the link at the above web site, or directly at
http://www.it.mtu.edu/OIT/documents/computer_use_policy.pdf

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 & 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 http://www.admin.mtu.edu/admin/procman/ch13/ch13p10.htm

D. Work Obligation of Teaching Assistants

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 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.

E. Work Obligation of Research Assistants

On the average, students supported by graduate research assistantships are expected to work 40 hours per week (including approved course work) 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.

F. Safety

There are a number of safety policies and procedures in effect at Michigan Tech that particularly apply to graduate students, such as those concerning hazardous waste, housekeeping, and safety orientation. Copies of these policies are supplied separately; please read them carefully. Additional safety policies concern students conducting research using the machine shop, any research or teaching laboratories, or using chemicals. Please consult your research advisor regarding all applicable safety policies and procedures before beginning work. Students must read the Physics Laboratory Safety rules and the General Laboratory Safety rules, and sign the Laboratory Worker Safety Agreement before beginning work. Questions can also be directed to the safety coordinator or department chair.

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.sas.it.mtu.edu/fm/oshs/

G. Absence Policy

Students receiving financial aid through the University (teaching assistantship, research assistantship, fellowship) are entitled to staff holidays. Please note that the breaks between academic terms and the break at Christmas are not automatically considered as holidays or time off. In the case of GRAs, excused absences must be arranged with the faculty advisor, and approved by the department coordinator on the physics absence form available online http://www.mtu.edu/physics/graduate/pdfs/PhysicsGradStudentAbsenceRequest_fields.pdf

GTAs follow a similar policy, but require the approval of the department and laboratory coordinators. In general, all graduate students may take up to two weeks off campus each year, excepting that in NO CASE may it be during an academic term or finals week. PRIOR written authorization is required from the department coordinator, in consultation with student's advisor, the Chair of the Graduate Studies Committee, and in the case of GTAs, the laboratory coordinator. Written approval is required for international travel http://www.admin.mtu.edu/acct/forms/travel/index.html in addition to the absence request form. Any absence which does not follow this policy will result in an automatic deduction of pay and disciplinary action.

H. Colloquium

The department organizes a colloquium series held on Thursday 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, PH5975, PH5999, PH6975, 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.

Students in their second year of study and beyond participate in the colloquium series through a departmental poster session and/or a 20-minute talk regarding their research. 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.

I. 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 http://www.mtu.edu/gradschool/admissions/admitted/online-orientation/
Further information on Scientific Misconduct Procedures may be found at http://www.admin.mtu.edu/admin/prov/facbook/appf/fapp.htm .

J. International Students

Upon arrival on campus all international students must register with the Office of International Programs and Services located in room 200 of the Administration Building. All matters concerning employment practice, visa renewals, and related matters are handled through this office. Changes in I-20 forms are handled in the Graduate School.

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, techtesting-l@mtu.edu . More detail 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 Teaching Assistants Assistance Program (IGTAAP). Students' language skills and their cultural competency will be assessed, and students will be provided with services on an as-needed basis so they can provide better service to our undergraduates and faculty while serving as graduate teaching assistants. Additional information is here http://www.mtu.edu/ctl/for-graduate-teaching-assistants/igtaap/

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

K. Stipend, Tuition, and Health Care

Graduate teaching assistants and graduate research assistants are paid a stipend set by the Graduate School and, in some cases, their research advisor. Stipend levels generally increase as you progress toward your degree and submit the required M- and D- forms (see the Graduate School web site for details). Stipend payments are issued bi-weekly. Supported graduate students must be enrolled for nine credits each semester during the academic year and one 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 (GRA, GTA) receive partial support toward their health insurance cost. More information about health

insurance and health care can be found at http://www.admin.mtu.edu/hro/stud%20insurance/index.shtml Questions regarding health insurance coverage can be addressed to the physics department representative to the Graduate Student Government (listed on page 1) or to Human Resources.

L. 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.

The PLC also houses the physics department "library" and attractive study space. Graduate students wishing 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 locked at all times unless occupied by PLC coaches, physics graduate students, or faculty. See the PLC faculty coordinator, Dr. Weidman, if you have any questions.

II. Advisors

Advisors help students structure a program of study that addresses their needs and satisfies degree requirements. New students are initially assigned the Chair of the Graduate Studies Committee as their advisor. The Graduate Studies Committee facilitates 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 for the Graduate School (M for M.S. degree; D for Ph.D. degree) at the appropriate times (see this link for current forms and instructions): http://www.mtu.edu/gradschool/administration/academics/forms-deadlines/

A. Course-Work Advisor

The Graduate Studies Committee chair currently serves as course work advisor for all entering physics graduate students. Entering students prepare their fall-semester course schedules in consultation with him 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 their advisor to prepare a course schedule for spring semester. Students may register for classes after consultation with their advisor. 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 typically takes three 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 credit hours per semester. To be considered full time during the summer semester, students must register for a minimum of one credit or one 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 and examinations, they may submit the petition the Graduate School to enter research mode http://www.mtu.edu/gradschool/administration/academics/forms-deadlines/pdfs/ResearchOnlyMode.pdf . Students must still maintain full-time status but are eligible for a lower full-time 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 the written pre-approval of the department chair, the Graduate Studies Committee chair, and the student's research advisor. Permission forms are available on our web site
http://www.mtu.edu/physics/graduate/pdfs/PhysicsPermissionNonPhysicsCourse_fields.pdf
Typically, such approval requires that students have taken or are taking required physics courses being offered during the same semester. In general, approval will be granted for taking only one course per semester outside of physics. Graduate research assistants 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 Graduate Studies Committee. After a student selects a research advisor the Advisor and Committee Recommendation Form should be completed (online), printed, and filed with the department and Graduate School (http://www.mtu.edu/gradschool/administration/academics/forms-deadlines/pdfs/advisor-committee.pdf)

For most students, the process of selecting a permanent faculty research advisor should begin during the fall semester of 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 fall 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. These individual sessions may be used to discuss specific research projects and availability of funding, but no formal or informal agreement as to research advisor selection normally is made at this time.

Upon completion of the research presentations and after suitable time for follow up interviews, each student should meet with their first choice of a 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 Graduate Studies Committee and department chairs as soon as possible. First-year students unable to find a research advisor must notify the Graduate Studies Committee and department chairs 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) track record of advisor-papers, funding, student graduation, and job success, and 3) current research group size. Please be aware that the availability of any particular research project is governed by the availability of funds to support that research.

C. Advisory Committee

Each student accepted into the graduate program in the Department of Physics is assigned an Advisory Committee initially consisting of three members of the Physics, Applied Physics, or Atmospheric Sciences Graduate Studies Committee. The chair of the respective Graduate Studies Committee will meet with the student and prepare an initial program of course study, as described above. The Applied Physics graduate program director will remain the advisor for students pursuing the MS-coursework option.

After passing the Qualifying Exam and prior to taking the Preliminary Exam, Ph.D. students, in consultation with the research advisor and with the approval of the department chair, should select the rest of the Advisory Committee members and file the form (http://www.mtu.edu/gradschool/administration/academics/forms-deadlines/pdfs/advisor-committee.pdf) with the department and Graduate School. The Advisory Committee includes the research advisor and the two members of the graduate faculty from the physics department who will ultimately serve on the dissertation committee. The primary purpose of the Advisory Committee is to guide and monitor the research work of the student. A graduate faculty member external to the Department of Physics is required for the final dissertation defense, but may be invited to participate on the Advisory Committee sooner.

III. Graduate Degree Requirements

The focus of the graduate program in the Department of Physics is on the doctoral programs. 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 Plan D outlined below. Students wishing to terminate their graduate study with a Master's degree are strongly encouraged to pursue the thesis option - Plan A. Plan B, the project option, is available to students under special circumstances.

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

		SP16	F16	SP17	F17	SP18	F18	SP19	F19	SP20	F20	SP21
PH4390	Computational Methods in Physics		X		X		X		X		X	
PH4395	Computer Simulation in Physics*											
PH4510	Intro to Solid State Physics		X		X		X		X		X	
PH4610	Stellar Astrophysics					X						X
PH4620	Galactic Astrophysics	X						X				
PH4630	Particle Astrophysics			X						X		
PH4640	Intro to Atmospheric Physics				X				X			
PH5010	Graduate Journal Club		X		X		X		X		X	
PH5090	Special Topics in Physics*											
PH5110	Classical Mechanics			X				X				X
PH5210	Electrodynamics I		X		X		X		X		X	
PH5211	Electrodynamics II			X				X				X
PH5310	Statistical Mechanics	X				X				X		
PH5320	Mathematical Physics		X		X		X		X		X	
PH5410	Quantum Mechanics I		X		X		X		X		X	
PH5411	Quantum Mechanics II	X				X				X		
PH5510	Theory of Solids	X				X				X		
PH5520	Materials Physics			X				X				X
PH5530	Special Topics in Nanotechnology			X				X				X
PH5610	High Energy Astrophysics*											
PH5640	Atmospheric Physics		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. Course work 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 (15 credits):

	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)

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

	Disciplinary Electives
PH4395	Computer Simulation in Physics
PH4610	Stellar Astrophysics
PH4620	Galactic Astrophysics
PH4630	Particle Astrophysics
PH5211	Electrodynamics II
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 (RCR) Training is an important aspect of being an effective scholar and is mandatory whether a Masters or Doctoral degree candidate. Basic training must be completed within the first two semesters at MTU or a registration hold will be placed on the student's account. Advanced training must be completed by the end of the third semester. Students may not graduate or enter research only mode if RCR training is not complete. http://www.mtu.edu/gradschool/administration/academics/resources/rcr/

A. Master of Science in Physics

1. Plan A - Thesis Option

Students intending to terminate their graduate study at the Master's level are encouraged to pursue Plan A. In addition to the course work requirement outlined above, the remaining credits (not less than six) 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 course work be completed in residence at Michigan Tech.

A degree schedule (Form M4 - see below) must be filed with the Graduate School the semester prior to the final defense. Approval of the degree schedule is necessary before the final oral examination may be scheduled.

Students should select an advisor and Advisory Committee during their second semester and file an Advisor and Committee Recommendation form with the Graduate School. No later than two weeks prior to the proposed oral examination date the student, in consultation with the research advisor, must complete the Pre-Defense Form to schedule the exam time and place. A title and abstract should be submitted to the office assistant one week before the oral examination so that announcements can be sent to the department and University community.

2. Plan B - Report Option

In addition to the coursework requirements, a minimum of three 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 research credits) as approved by the Physics

graduate program director 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.

3. Plan D - 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 Plan D.

The course work 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 Plan A option. In addition, six 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 Preliminary Examination described below.

The student, in consultation with the Graduate Studies Committee, will file all necessary forms (M forms) for students completing a Master's degree in Physics under Plan D.

4. Masters Form Submission Schedule

Form:	**Term Due:**
Advisor and Committee Recommendation Form	SECOND
M4 Degree Schedule	TERM PRIOR TO DEFENSE TERM
Pre-Defense Form	TWO WEEKS PRIOR TO EVENT
Verification of Final Degree Requirements	TWO WEEKS after oral exam or at end of final exam week of final semester
Degree Completion Form	See deadlines on Graduate School web site (see link below)

Current versions of all tracking forms are available online at:
http://www.mtu.edu/gradschool/administration/academics/timeline/dissertation/

Note for International Students: **Visa requirements for international students often change. International students should stay well informed of current visa requirements through the offices of International Programs or 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 etc. Most of the faculty members of the department 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 (offered since Fall 2015) 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.

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 proposed program. These requirements are in addition to those of the Graduate School. A minimum of 30 credits are required for the program.

Degree	Course Requirements Beyond Those of the Graduate School
M.S. in Applied Physics Thesis option Report option Coursework option	<u>Core Courses:</u> *Minimum of 10 PH credits at the 4000-level or higher including a minimum of 6 credits from the following list:* 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) <u>Application Electives</u> *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.* *Additional courses may be required by the student's advisory committee under plans A and B.* <u>Research</u> *PH5999 Master's Research* Minimum 6 credits for thesis degree (Thesis option) Minimum 3 credits for report degree (Report option) No research for coursework degree (Coursework option)

Application Elective course lists, shown below, will be updated annually. New lists may be created by the 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
CE 5800/GE 5800 - Mathematical Modeling of Earth Systems
ENVE 4501 - Environmental Engineering Chemical Processes
ENVE 4504 - Air Quality Engineering and Science
EE 5540 - Statistical Optics
FW 5340 - Advanced Topics in Climate Change
GE 4250 - Fundamentals of Remote Sensing
GE 5030 - 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,
MY 6200 - Advanced Topics in Materials Characterization,
PH 4510 - Introduction to Solid State Physics
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

Degree Options

1. Plan A - Thesis Option

In addition to the coursework requirements described above, a minimum of six 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 ten research credits) as approved by the director of the Applied Physics graduate program 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. Requirements of this option also include a written Master's thesis and a final oral examination based on the student's thesis.

2. Plan B - Report Option

In addition to the coursework requirements described above, a minimum of three 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 research credits) as approved by the Applied Physics graduate program director 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.

3. Plan D - 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 program director. A minimum of 18 credits must be at the 5000-6000 level and a maximum of 12 credits can be at the 3000-4000 level.

C. Doctor of Philosophy in Physics

1. Residency

University policy requires that doctoral students spend at least four semesters (including summer) on campus at Michigan Tech beyond attainment of a bachelor's degree or two semesters on campus at Michigan Tech beyond attainment of a Master's degree in a formal program of study and research under direct supervision. Continuous enrollment in the fall and spring semesters is also required. This requirement may be waived under special circumstances with pre-approval. See the Graduate School Catalog for details.

2. Coursework

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

The core course and disciplinary elective requirements are detailed above. Additional course work 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 D5 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. The Qualifying Examination will be authored and administered by the Qualifying Examination Committee and will cover four areas: classical mechanics (including introductory special relativity), electricity and magnetism, quantum mechanics, and general physics. Sample examinations are available at http://www.mtu.edu/physics/graduate/degree/qualifying/

Questions regarding the qualifying exam policies may be directed to the chair of the Qualifying Exam 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 general physics section of the exam will consist of short questions covering all areas of physics normally taught at the undergraduate level including mechanics, special relativity, electromagnetism (including AC and DC circuits), quantum and atomic physics, thermal and statistical physics, optics, and laboratory techniques including data analysis.

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.	general physics
Week 3	Saturday	3:00 – 5:00 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.	general physics
Week 3	Saturday	2:00 – 4:00 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. This "free shot" does not count as one of the two attempts that students are allowed to pass the exam. The main purpose of the "free shot" is to acquaint new students with the exam. Students who pass the entire exam on the free shot fully satisfy the Qualifying Examination requirement. Any of the four areas passed on the "free shot" need not be retaken in future attempts. 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 are required to take the Qualifying Examination no later than the fall semester of the following year; students who enter the Ph.D. program during the spring semester are required to take the Qualifying Examination no later than the spring semester of the following year. Students are allowed two attempts to pass the Qualifying Examination. Passing scores in each of the four areas are required to pass the exam.

Students are usually informed of the outcome of the written exam within three weeks of the last-scheduled examination date. The outcomes of the exam are either a pass or a fail for each area of the exam. Any of the four areas 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 four areas of the exam, the Qualifying Exam 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, an *ad hoc* committee may be formed consisting of the Qualifying Exam Committee, department, and Graduate Studies Committee chairs, as well as the student's research advisor. This *ad hoc* committee will determine whether or not it is appropriate to continue the failed area of the 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 may 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 area of the Qualifying Examination that had been initially failed.

After passing the Qualifying Exam, the Report on Comprehensives Form is signed by the chair of the Graduate Studies Committee and filed with the department office assistant.

4. Preliminary Examination (Research Proposal Examination)

The Preliminary Exam (Research Proposal Examination) is taken after the Qualifying Exam 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 his or her research advisor, has become familiar with the related literature, and has devised a plan for research, the Preliminary Exam should be scheduled. A paper describing the proposed research, not exceeding fifteen pages in total length, should be distributed to the Advisory Committee one 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. No special form is needed for scheduling the Preliminary Exam although the Graduate Studies Committee chair should be informed of the committee members (D2 form may need updating). Please consult an office assistant to schedule a room, advertise the talk to the department and University community, and prepare the departmental assessment Form E.

The Report on Research Proposal Examination (D6) and Form E are filed with the physics office assistant upon successful completion of the Preliminary Examination.

5. Doctoral Dissertation and Final Oral Examination

The final examination may be scheduled any time after a period of two academic semesters following the successful completion of the preliminary exam 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 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 completed Pre-Defense Form (D7). 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 members of the student's Advisory Committee and a fourth member chosen from a cognate department or program.

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

The day of the defense, the student completes the Report of Final Oral Examination (D8); the Advisory Committee will be given the necessary departmental assessment Forms F and GH for the final defense. Following the defense, the Ph.D. candidate incorporates all corrections and suggestions of the examining 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
http://www.mtu.edu/gradschool/administration/academics/timeline/dissertation/

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

6. Time Limit (See timeline to degree on page 24)

The Graduate School requires that the qualifying examination must be taken within five years, and all requirements must be completed within eight years, from the time of a student's first enrollment in the doctoral program.

D. Doctor of Philosophy in Applied Physics

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 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 is 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 chair of the Applied Physics Graduate Studies Committee as their advisor who will help 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 each student selects a research advisor who will serve to guide and direct the student's subsequent course of study and research, and to chair the student's Advisory Committee. After choosing a research advisor, the D2 form should be filed with the Graduate School. By the end of the second semester in the program, an Advisory Committee should be formed whose purpose is to assist in guiding and monitoring the research work of the student. In addition to the research advisor, the Advisory Committee must consist of three other members, including at least one member of the graduate faculty from the physics department. If desired, Committee members can be graduate faculty from another cognate department. The Advisory Committee will ultimately serve on the student's examining committees. Committee members are chosen by the research advisor and the student, with approval of the department chair. An Advisor and Committee Recommendation Form naming the advisor and Advisory Committee should be filed in the department office.

2. Coursework

A grade of B or better is required 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

MY4530 Surfaces and Interfaces
MY4700 Electronic Properties of Materials
MY4710 Materials Science/Electronic Devices
MY5100/5110 Thermodynamics and Kinetics I & II
MY5400 Mechanical Behavior of Materials
MY5550 Solid Surfaces
MY6100 Computational Materials Science and Engineering
MY6110 Advanced Topics in Materials Processing
MY6200 Advanced Topics in Materials Characterization
MY6400 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 semester before the final oral defense is scheduled on the Degree Schedule form (D5).

3. Qualifying Examination

Students accepted into the Applied Physics Ph.D. program must pass the Qualifying Examination, which is composed of a physics component and an application component. Questions regarding the Qualifying Exam policies may be directed to the Qualifying Exam Committee chair (listed on page 1).

The physics component of the Qualifying Exam will cover three of the four following areas, to be chosen in advance, by the student: classical mechanics (including special relativity), electricity and magnetism, quantum mechanics, and general physics. Sample examinations are available on the web at http://www.phy.mtu.edu/qual.html. Each of these areas will be covered in a separate two-hour written examination. 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 general physics section of the exam will consist of short questions covering all areas of physics normally taught at the undergraduate level including mechanics, special relativity, electromagnetism (including AC and DC circuits), quantum and atomic physics, thermal and statistical physics, optics, and laboratory techniques including data analysis.

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.	general physics

Week 3	Saturday	3:00 – 5:00 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.	general physics
Week 3	Saturday	2:00 – 4:00 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. This "free shot" does not count as one of the two attempts that students are allowed to pass the exam. The main purpose of the "free shot" is to acquaint new students with the exam. Students who pass the entire exam on the free shot fully satisfy the Qualifying Examination requirement. Any of the four areas passed on the "free shot" need not be retaken in future attempts. 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 are required to take the physics component of the Qualifying Examination no later than the fall semester of the following year; students who enter the Ph.D. program during the spring semester are required to take the physics component of the Qualifying Examination no later than the spring semester of the following year. Applied Physics Ph.D. students must pre-select the three exam areas they need to pass, by the deadline set by the department coordinator. Students are allowed two attempts to pass the physics component of the Qualifying Examination. Passing scores in each of the three pre-selected areas are required to pass the physics component of the exam. Students may not change the three pre-selected areas for the second and final attempt if a second attempt is necessary.

Students are usually informed of the outcome of the written exam within three weeks of the last-scheduled examination date. The outcomes of the exam are either a pass or a fail for each area of the exam. Any of the three areas 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 areas of the exam, the Qualifying Exam 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, an *ad hoc* committee may be formed consisting of the Qualifying Exam Committee, department, and Graduate Studies Committee chairs, as well as the student's research advisor. This *ad* hoc committee will determine whether or not it is appropriate to continue the failed area of the 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 which may 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 area of the physics component Qualifying Examination that had been initially failed.

The student's Advisory Committee formulates the application component of the Qualifying Examination that is two to three 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 format of the application component of the Qualifying Examination is determined by the student's Advisory Committee and should be taken by the end of the student's spring semester of the second year.

4. Preliminary Examination (Research Proposal Examination)

The Preliminary Exam (Research Proposal Examination) is taken after the Qualifying Exam has been passed. It is administered by the student's Advisory Committee for the purpose of reviewing the student's proposed plan for research. Once a student has identified a research problem in consultation with his or her research advisor, has become familiar with the related literature, and has devised a plan for research, the Preliminary Exam should be scheduled. A paper, not exceeding 15 pages, describing the proposed research should be distributed to the Advisory Committee one 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. Form D6 should be filed with the Graduate School upon successful completion of the Preliminary Examination.

E. Student Responsibilities

It is the responsibility of each physics graduate student to be familiar with physics department policies as outlined in this handbook, and with Graduate School policies as outlined in the Graduate School Catalog. It is the responsibility of each physics graduate student to be sure that Masters (M) or Doctoral (D) forms are completed and authorized in a timely fashion, and are filed with the secretaries in the physics department office.

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	BASIC by end of first academic year ADVANCED by end of third semester
Report on Qualifying Examination	Physics: Within first two years in program Grad School: Within five years of starting program
Advisor and Committee Recommendation Form	SEMESTER FOLLOWING passing qualifying exams naming advisory committee
D5 Degree Schedule	SEMESTER PRIOR TO ROM* or FINAL DEFENSE earlier discussions w/advisor regarding coursework is recommended
D6 Report on Research Proposal Examination	AFTER PASSING "PRELIMINARY EXAM" w/in six years after enrollment
*Petition to Research Only Mode (ROM) Petition	Due one week prior to the first day of classes in the semester student plans to enter research only mode
D7 Pre-Defense Form	TWO WEEKS PRIOR TO ORAL DEFENSE submitted with draft copy of dissertation to graduate school & advisory committee
D8 Report on Final Oral Examination	FIRST DAY OF FINAL EXAMS completed for advisory committee signatures day of oral exam
Approval of Dissertation, Thesis, Report	FRIDAY OF FINALS WEEK
Degree Completion Form	WITHIN ONE WEEK of submitting APPROVAL form (above) Uploaded with final dissertation to CANVAS Submit dissertation to PROQUEST
Workspace Cleanout Form	BEFORE GRADUATING/LEAVING MTU
Survey of Earned Doctorate; Exit Survey	BEFORE COMPLETING DEGREE

Current versions of all tracking forms are available online at:
http://www.mtu.edu/gradschool/administration/academics/timeline/dissertation/

V. Illustrative Time Line For Academically Prepared Physics Ph.D. Graduate Students

Year 1 - (assuming fall entry)

- September: Qualifying Examination (free shot)
- 2-3 physics courses each semester (9 credits)
- Funding via a teaching assistantship
- 20 hours of work/week, typically in introductory physics labs.
- January: Qualifying Examination
- Spring of year 1- select a research advisor
- Summer of year 1- begin research
  If funded by a GRA, ~40 hrs/week; if GTA, ~20 hrs/week

Year 2 - 1-2 courses/semester

- Divide remaining time between research and teaching (if still on GTA)
- September- retake un-passed Qualifying Examination sections if necessary

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

- Take Preliminary Exam in the fall or winter

Years 4 & 5 - finish research

- Write thesis (no more than 6 months)
- Submit 1-2 co-authored manuscripts for publication in a refereed journal, in collaboration with your research advisor
- During years 3-5, you should have attended and presented talks and/or posters at a few national meetings
- Final dissertation defense
- Latter part of year 5 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.