



Department of Physics
COLLEGE OF LETTERS & SCIENCES
UNIVERSITY OF WISCONSIN-MADISON

M.S. PHYSICS QUANTUM COMPUTING PROGRAM

**GRADUATE STUDENT HANDBOOK
2019-2020**

Table of Contents

PROGRAM OVERVIEW	3
CREDIT REQUIREMENTS	3
<i>Total Credits</i>	3
<i>Graduate Level Credits (G50%)</i>	3
SATISFACTORY PROGRESS	3
ENROLLMENT	4
COURSEWORK	4
• <i>Required:</i>	4
• <i>Or:</i>	4
• <i>Electives:</i>	5
• <i>Directed study:</i>	5
<i>Coursework outside of Physics</i>	5
<i>Course Waivers: Prior Coursework</i>	5
GPA REQUIREMENT	5
TUITION & FEES	5
TIMELINE	6
FACULTY ADVISOR	6
COMMITTEE & DEGREE PROCESSING	6
GRIEVANCES	6
LEAVE OF ABSENCE	7
<i>Re-entry</i>	7
<i>Time Limits</i>	8
EXCEPTIONS	8
CAMPUS POLICIES	8
<i>Graduate Assistantship</i>	8
<i>Program/Course Enrollment</i>	8
<i>Current Ph.D. Students</i>	8

PROGRAM OVERVIEW

The Masters of Science in Physics-Quantum Computing (MSPQC) is excited to welcome the first class for the Fall of 2019. The program provides students with a thorough grounding in the new discipline of quantum information and quantum computing. In the classroom, students will study the relevant parts of quantum theory, and proceed to quantum gates, measurements, algorithms, quantum error correction and decoherence. Quantum communication theory and the secure transmission of information will also be covered. The supporting areas of statistical mechanics, solid-state physics and atomic physics will form part of the classroom training. Just as important, the program will give students a mastery of the advanced lab skills involved in quantum computation. After graduation, students will have the tools to succeed as researchers or program managers in a quantum computing or quantum technologies enterprise. Students may also use the program as a springboard to Ph.D. programs in physics or related areas.

CREDIT REQUIREMENTS

The GUIDE at UW-Madison outlines all of the requirements for the MSPQC program: <https://guide.wisc.edu/graduate/physics/physics-ms/physics-quantum-computing-ms/#requirements>

Total Credits

The MSPQC degree requires 30 credits to align with the Graduate School minimum graduate degree credit requirement:

<https://grad.wisc.edu/documents/minimum-graduate-degree-credit-requirement/>

Graduate Level Credits (G50%)

The MSPQC degree requires that at least 15 credits carry the Graduate Coursework (G50%) attribute to align with the Graduate School minimum graduate coursework (50%) requirement:

<https://grad.wisc.edu/documents/minimum-grad-coursework-requirement/>

To determine which courses can be used to satisfy the graduate level (G50%) credit requirement, please consult: <http://enroll.wisc.edu> (Search: “Other Options”, check the box “50% Graduate Coursework Requirement”). This will provide accurate information as to which courses have been approved through the University to count towards the G50% requirement. Typically, courses that carry the G50% attribute are those at the 700 level and above and any other courses that have been designed and approved for graduate work. Most of the 500 level courses in the Department of Physics carry the G50% attribute, but students should check before enrolling in courses.

SATISFACTORY PROGRESS

The criteria for satisfactory progress and the items required to maintain good standing in the MSPQC program are outlined below. Satisfactory progress is important to staying on track and completing the degree in a timely manner. Graduate students who do not achieve satisfactory

progress are considered not in good standing and may not be allowed to continue in the MSPQC program. To achieve satisfactory progress, students must:

- Enroll each semester according to the Graduate School minimum enrollment requirements: <https://grad.wisc.edu/documents/enrollment-requirements/>
- Enroll in coursework suited to the MSPQC program in consultation with the faculty advisor
- Maintain an overall graduate GPA of 3.0 or above according to the Graduate School GPA requirement: <https://grad.wisc.edu/documents/gpa-requirement/>

ENROLLMENT

The Graduate School policy indicates the minimum enrollment requirements each semester: <https://grad.wisc.edu/documents/enrollment-requirements/>

COURSEWORK

At least 30 credits must be completed for the MSPQC degree. At least 15 of them must be at the graduate level. One suggested curriculum can be found on the website.

http://www.physics.wisc.edu/sites/default/files/MSQC_Suggested_Curriculum.pdf

The coursework is individualized for each student depending on undergraduate preparation and background. Students will work with the faculty advisor to determine the appropriate coursework each semester and to develop a full MSPQC degree plan of study. The following categories describe the various types of courses in the MSPQC program: required, or, electives, and directed study.

- **Required:** all MSPQC students must take these courses while in the program. They are offered during separate semesters to allow students to take one required course each semester. The required courses should be taken in the following order.
 - Physics 709: Introduction to Quantum Computing (3 credits-Fall)
 - Physics 779: Advanced Quantum Computing (3 credits-Spring)
 - Physics 707: Quantum Computing Laboratory (4 credits-Summer)
- **Or:** there are a few courses that are designated as “or” meaning that you will take one or the other, but not both. Typically, students take one “or” class each semester. These are decided based on the academic preparation that each student has upon entering the MSPQC program. Students should consult with their faculty advisor to determine the best option for the “or” courses.
 - Physics 415: Thermal Physics **OR** Physics 715: Statistical Mechanics
 - Physics 449: Atomic and Quantum Physics **OR** Physics 545: Introduction to Atomic Structure

- Physics 531: Introduction to Quantum Mechanics **OR** Physics 731: Quantum Mechanics
- Physics 551: Solid State Physics **OR** Physics 751: Advanced Solid State Physics
- **Electives:** there are various electives that students might select based on the list of all Physics courses numbered 300 and above. Typically, students take at least one elective each semester. The list of all Physics courses can be found in the GUIDE.
<https://guide.wisc.edu/courses/physics>
- **Directed study:** during the summer semester, students will generally enroll in at least 2 credits of directed study. This allows students to gain experience in quantum computing research setting while working directly with a faculty advisor on a specific project. The project may consist of enrichment in a particular topic or may involve original research.
 - Physics 799: Directed Study

Coursework outside of Physics

Most students will take all coursework through the Department of Physics. Occasionally, if students wish to take courses outside of the Department of Physics, they must request special permission from the faculty advisor and the MSPQC Program Director before doing so.

Course Waivers: Prior Coursework

Students who believe that they have done graduate-level work in one or more of the core course subjects prior to their arrival at UW-Madison may be eligible for course waivers. Course waivers forms are available for those students who have taken equivalent courses at another institution. Waivers of core courses can be granted for credits earned at other universities in equivalent graduate-level courses, pending approval by the MSPQC Program Director. Students who believe that they qualify for a waiver of the course requirement based on prior graduate course work from another institution should request consideration for a waiver within the first month of the graduate program. The Graduate School will allow these credits to count towards the graduate degree at UW-Madison only if they were earned post-baccalaureate as outlined in the Prior Coursework policy:

<https://grad.wisc.edu/documents/prior-coursework/>

GPA REQUIREMENT

Student must earn an overall graduate GPA of 3.0 or higher in accordance with the Graduate School GPA requirement policy:

<https://grad.wisc.edu/documents/gpa-requirement/>

TUITION & FEES

The tuition for the MSPQC program is \$1,600 per credit. In addition, all enrolled graduate students must pay the UW-Madison segregated fees assessed each semester. Students can find

their officially assessed tuition rate by accessing their MyUW Student Center and viewing the “Tuition Account Summary” located under the “Finances” section:
<https://bursar.wisc.edu/tuition-and-fees>

TIMELINE

The MSPQC program is designed so that it can be completed in a single calendar year. All students begin in the Fall semester and continue through Spring and Summer semesters. Fall semester starts in September, but all students will be required to arrive for new student orientation which will be held during the last week of August. The MSPQC program finishes at the end of the following Summer semester, which is usually in early August. The schedule may be extended in exceptional circumstances with approval of the faculty advisor and the MSPQC Program Director.

FACULTY ADVISOR

The summer before students begin the MSPQC program, all new incoming students will be assigned a faculty advisor. Students will work with the faculty advisor to select courses each semester and determine a plan of study. The faculty advisor must agree to the full MSPQC degree plan of study and each plan will be tailored to the needs of the individual based on the interests and academic preparation of each student.

COMMITTEE & DEGREE PROCESSING

The Master’s degree committee that evaluates MSPQC graduate student work must coincide with the Graduate School policy on committees.
<https://grad.wisc.edu/documents/committees/>

Master’s committees must have at least one graduate faculty from the Department of Physics, which shall be the faculty advisor. In addition, the MSPQC Program Director will serve on the committee and sign off on the final degree warrant. Students cannot have more than one dissenting vote from their committee on the final degree warrant.

Since the MSPQC is a coursework only degree, the Graduate Coordinator will automatically request the MS in Physics-Quantum Computing degree warrant from the Graduate School during the final semester of the program. The student does not need to request a warrant for the MSPQC degree.

GRIEVANCES

Graduate students should consult their faculty advisor, MSPQC Program Director, or Graduate Coordinator about any concerns related to academic issues or the academic environment. Graduate students may also reach out directly to the Department Chair as an alternate

approach. The hope is that this will result in the development of a working environment that all will find supportive. If graduate students have a question of whether or not a situation or discomfort should be discussed, the answer is YES! Any issue that is troubling should be addressed and, if it is within the Department's authority, it will be resolved.

If a graduate student feels unfairly treated or aggrieved by faculty, staff, or another student, it is recommended that the concerns are first handled directly with the person responsible for the objectionable action, if possible. If the student is uncomfortable making direct contact with the individual(s) involved, the student should contact the faculty advisor or the person in charge of the unit where the action occurred (program or department chair, section chair, lab manager, etc.), and/or contact the people mentioned above.

There are also resources and formal grievance procedures at the campus level that can be followed, which are outlined in the Graduate School policies:

<https://grad.wisc.edu/documents/grievances-and-appeals/>

LEAVE OF ABSENCE

While in most cases participation in the program is continuous over time, students sometimes find it necessary to take a temporary leave of absence. Graduate students may request a leave of absence for one semester by submitting a form outlining the timeline for the leave and general reasons. The faculty advisor must agree that the student is leaving in good standing and may re-enter the program in a reasonable stated length of time. Written requests for a leave of absence should be addressed to the MSPQC Program Director and the Graduate Coordinator. Please note that the Department Chair, in consultation with the Associate Chair and MSPQC Program Director, approves any leave of absence requests.

If a student is granted a one semester leave of absence, the milestone due dates are pushed back one semester. Students may be granted a leave of absence for no more than one semester at a time. Students who do not register for more than one semester (Fall or Spring) will be considered inactive and must apply for re-entry.

Re-entry

Graduate students who leave the program in good standing for more than one term (not including summer) may request re-entry to the program by completing the Graduate School application for re-admission. The MSPQC Admissions Committee, in consultation with the faculty advisor, MSPQC Program Director, Associate Chair, and Department Chair, will review the request based on the information provided.

The Graduate School outlines the policy for readmission for previously enrolled graduate students:

<https://grad.wisc.edu/documents/readmission/>

Time Limits

In addition, the Graduate School specifies time limits for completion of current coursework. Students who take a leave of absence or re-enter into the program should be aware of these policies:

<https://grad.wisc.edu/documents/time-limits/>

EXCEPTIONS

The MSPQC Program Director and the Chair of the Department have the authority to make individual exceptions to policies found in the MSPQC program handbook. Exceptions must involve extenuating and/or unique individual circumstances. Requests for such exceptions should be made in writing to the MSPQC Program Director, and/or the Department Chair.

CAMPUS POLICIES

The following campus policies outline certain criteria that programs like the MSPQC must meet.

<https://kb.wisc.edu/vesta/page.php?id=59300>

Graduate Assistantship

Students enrolled in the MSPQC program are not permitted to accept teaching assistantships, project assistantships, research assistantships, or other appointments that would result in a tuition waiver.

Program/Course Enrollment

Students in the MSPQC program cannot enroll in another graduate program at UW-Madison simultaneously. Students can take courses outside of the prescribed curriculum only with the permission of the faculty advisor and the MSPQC Program Director.

Current Ph.D. Students

Current students in the Physics Ph.D. program, or any other graduate program at UW-Madison, may not earn the MSPQC degree while they are also enrolled in another graduate program. In order to earn the MSPQC degree, a student would need to apply to change majors from the original program of study to the MSPQC program, be admitted by the MSPQC Admissions Committee, enroll as an MSPQC student, pay the MSPQC tuition rate, and meet all of the MSPQC program requirements.