

PHYSICS
Ph.D. AND MS DEGREE REQUIREMENTS

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A. Introduction

- 1) **Aims and Scope:** The mission of the Physics graduate program at UC Merced is to train our next generation of scientific leaders. Our graduates will be well prepared to conduct and communicate independent research at the knowledge frontier, advancing fundamental understanding of the world around us and using physics to solve important problems in society.
- 2) **Admissions Requirements:** All persons seeking admission to graduate standing must make formal application for admission through the Graduate Division's on-line application system. Applications are reviewed by the Admissions Committee, which makes recommendations on admission to the Graduate Division; the Graduate Dean makes final decisions on admission. The deadline for receipt of applications is December 15 for enrollment in the Fall semester. Applicants are encouraged to contact individual faculty members about their areas of research and teaching interests prior to applying.

Materials to be submitted:

The complete official application form;

The application fee;

All official university/college/junior college transcripts;

An official Graduate Record Exam (GRE) score report. Only the general tests are required, but the subject test in physics is also recommended;

Three letters of recommendation from instructors or supervisors who can comment on the applicant's scholarly ability and promise as a researcher;

Official score reports from the Test of English as a Foreign Language (TOEFL) if the applicant's native language or language of instruction is other than English.

The minimum requirement for graduate admission to UCM is a bachelor's degree, or any other degree or certificate which the Graduate Council accepts as equivalent, and a grade point average no lower than 3.0 on a 4.0 scale. This minimum will be waived only under circumstances where the applicant has demonstrated strong academic skills subsequent to their undergraduate studies. Performance on the GRE, accomplishments in undergraduate research, and letters of recommendation will also be evaluated as important determinants of an applicant's potential for success in graduate education. Foreign students from non-English speaking countries are required to attain a minimum score on the TOEFL exam as required by UC Merced policy for admission to graduate programs. Students from non-English speaking countries will normally be interviewed by telephone by a member of the Admissions Committee in order to evaluate English proficiency.

3) General Committees:

Executive Committee

The Executive Committee shall determine and implement policy for the good of the Group and represent the interests of the Group to the University and other agencies.

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The Executive Committee will consist of three members who will serve rotating terms of three years. The Group chair will serve as an *ex officio* member of the Committee. It will be the responsibility of the Executive Committee to prepare an annual slate of nominees that will be put before the membership for election to serve on the Executive Committee. Members can be re-elected and serve two consecutive three year terms but must sit out one election cycle before running for a third term. The Executive Committee will make appointments to the standing committees from the membership of the group.

Membership Committee

The Membership Committee shall consist of three members appointed by the Chair of the EC for terms of three years. The Membership Committee will be responsible for reviewing applications from faculty who wish to be part of the Group. In addition, the Committee will review the membership of each member of the Group every four years. Members of the Membership Committee will excuse themselves while their own cases are being reviewed.

Educational Policy Committee

The Committee on Educational Policy shall consist of the chair of the Group, two graduate advisors, and two additional representatives and serve a term of three years. Membership on this committee is limited to regular UC Merced faculty. The EPC is responsible for establishing and guiding the educational programs of the Group. The EPC in consultation with the group faculty will determine changes in coursework, exam, and teaching requirements for students in the Group. The EPC will periodically conduct reviews of the program and will oversee the self-study associated with formal program reviews.

Admissions Committee

The Admissions Committee is charged with the development of recruiting materials for the Group, reviewing applications for admissions, and exploring graduate student support mechanisms. The Admissions Committee shall consist of the chair of the Group, two members, one of who will serve as the Graduate Admissions Chair, and serve a term of one year.

B. Master's Degree Requirements

1) **Degree Plan II- Non-thesis:** Students may be admitted to the graduate program in Physics to work towards a Masters Degree (M.S.). Additionally, a Ph.D. student who has been in residence for at least two semesters, is in good academic standing, and has completed at least the four core courses may petition the Admissions Committee to pursue a terminal M.S. degree. The recipient of a M.S. degree is understood to possess knowledge of a broad field of learning that extends well beyond that attained at the undergraduate level, but is not necessarily expected to have made a significant original contribution to knowledge in that field.

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Students are normally admitted to the graduate program in Physics to work toward the Ph.D. degree. The Physics group has established the following requirements for the M.S. degree. Each M.S. student has a committee with at least three members.

- Complete at least two semesters of full-time academic residence (12 units minimum) at UC Merced;
- Pass the preliminary examination
- Complete at least 24 semester hours of upper-division and graduate course work with a cumulative grade-point average of at least 3.0. At least 16 semester hours must be from regular, letter-graded lecture or discussion courses, while the remaining 8 hours may be research or similar courses;
- Pass a comprehensive oral examination administered by the faculty committee. This examination will test the student's understanding of the main concepts in the field at the graduate level. If the student has advanced to candidacy, the qualifying exam can be used to substitute for the comprehensive oral examination requirement.

In addition, the M.S. program requires attendance at physics seminars and M.S. students are recommended to take research units (PHYS 295), attend journal clubs and group meetings to help fulfill their unit requirements. Many of the mandatory Physics courses are "letter grade only". Graduate students should be aware that grades obtained of B- may land them in a state of unsatisfactory degree progress, as they must maintain an overall GPA of 3.0, and their semester GPA must not remain below 3.0 for two consecutive semesters. Graduate students should also be advised that S/U grades do not count towards GPA calculation by the registrar.

Residency: In accordance with SR 682 and 686, the minimum residency requirement for any advanced degree is two semesters. M.S. students must be registered as a full-time student for at least one semester before advancement to candidacy. M.S. students must be in residency for at least one semester after advancement to candidacy before conferral of the degree. For the purposes of determining residency, only the Fall and Spring semester will be counted; however, the summer semester may be counted in evaluating students on academic probation. Residency is established by satisfactory completion of at least 12 units of graduate coursework (including research) per term. Ordinarily, a graduate student shall not receive credit for more than 12 units of graduate courses in any semester. The physics graduate group only accepts full time students. Exceptions will only be granted for students in the Masters Degree program with the permission of the graduate group chair, in consultation with the Executive Committee.

Scholarship: Graduate students must maintain at least a 3.0 grade-point average to be considered in good academic standing or to be awarded an academic graduate degree. A student whose cumulative graduate grade-point average falls below 3.0, or who is judged not to be making satisfactory progress toward the degree by his or her graduate advisor or faculty committee, will be placed on academic probation. The student will then be allowed a maximum of two semesters to make up the deficiencies and be returned to good academic standing. Otherwise, the student will be dismissed from the graduate program.

Specific scholarship requirements are as follows:

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- 1 Only courses in the 100 and 200 series in which the student receives grades of “B” or above, or “S” may be counted in satisfaction of the requirements for advanced degrees. A course in which a student receives a “C” or “D” or lower cannot be used to satisfy the unit requirement for the degree but will count in determining the grade point average.
- 2 Candidates must maintain an average of at least three grade points per unit in all upper division and graduate courses elected during their residence as graduate students at the University of California. Students must maintain an average grade point of 3.0 for advancement to candidacy and conferral of the degree.
- 3 Courses graded “S/U” will not be counted in determining grade point averages.
- 4 Students must make satisfactory progress on their programs of study as determined by their graduate advisor.

Program Learning Outcomes (PLOs): Graduates of the Physics Masters program will:

- 1) **Possess a broad foundation** in the fundamentals of physics and a deep understanding of their chosen subfield, which will permit them to understand and critically evaluate current research.
- 2) **Be proficient in professional skills** necessary to lead a productive career in physics or a related career.
- 3) **Communicate** both fundamental concepts of physics and details of their own research effectively, in written and oral form, to expert and non-expert audiences.

Course Requirements - Core and Electives (27 units minimum)

All Ph.D. and Masters students in the Physics group are required to take:

A. Core Course Requirements:

To be completed within the first four semesters.

- 1) PHYS 237 - Quantum Mechanics I
- 2) PHYS 210 - Electrodynamics
- 3) PHYS 212 - Statistical Mechanics
- 4) PHYS 205 - Classical Mechanics

B. Electives:

To be completed at any time during the PhD or Masters

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- 1) An elective from the physics courses
- 2) A second elective which may be chosen from any graduate level course in the School of Natural Sciences or Engineering

Physics electives include advanced physics courses such as Quantum Mechanics II, Condensed Matter Physics, Biophysics and any other PHYS 2XX courses available. They can also include graduate courses from the applied math, BEST or chemistry groups as long as they are 3 units and taken as a graded class. Any elective must be at least 3 units and we require at least one elective be a course outside the student's primary research area for Ph.D students, which can be selected by discussion with the student's graduate advisor or the graduate group chair for Physics.

C. In addition, students must take 1 unit of BEST/QSB294 Responsible Conduct of Research, 4 semesters of Physics seminar.

Other courses may be added to these lists as fulfilling the requirements at any time, as designated by the physics faculty.

Summary: The required courses noted above and electives together constitute a minimum of 27 units. If a student would like to attain a waiver for any of the courses above, the rules are:

1. No waiver will be granted unless the student has passed the preliminary exam.
2. For waivers regarding elective courses, a student can only ask for a waiver on one elective course. All core courses can be waived if competency is demonstrated.
3. For a waiver on any of the courses, the student will need to attain the waiver from the faculty member who taught the course most recently. The faculty member granting the waiver will only do so if the student can successfully complete an exam in the course. This exam can be given at any time at the faculty and student's convenience, any time of the year. The final decision to grant the waiver will be taken by the Graduate Division.

Course electives must be regular graduate courses (not research or independent study). Courses offered by other graduate programs may be taken as electives but require approval of the graduate advisor. Requirements for formal course work beyond the minimum are flexible and are determined by the individual student's background and research topic in consultation with the graduate advisor.

All Physics graduate students must successfully complete their core course requirements with a grade of S or B or better. A student may petition the graduate chair for a single B- grade to be accepted. Graduate students should be aware that grades obtained of B- may land them in a state of unsatisfactory degree progress, as they must maintain an overall GPA of 3.0, and their semester GPA must not remain below 3.0 for two consecutive semesters. Graduate students should also be advised that S/U grades do not count towards GPA calculation by the registrar. A minimum course load is 12 units each academic semester, and that per UC regulations students cannot enroll in more than 12 units of graduate level courses (200).

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Special Requirements: There is no foreign language course requirement. One semester of teaching assistantship is required. As noted in the course requirements, , students must take 1 unit of BEST/QSB294 Responsible Conduct of Research and 4 semesters of Physics seminar All students in the group are required to pass a written preliminary examination that tests undergraduate-level understanding of the fundamental concepts in the field. This exam is administered twice each year, at the beginning of Fall and Spring semesters. The exam consists of three papers – Classical Mechanics, Quantum Mechanics and Electromagnetism. Students may elect to take the exam for the first time at the start of either the first or second semester in residence. The exam may be taken once each time it is offered, but must be passed no later than the start of the fourth semester. Students need to pass each paper individually but not necessarily at the same time. Students who have not passed the exam by the start of their fourth semester may be subject to dismissal.

Advancement to Candidacy: Before advancing to candidacy for the Master's degree, a student must have satisfied all plan requirements set by the graduate program and must have maintained a minimum GPA of 3.0 in all course work undertaken. Normally, students advance by the end of the third semester. The student must file the appropriate paperwork -Application for Advancement to Candidacy for the Master's Degree.

Comprehensive Examination: The comprehensive exam is a 2 hour long oral exam administered by the student's faculty committee at the end of the fourth semester. When students take the exam, they must be registered or in current filing fee status. The scope of the oral exam is the candidate's coursework. The committee's unanimous vote is required to pass a student on the exam. If a student does not pass the exam, the committee may recommend that the student be reexamined one more time on the entire examination or on the components failed. The second exam must take place within 15 days of the first exam. The second exam may have a format different from the first, but the substance should remain the same. The examination may not be repeated more than once. A student who does not pass on the second attempt is subject to disqualification from further graduate work in the program. Once passed, the Final Report for the Master's Degree Form is signed by the Program Graduate Advisor and then forwarded to the Graduate Division. The deadlines for completing this requirement are listed each semester in the Graduate Division website. The committee must report to the Graduate Council via the Vice Provost and Dean of Graduate Education within 30 days.

2) **Advising Structure and Mentoring:** Masters students are mentored by a graduate advisor who is appointed by the Graduate Group Chair and is a resource for information on academic requirements, policies and procedures, and registration information. The Graduate Group Coordinator assists students with identifying appointments and general university policies. Mentoring practices are consistent with UCM Mentoring guidelines,

3) Master's Degree Committees:

- a) **Comprehensive Examination Committee:** The student, in consultation with his/her graduate advisor and graduate group chair, nominate three faculty(including the advisor) to serve on the Comprehensive Examination

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Committee. These nominations are submitted to the Graduate Division for formal appointment in accordance with Graduate Council policy. This committee of three faculty members shall approve the subject, pass on the content of examination, and administer the examination. Usually one of the committee members directs the examination

4) Normative Time to Degree: The normative time to degree is two years.

5) Typical Timeline and Sequence of Events: A Sample Plan for Completing the M.S. Degree in the Normative Time to Degree.

Fall 1	Spring 1	Fall 2	Spring 2
PHYS210 C (4) Electrodynamics and Optics I	PHYS237 C (4) Quantum Mechanics I	PHYS238 (4) Quantum Mechanics II	PHYS241 (4) Condensed Matter Physics
PHYS205 C (4) Classical Mechanics	PHYS 212 C (4) Statistical Mechanics	PHYS 270 (2) Academic Writing in Graduate Studies	
QSB/BEST 294 (1) (Responsible Research)	PHYS 295 (3) Graduate Research	PHYS 295 (5) Graduate Research	PHYS 295 (7) Graduate Research
PHYS293 (1) Physics Colloquium	PHYS293 (1) Physics Colloquium	PHYS293 (1) Physics Colloquium	PHYS293 (1) Physics Colloquium
	Pass Preliminary Exam		Pass Comprehensive Exam

6) Sources of Funding: Students will be typically supported as Teaching assistants unless they are self-financing.

C. Doctoral Degree Requirements

The Doctor of Philosophy degree is not granted by the University of California merely for the fulfillment of technical requirements, such as residence or the completion of fundamental courses. The recipient of a Ph.D. degree is understood to possess thorough knowledge of a broad field of learning and to have given evidence of distinguished accomplishment in that field; the degree is a warrant of critical ability and powers of imaginative synthesis. The degree also signifies that the recipient has presented a doctoral dissertation containing an original contribution to knowledge in his or her chosen field of study.

The Physics group has established the following requirements for the Ph.D. degree:

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- Complete at least four semesters of full-time academic residence (12 units minimum) at UC Merced;
- Complete the required courses with a letter grade of at least "B" in each course ("S" in seminar courses graded S/U);
- Serve as a teaching assistant for at least one semester;
- Pass a preliminary examination;
- Pass the oral Ph.D. qualifying examination;
- Present and successfully defend a doctoral dissertation containing an original contribution to knowledge in the field.

Residency: In accordance with SR 682 and 686, the minimum residency requirement for any advanced degree is two semesters. The minimum residency requirement for the Ph.D. degree is four semesters. Before advancement to candidacy Ph.D. students must be registered in regular University courses as a full-time student for at least two semesters. For the purposes of determining residency, only the Fall and Spring semester will be counted; however, the summer semester may be counted in evaluating students on academic probation. Residency is established by satisfactory completion of at least 12 units of graduate coursework (including research) per term. Ordinarily, a graduate student shall not receive credit for more than 12 units of graduate courses in any semester. The physics graduate group only accepts full time students. Exceptions will only be granted for students in the Masters Degree program with the permission of the graduate group chair, in consultation with the Executive Committee.

Scholarship: Graduate students must maintain at least a 3.0 grade-point average to be considered in good academic standing or to be awarded an academic graduate degree. A student whose cumulative graduate grade-point average falls below 3.0, or who is judged not to be making satisfactory progress toward the degree by his or her graduate advisor or faculty committee, will be placed on academic probation. The student will then be allowed a maximum of two semesters to make up the deficiencies and be returned to good academic standing. Otherwise, the student will be dismissed from the graduate program.

Specific scholarship requirements are as follows:

Only courses in the 100 and 200 series in which the student receives grades of "B" or above, or "S" may be counted in satisfaction of the requirements for advanced degrees. A course in which a student receives a "C" or "D" or lower cannot be used to satisfy the unit requirement for the degree but will count in determining the grade point average.

Candidates must maintain an average of at least three grade points per unit in all upper division and graduate courses elected during their residence as graduate students at the University of California. Students must maintain an average grade point of 3.0 for advancement to candidacy and conferral of the degree.

Courses graded "S/U" will not be counted in determining grade point averages.

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Students must make satisfactory progress on their programs of study as determined by their graduate research advisor.

1) **Program Learning Outcomes (PLOs):**

Graduates of the Physics PhD program will:

- 1) **Possess a broad foundation** in the fundamentals of physics and a deep understanding of their chosen subfield, which will permit them to understand and critically evaluate current research.
- 2) **Have the experimental, theoretical, and/or computational skills** necessary to conduct and lead independent responsible research and contribute to knowledge in their chosen subfield.
- 3) **Identify new research opportunities**, which may cross traditional discipline boundaries, plan effective strategies for pursuing these opportunities and conduct research that makes a new contribution to knowledge in their chosen subfield of physics and solve important problems in society.
- 4) **Communicate** both fundamental concepts of physics and details of their own research effectively, in written and oral form, including in a classroom setting to expert and non-expert audiences. This includes the publication of original research results in peer reviewed scientific journals.

2) **Course Requirements - (27 units minimum)**

All Ph.D. and Masters students in the Physics group are required to take:

A. Core Course Requirements:

To be completed within the first four semesters.

- 1) PHYS 237 - Quantum Mechanics I
- 2) PHYS 210 - Electrodynamics
- 3) PHYS 212 - Statistical Mechanics
- 4) PHYS 205 - Classical Mechanics

B. Electives:

To be completed at any time during the PhD or Masters

- 1) An elective from the physics courses (see table below)
- 2) A second elective which may be chosen from any graduate level course in the School of Natural Sciences or Engineering

Physics electives include advanced physics courses such as Quantum Mechanics II, Condensed Matter Physics, Biophysics and any other PHYS 2XX courses available. They can also include graduate courses from the applied math, BEST or chemistry groups as

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long as they are 3 units and taken as a graded class. Any elective must be at least 3 units and we require at least one elective be a course outside the student's primary research area for Ph.D students, which can be selected by discussion with the student's graduate advisor or the graduate group chair for Physics.

C. In addition, students must take 1 unit of BEST/QSB294 Responsible Conduct of Research, 4 semesters of Physics seminar.

Other courses may be added to these lists as fulfilling the requirements at any time, as designated by the physics faculty.

Physics Graduate Level Courses

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Course number	Title, units	Description	Recent Instructor(s)
PHYS 204	Biophysics [4]	Aims to give students an understanding of relevant physical principles for biological systems, introduce them to experimental and theoretical techniques of biophysics and to communicate the excitement of cutting-edge biophysics research. Topics include diffusion, fluids, entropic force, motor proteins, enzymes, nerve impulses, networks and evolution	Gopinathan
PHYS 205 (Core)	Classical Mechanics [4]	Topics in classical mechanics, including Lagrangian and Hamiltonian formulations, Conservation Laws and Symmetry and the relationship, Calculus of variations and variational principle, Euler angles and rigid body dynamics, Oscillations and normal modes.	Scheibner
PHYS 210 (Core)	Electrodynamics and Optics I [4]	Continuation of electrodynamics. Wave guides and resonant cavities, Multipole radiation, Relativistic charged particles in electromagnetic fields, Collisions between charged particles and radiation from moving charges with relativistic corrections, introductory magnetohydrodynamics.	Winston
PHYS 211	Electrodynamics and Optics II [4]	Theory and practical application of molecular quantum mechanics. Schrödinger equation and matrix representations of quantum mechanics; simple exactly solvable model problems; calculation of observable properties; vibrational and electronic wave functions; approximation methods; quantum mechanics of spectroscopy.	
PHYS 212 (Core)	Statistical Mechanics [4]	Topics include: General principles of statistical mechanics including microcanonical, macrocanonical and grand canonical ensembles, fluctuations and equilibrium. Thermodynamics including Legendre transforms and Maxwell relations, fluctuations and stability and Landau theory. Quantum statistical mechanics including Bose-Einstein and Fermi-Dirac statistics.	Gopinathan
PHYS 237	Quantum Mechanics I [4]	Introductory Quantum Mechanics starting with simple Quantum two-state systems and one	Tian, Scheibner

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(Core)		dimensional problems, Uncertainty relations, Solution of Schrodinger's equation for important two and three dimensional physical situations, Angular momentum, identical particles and spin statistics. Hydrogen and multi-electron atoms.	
PHYS 238	Quantum Mechanics II [4]	Perturbation methods, both stationary and time-dependent, Scattering, interaction with electromagnetic fields, Stark effect, Measurement theory and decoherence, Quantum Hall effect.	Tian

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PHYS 241	Condensed Matter Physics [4]	An introduction to the physics of materials designed for graduate students in physics or chemistry. The course will cover traditional solid state physics and include topics in soft matter. This class will examine the relationship between microscope structure and bulk properties in different properties.	Hirst, Ghosh
PHYS 248	Quantum Optics [3]	Covers the quantum nature of light, atom-light interaction and experimental quantum optics. It will provide a basis for research in the field of quantum optics. Fundamental concepts and techniques will be linked to modern experimental research.	Sharping
PHYS 249	Introduction to Quantum Field Theory [4]	Introduces quantum field theory with a special emphasis on quantum electrodynamics (QED). Topics include canonical quantization of scalar fields, electromagnetic fields, perturbation theory and renormalization methods among others.	Chiao
PHYS 270	Academic Writing in Graduate Studies [2]	Designed to increase the writing proficiency of graduate students, with a focus on strategies for reading critically, organizing and developing thoughts, choosing appropriate vocabulary, and generating and revising writing in a given scientific field. Topics address scientific disciplines. Projects may include writing abstracts, research reports, literature reviews, posters, and grant proposals.	
PHYS 290	Current Topics in Physics and Chemistry [3]	Exploration of current research directions, problems, and techniques in molecular and materials chemistry, physics and engineering. Course format emphasizes student-led presentation, analysis, and discussion of reading assignments from the current and recent scientific literature. Topics determined by the instructor and changes each semester.	
PHYS 291	Physics and Chemistry Seminar [1]	Graduate seminar on current research in molecular and materials chemistry, physics, and engineering. Satisfactory/Unsatisfactory grading only.	NA
PHYS 292	Special Topics in Physics [1-4]	Treatment of a special topic or theme in Physics at the graduate level. May be repeated for credit. Laboratory included.	

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PHYS 293	Physics Colloquium [1]	This is a colloquium series with talks on a wide range of research topics in Physics. Speakers for the colloquia are primarily invited researchers from other Institutions. Some of the seminars additionally showcase the research performed by UC Merced Physics faculty, post doctoral researchers and graduate students. This is a forum to introduce the undergraduate and graduate students to cutting edge research in Physics conducted on-site and elsewhere, and to give them an opportunity to meet researchers and faculty from other Universities/Research Institutions.	NA
PHYS 295	Graduate Research [1 - 15]	Supervised research. Permission of instructor required. S/U grading only.	Multiple sections each semester
PHYS 298	Directed Group Study [1 - 6]	Group project under faculty supervision. Permission of instructor required. S/U grading only.	
PHYS 299	Directed Independent Study [1 - 6]	Independent project under faculty supervision. Permission of instructor required. S/U grading only.	Multiple sections each Fall

*Required Core courses for both M.S. and Ph.D degrees have been indicated (Core)

Summary: The required courses noted above and electives together constitute a minimum of 27 units. This does not include research units that will be taken as described below. If a student would like to attain a waiver for any of the courses above, the rules are:

1. No waiver will be granted unless the student has passed the preliminary exam.
2. For waivers regarding elective courses, a student can only ask for a waiver on one elective course. All core courses can be waived if competency is demonstrated.
3. For a waiver on any of the courses, the student will need to attain the waiver from the faculty member who taught the course most recently. The faculty member granting the waiver will only do so if the student can successfully complete an exam in the course. This exam can be given at any time at the faculty and student's convenience, any time of the year. The final decision to grant the waiver will be taken by the Graduate Division.

Course electives must be regular graduate courses (not research or independent study). Courses offered by other graduate programs may be taken as electives but require approval of the graduate advisor. Requirements for formal course work beyond the minimum are flexible and are determined by the individual student's background and research topic in consultation with the graduate advisor.

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All Physics graduate students must successfully complete their core course requirements with a grade of S or B or better. A student may petition the graduate chair for a single B- grade to be accepted. Graduate students should be aware that grades obtained of B- may land them in a state of unsatisfactory degree progress, as they must maintain an overall GPA of 3.0, and their semester GPA must not remain below 3.0 for two consecutive semesters. Graduate students should also be advised that S/U grades do not count towards GPA calculation by the registrar. A minimum course load is 12 units each academic semester, and that per UC regulations students cannot enroll in more than 12 units of graduate level courses (200).

Research units: Full-time students must enroll for 12 units per semester including research, academic and seminar units. Courses that fulfill any of the program course requirements may not be taken S/U. Once course requirements are completed, students can take additional classes as needed, although the 12 units per semester are generally fulfilled with a research class 295. Per UC regulations students cannot enroll in more than 12 units of graduate level courses per semester.

3) Special Requirements: There is no foreign language course requirement. One semester of teaching assistantship is required. As noted in the course requirements, , students must take 1 unit of BEST/QSB294 Responsible Conduct of Research and 4 semesters of Physics seminar

All students in the group are required to pass a written preliminary examination that tests undergraduate-level understanding of the fundamental concepts in the field. This exam is administered twice each year, at the beginning of Fall and Spring semesters. The exam consists of three papers – Classical Mechanics, Quantum Mechanics and Electromagnetism. Students may elect to take the exam for the first time at the start of either the first or second semester in residence. The exam may be taken once each time it is offered, but must be passed no later than the start of the fourth semester. Students need to pass each paper individually but not necessarily at the same time. Students who have not passed the exam by the start of their fourth semester may be subject to dismissal.

4).Dissertation Plan: In accordance with University of California policy, a minimum of four semesters in academic residence is required prior to awarding the Ph.D. Typically, a longer period of study, four to six years, is required for completion of all degree requirements. It is the responsibility of the Graduate Group to inform the student upon admission to the program of the expected degree time. All graduate students are considered resident graduates not candidates for a degree, unless admitted to candidacy after completion of all candidacy requirements and approval by the Graduate Division after formal application. A student advances to candidacy for the Ph.D. upon successfully demonstrating a high level of scholarship at the Ph.D. level, and upon completing all preparatory work and demonstrating readiness to proceed to the dissertation phase.

5).Advising Structure and Mentoring:

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Selection of advisor: The heart of the Physics Ph.D. program is the completion of a piece of original scientific research leading to the preparation and defense of a Ph.D. thesis. To this end, each student should discuss research interests and possible Ph.D. projects with faculty in the group as early as possible, and select a graduate research advisor by the end of the first year of study. Selection of a graduate research advisor must be approved by the graduate group and must occur before the student's faculty committee can be constituted. The student and the graduate research advisor together will develop a research topic, and research will normally occupy a majority of the student's time after the first year of residence. Interdisciplinary projects are encouraged, as are research collaborations with faculty or senior scientists outside UC Merced.

Rotations: Students will be assigned two mentors, one each for the first two semesters, when they first enroll, based on the preferences they indicate and faculty availability and interest. Students will perform rotations of 1-3 research units in each assigned mentor's lab. Rotations will typically consist of activities that form part of the group's routine, including attending and presenting at group meetings, one-on-one weekly meetings with the mentor, literature review and readings and possible work on short-term projects. Rotations are for the students to gain exposure to different working environments, integrate into the graduate student community and learn more about ongoing research. Requests for changes to the assigned mentors can be made in exceptional circumstances and approval will be granted at the discretion of the graduate group chair. There is no implied commitment from either mentor to take on the students nor are students expected to choose one of the two mentors as their graduate research advisor. In the case that a faculty member is paying a student during the first year as a graduate student researcher, the rotation requirement will be waived.

Graduate advisors are also a resource for information on academic requirements, policies and procedures, and registration information and can minimally direct the students to the appropriate information. The Graduate Group Coordinator assists students with identifying appointments and general university policies. Mentoring practices are consistent with UCM Mentoring guidelines,

6) Doctoral Degree Committees: The graduate advisor, normally in consultation with the student and other program faculty, recommends appointment of faculty members to advise on and supervise the student's dissertation research as part of their examination committees. Final approval of the membership on these committees rests with the Graduate Dean. **The Candidacy Committee is charged with determining the fitness of the student to proceed with the doctoral dissertation through a formal Qualifying Examination. The Doctoral Committee shall supervise the preparation and completion of the dissertation and the final examination. In the Physics group,** one committee shall serve as both candidacy and doctoral committee for a single student.

Advanced degree committees in the Physics group shall consist of at least three members. One must be the student's graduate advisor, one other must be a UC Merced faculty member in the group who is not an advisor of the student (who is also appointed as Chair), and one other may be from outside the group. This outside member may be a regular or adjunct faculty member

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from any UC campus or an individual from outside the University of California who has special expertise and qualifications. In this case, the graduate advisor should submit a brief statement indicating the appointee's affiliation and title and how the prospective appointee has special expertise or qualifications that are not represented on the campus. In addition to the justification letter from the graduate advisor, a curriculum vitae and a letter from the proposed appointee indicating a willingness to serve must be submitted to the Graduate Dean for review and approval.

A student may opt to choose a graduate advisor from outside of the physics group faculty (for example in applied math or chemistry). In such a case a nominal additional advisor from the physics group will be assigned in addition to the regular committee membership and will be responsible for ensuring the appropriateness of the student's research project.

All members of the committee must be in attendance for Ph.D. qualifying and final examinations or Master's comprehensive oral examination. All members of the committee must approve the Ph.D. dissertation. If a committee member's absence from campus for an extended period of time makes scheduling of examinations unreasonably difficult, the student may request that the committee be reconstituted. Reconstitution of the committee may also be justified by a substantial change in the student's thesis topic or may be required by the departure of a committee member from the university. When membership changes must be made, the graduate advisor in consultation with the student should recommend a new committee member, giving the reason for the change. The reason must be acceptable to the Graduate Dean.

7) Advancement to Candidacy: All students in the Physics Ph.D. program are required to pass an oral qualifying examination before advancement to candidacy for the Ph.D. degree. Students are expected to take and pass the qualifying examination before the end of their third year of graduate study unless they successfully petition the Graduate Group Chair to take it at a specific later date. The qualifying examination may not be scheduled until the preliminary examination has been passed and the four core courses have been completed. The intent of this examination is to ascertain the breadth of a student's comprehension of fundamental facts and principles that apply in his or her major field of study. It will also determine the student's ability to think critically about the theoretical and practical aspects of the field. Accordingly, the examination should be focused on the student's field of research but may and should venture into other areas of scholarship that underlie or impinge on the thesis topic. The scope of this examination should be communicated to student by the committee chair at least two months in advance of the exam date.

At least four weeks before the qualifying exam, the student will provide to the faculty committee a written document that describes his or her research topic, summarizes progress to date, and outlines what he or she proposes to do, why it is relevant, and what will be learned. The format of the research proposal will be determined by the student in consultation with their advisor and committee; however the proposal must follow the format of a research proposal to a major funding agency in the student's area of research. The committee will review this document with the student and determine if the student has outlined a project that is

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appropriate for a Ph.D. If not, the student is given a month to rewrite the research plan. Once the research plan is approved the student may take the oral portion of the Qualifying Examination.

8) Qualifying Examination:

The examination committee is the same as the student's faculty committee. The graduate advisor is a voting member of the committee, but will normally not participate in the examination except to provide technical clarifications as requested by the other members of the committee.

The date of the examination is arranged between the student and the committee chairperson. At least four weeks prior to the examination date, the student will provide to the committee a research proposal (typically about ten pages) that describes his or her research topic, summarizes progress to date, and outlines what he or she proposes to do, why it is relevant, and what will be learned (see Sec.2.3.5 for details on the proposal). A pre-qualifying meeting will be conducted two weeks before the actual exam, where the student can present a trial run of their qualifying exam presentation and the committee will provide feedback. The committee then conducts the actual examination on the pre-arranged date, and immediately thereafter submits the results of the examination to Graduate Division.

The committee members should include in their deliberations such factors as relevant portions of the previous academic record, performance on the examination, and an overall evaluation of the student's performance and potential for scholarly research as indicated during the examination. A unanimous decision is required for a "Pass". If not all members of the committee vote to pass, they must write a report explaining their decision and must inform the student of the reasons for the decision. A student who has not passed the examination may repeat the qualifying examination after a preparation time of at least three months. The examination must be held by the same committee except that members may be replaced, with the approval of the graduate advisor, for cause such as extended absence from the campus. Failure to pass the examination on the second attempt means that the student is subject to disqualification from further study for the doctoral degree.

Upon successful completion of the examination, the student is given an application for advancement to candidacy by the examining committee chair. When it is filled out and signed by the graduate advisor and graduate group chair, the student pays a candidacy fee and submits the form to Graduate Division. Upon advancement to candidacy for the degree, the faculty committee is then charged to guide the student in research and in the preparation of the dissertation.

9) Dissertation:

The Ph.D. dissertation must be creative and independent work that can stand the test of peer review. The expectation is that the material will serve as the basis for publication(s) in a peer reviewed journal. The final confirmation of the quality of a PhD dissertation is the ability to publish the research results in a peer-reviewed journal. The research field may influence the timing and work required to publish research results, making it difficult to define the number of publications required for each dissertation. For this reason, whether a student has made

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sufficient progress for the PhD will ultimately be determined by the student's advisor and thesis committee. The process of writing journal articles will be undertaken with the assistance and guidance of the student's research adviser. Published work should be presented to the graduate committee at the time of the student's thesis defense. The work must be the student's, and it must be original and defensible. The student is encouraged to discuss with members of the faculty committee both the substance and the preparation of the dissertation well in advance of the planned defense date. Detailed instructions on the form of the dissertation and abstract may be obtained from the Graduate Division office.

The student must provide a copy of the dissertation to each member of the faculty committee and allow each committee member at least four weeks to read and comment on it. If one or more committee members believe that there are significant errors or shortcomings in the dissertation or that the scope or nature of the work is not adequate, the student must address these shortcomings before scheduling a defense. Once the committee members are in agreement that the dissertation is ready to be defended (although minor errors or matters of controversy may still exist), the final examination date may be scheduled by the student in consultation with the committee. The date must be reported to the Graduate Dean, and one copy of the dissertation filed, no later than three weeks before the proposed date of the final examination.

The Ph.D. final examination consists of an open seminar on the dissertation work followed by a closed examination by the faculty committee. During the examination, the student is expected to explain the significance of the dissertation research, justify the methods employed, and defend the conclusions reached. At the conclusion of the examination, the committee shall vote on whether both the written dissertation and the student's performance on the exam are of satisfactory quality to earn a University of California Ph.D. degree. A majority is required for a pass. Members of the committee may vote to make passing the exam contingent on corrections and/or revisions to the dissertation. In this case, the committee will select one member, normally the graduate advisor, who will be responsible for approving the final version of the dissertation that is submitted to Graduate Division.

10) Normative Time to Degree: The Physics group places no strict limits on the length of time a graduate student may remain in residence. However, it is normally expected that successful completion of the Ph.D. will require no more than six years. In order to ensure satisfactory progress toward the degree, each student must meet with his or her faculty committee for an annual review of progress at a mutually agreeable time prior to the first day of each Fall semester. At least three members of the committee, including the graduate advisor, must be present. The committee will review the student's progress toward the degree during the past year and develop a time table, mutually agreeable among student, graduate advisor, and faculty committee, for completion of the remaining requirements. The annual report of the committee will become part of the student's record. Should the committee conclude that the student is not making satisfactory progress toward the degree, the student may be placed on academic probation. This requirement of annual meetings with the committee necessitates that students identify and sign on with a particular graduate advisor and form a faculty committee before the end of their second year and advance to candidacy by the end of their third year.

11) Typical Timeline and Sequence of Events

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A sample timeline for the first 8 semesters of courses for a PhD student is shown below.

Fall 1	Spring 1	Fall 2	Spring 2
PHYS210 C (4) Electrodynamics and Optics I	PHYS237 C (4) Quantum Mechanics I	PHYS 238 (4) Quantum Mechanics II	PHYS241 (4) Condensed Matter Physics
PHYS205 C (4) Classical Mechanics	PHYS 212 C (4) Statistical Mechanics		
QSB/BEST 294 (1)(Responsible Research)	PHYS 295 (3) Graduate Research	PHYS 295 (7) Graduate Research	PHYS 295 (7) Graduate Research
PHYS293 (1) Physics Colloquium	PHYS293 (1) Physics Colloquium	PHYS293 (1) Physics Colloquium	PHYS293 (1) Physics Colloquium

C = core class, brackets indicate units.

Fall 3	Spring 3	Fall 4	Spring 4
PHYS 295 (12) Graduate Research	PHYS 295 (12) Graduate Research	PHYS 295 (12) Graduate Research	PHYS 295 (12) Graduate Research
Fall 5	Spring 5	Fall 6	Spring 6
PHYS 295 (12) Graduate Research	PHYS 295 (12) Graduate Research	PHYS 295 (12) Graduate Research	PHYS 295 (12) Graduate Research

The physics group has developed the following sample guidelines for students to make good progress in the PhD program.

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Year/semester	Activities
Year 1 (Semesters 1,2)	<p>Learn about all research groups</p> <p>Perform rotations with assigned mentors</p> <p>Take classes</p> <p>Pass preliminary exam (if applicable)</p> <p>Pick PhD advisor by end of second semester</p>
Summer 1	<p>Begin full time research with PhD advisor</p>
Year 2 (Semesters 3,4)	<p>Continue full time research with PhD advisor</p> <p>Take one class per semester if necessary</p> <p>Assemble faculty committee (beginning of third semester)</p> <p>Prepare for qualifying exam</p> <p>Schedule qualifying exam (during fourth semester) – defend PhD research proposal</p> <p>Apply for candidacy after passing qualifying exam (end of fourth semester)</p>
Years 3	<p>Conduct research</p> <p>Prepare manuscripts for publication</p> <p>Present work at a scientific conference; network for career</p>
Years 4	<p>Conduct research</p> <p>Continue publishing manuscripts</p> <p>Present work at a scientific conference; network for career.</p>
Year 5 (Semesters 9,10)	<p>Conduct research</p> <p>Present work at a scientific conference; network for career</p> <p>Declare candidacy for graduation (ninth semester)</p> <p>Defend and publish dissertation (tenth semester)</p>

12) Sources of Funding:

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Newly admitted students will normally be supported as graduate TAs during their first two semesters in residence, with Ph.D students being prioritized. After that, students will be supported as either TAs or GSRs depending on availability of TAships and the research advisor's funding situation.

New students who cannot be appointed as TAs because of limited English proficiency or lack of available TA positions may be appointed as GSRs for their first one or two semesters by mutual agreement of the student and the research advisor. The conditions of appointment will be the same as in #3 and #4 below. Normally all students will be required to TA for at least one semester as long as a suitable TA position is available. TA experience at other institutions could satisfy this requirement.

Graduate students serving as GSRs during the academic year will be appointed at 49.9% at the step for which the monthly stipend is most nearly equal to that for a first year TA in the Natural Sciences. There will be no additional or reduced pay during break periods.

Graduate students serving as GSRs during the summer will be appointed at the step determined above. The appointment will be 60% for students who have not yet been advanced to candidacy for the Ph.D. degree, and 70% for those who have been advanced to candidacy. Students are expected to spend the remainder of their time pursuing independent study toward the degree. GSRs do not accrue paid vacation time.

Students are also encouraged to make use of other sources of funding including Physics Summer Fellowships, campus-wide fellowships provided by the Graduate Division as well as extra-mural funding opportunities from both federal, state and private sources. Lists of these are available on the Graduate Division website.

Following advancement to candidacy, doctoral students who are not California residents will have their Nonresident Tuition reduced by 100 percent for a maximum of three consecutive calendar years. Any such student who continues to be enrolled or who re-enrolls after receiving the reduced fee for three years will be charged the full Nonresident Tuition that is in effect at that time.

Exceptions to these policies may be made at the recommendation of the student's research advisor, the graduate group chair, and the graduate dean.

- 13) **Leaving the Program Prior to Completion of the PhD Requirements:** A student admitted for the Ph.D. degree, which, in the judgment of the unit's graduate affairs committee should not continue past the master's degree, must be notified in writing by the Graduate Group Chair of the Graduate Group offering the degree. A copy of the letter must be sent to the Vice Provost and Dean of Graduate Education. In some cases a doctoral student may choose to leave the program with a master's degree only. It is the responsibility of the Graduate Group unit to notify the Graduate Division via the Change of Degree form so that the

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student's record may be updated to reflect the student's degree status. This notice must include the student's written permission to have his/her degree objective changed officially from doctorate to master's.

D. General Information

1) PELP, In Absentia and Filing Fee status.

Information about PELP (Planned Educational Leave Program), In Absentia (reduced fees when researching out of state), and Filing Fee status can be found in the Graduate Group Policies and Procedures Handbook available on Graduate Division.