Department of Applied Physics and Applied Mathematics
Doctoral Qualifying Examination 2019-2020

The Doctoral Qualifying Examination is a two-day written test, with the General Exam on the first day and the Specialty Exam on the second. It is given once a year, usually in May, during the week of commencement. Both examinations are four hours in length, and each is closed book.

Although all doctoral/doctoral track students will take the qualifying examination at the same time, students will answer different questions depending upon their graduate programs. Four problems will be solved on the first day; four problems will be solved on the second day. Each graduate program defines its own requirements for a subset of the problems that must be solved. These requirements are described below.

**DAY ONE: GENERAL EXAM**

The Day One, or General Exam, consists of problems in fundamental subject areas. These questions are intended to be basic and should be solved by a typical doctoral student in about 40 minutes. The course listed for each subject area is recommended for preparation, but a student can choose the subject area without first taking the corresponding course.

**Applied Physics and Applied Mathematics**
Students choose four of seven problems.

   Applied Physics students* must do problems # 1-3 and choose one other.
   Applied Mathematics/Applied Analysis students must do no fewer than three of problems #4-7.
   Appl. Math/Atmospheric Science and Medical Physics students may choose any four of the seven problems.

1. Classical mechanics (PHYS GU4003y** "Advanced mechanics")
2. Electromagnetism (APPH E4300x "Applied electrodynamics")
3. Quantum mechanics (APPH E4100x "Quantum physics of matter")
4. Linear algebra (APMA E4001y*** "Principles of applied math!")
5. Partial differential equations (APMA E4200x**** "Partial differential equations")
6. Applied dynamical systems (APMA E41 0 I x "Introduction to dynamical systems")
7. Numerical Methods (APMA E4300x "Introduction to Numerical Methods")

* Plasma Physics, or Solid State and Optical Physics
**At the level of Chapters 1-6 and 8 in Classical Mechanics, Third Edition, by H. Goldstein, C. Poole and J. Safko,
****At the level of Chapters 1-5 and 7-10 in Applied Partial Differential Equations, Fourth Edition, by Richard Haberman.
**Materials Science and Engineering**
Students do the first three problems, and choose one other- for a total of four.

1. Crystallography- Symmetry, structure, anisotropy (MSAE E4100x, "Crystallography")
2. Materials thermodynamics and phase diagrams (MSAE E4200y, "Materials thermodynamics and phase diagrams")
3. Kinetics of solids (MSAE E4202y, "Kinetics of transformations in materials")
4. Partial differential equations (APMA E4200x* "Partial differential equations")
5. Linear algebra (APMA E4000y*** "Principles of applied math")

*At the level of Chapters 1-5 and 7-10 in Applied Partial Differential Equations, Fourth Edition, by Richard Haberman.


**DAY TWO: SPECIALTY EXAM**

Each student must select the Specialty Examination with in the program they have been admitted to. Plasma Physics, and Solid State and Optical Physics students must have done no fewer than two of problems #1-3 on Day One. Applied Analysis and Computational Math students must have done no fewer than two of problems #4-6 on Day One.

The Specialty Examination consists of four problems. A typical doctoral student should solve these specialty problems in about 40 minutes. Each Specialty Examination lists the problem options; required problems are in bold. Students should talk to faculty or graduate student advisors with any questions about the requirements for these graduate program areas.

**Applied Mathematics/Applied Analysis**
(Students do all four problems)

1. Partial differential equations (APMA E6300y "Analytic methods for partial differential equations")
2. Applied functional analysis (APMA E4150x "Applied functional analysis")
4. Applied real and complex analysis (APMA E4204x* "Functions of a complex variable")

*Students must also know vector calculus, at the level of Vector Calculus, by J. E. Marsden and A. J. Tromba, Fifth edition.

**Applied Mathematics/Atmospheric, Oceanic and Earth Physics**
(Students do the first three problems and choose one other- for a total of four.)

1. Physics of fluids (MECE E4100y "Mechanics of Fluids")
2. Introduction to atmospheric science (EESC GU4008x "Introduction to atmospheric science")
3. Geophysical fluid dynamics (APPH E4210y "Geophysical fluid dynamics")
4. Partial differential equations (APMA E6301y "Analytic Methods for partial differential equations")
6. Applied real and complex analysis (APMA E4204x* "Functions of a complex variable")
7. Applied functional analysis (APMA E4150x "Applied functional analysis")
8. Statistical Mechanics (CHAP E4120x "Statistical mechanics")
*Students must also know vector calculus, at the level of Vector Calculus, by J. E. Marsden and A. J. Tromba, Fifth edition.

**Materials Science and Engineering**
(Students do all four problems.)

1. Crystallography- Diffraction (MSAE E4100, "Crystallography")
3. Electronic and magnetic properties of solids (MSAE E4206x "Electronic and magnetic properties of solids")
4. Mechanical behavior of materials (MSAE E4215y "Mechanical behavior of materials")

**Applied Physics/Plasma Physics**
(Students do all four problems.)

1. Plasma A- MHD (APPH E6101x "Plasma Physics 1"/APPH E430ly "Introduction to plasma physics")
2. Plasma B- Two fluid theory (APPH E61 Olx "Plasma Physics!")
3. Plasma C- Kinetic theory (APPH E61 02y "Plasma physics 11")
4. Advanced EM (APPH E4300x "Applied electrodynamics")

**Applied Physics/Solid State and Optical Physics**
(Students do the first three problems and choose one other- for a total of four.)

1. Solid state I (APPH E608lx "Solid State Physics!")
2. Optical physics (APPH E411 Oy "Modern Optics")
3. Statistical mechanics (CHAP E4120x "Statistical mechanics")
4. Laser physics (APPH E4112x "Laser physics")
5. Solid State II (MSAE E4203y "Theory of Crystalline Materials: Electrons")

**Medical Physics**
(Students do all four problems.)

1. Nuclear medicine physics (APPH E6319y "Clinical Nuclear Medicine Physics")
2. Radiological physics aud dosimetry (APPH E4600x "Fundamentals of Dosimetry")
3. Diagnostic radiology physics (APPH E6330y "Diagnostic Radiology Physics")
4. Radiation therapy physics (APPH E6335y "Radiation Therapy Physics")

* At the level of chapters 1-9, 10-23 and 27 in Solid State Physics by Ashcroft and Mermin.
** At the level of chapters 10, 13, 14, 20-34 and Appendix K in Solid State Physics by Ashcroft and Mermin.
***At the level of chapters 28 and 29 in Solid State Physics by Ashcroti and Mennin.
All DES and PhD degree candidates who have not yet passed the written Qualifying Exam must take this exam in May (at the end of the first year for study). All doctoral track MS candidates who are registered as fulltime degree candidates in the Fall or prior semesters and have not yet passed the written Qualifying Exam also must take the exam in May if they intend to continue after the MS toward the DES or PhD degree.

Use this outline of the qualifying examination to help you plan your course schedule for the first year. You may make copies of previous exams, which are available in the department office. Practicing problems from old exams is excellent preparation for taking the qualifying examination.