Department of Applied Physics and Applied Mathematics

Doctoral Qualifying Examination 2013-2014

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 selected 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 six problems.
Applied Physics students* must do no fewer than two of problems #1-3.
Applied Mathematics students must do no fewer than two of problems #4-6.
Atmospheric Science students may choose any four of the six problems.

1. Classical mechanics (PHYS G4003y** "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 I")
5. Partial differential equations (APMA E4200x**** "Partial differential equations")
6. Applied dynamical systems (APMA E4101x "Introduction to dynamical systems")

* 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 1-6, Linear Algebra and its Applications, Third Edition, by Gilbert Strang, HBJ Publishers.
**** 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 all four problems.
1. **Crystallography** (MSAE E4100x, "Crystallography")
2. **Thermodynamics of solids** (MSAE E4202y, "Thermodynamics and reactions in solids")
3. **Kinetics of solids** (MSAE E4202y, "Thermodynamics and reactions in solids")
4. **Partial differential equations** (APMA E4200x* "Partial differential equations")

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

Doctoral Qualifying Examination, cont.

DAY TWO: SPECIALTY EXAM

Each student must select the Specialty Examination corresponding to his or her intended area of graduate study. It is **not permitted** to change the area of your specialty examination after the start of the examination. 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 E6301y "Analytic methods for partial differential equations")
2. Applied functional analysis (APMA E4150x "Applied functional analysis")
3. Numerical methods for PDEs (APMA E4301x "Numerical methods for partial differential equations")
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 Science

(Students do the first two problems and choose two others – for a total of four.)

1. **Physics of fluids** (APPH E4200x "Physics of fluids")
2. **Introduction to atmospheric science** (EESC W4008x "Introduction to atmospheric science")
3. Partial differential equations (APMA E6301y "Analytic Methods for partial differential equations")
4. Numerical methods for PDEs (APMA E4301x "Numerical methods for partial differential equations")
5. Applied real and complex analysis (APMA E4204x* "Functions of a complex variable")
6. Applied functional analysis (APMA E4150x "Applied functional analysis")
7. Statistical Mechanics (CHAP E4120y "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 the first three problems, and choose one other – for a total of four.)

1. **Structural analysis of materials** (MSAE E4101x, "Structural analysis of materials)
2. **Electronic and magnetic properties of solids** (MSAE E4206x "Electronic and magnetic properties of solids")
3. **Mechanical behavior of materials** (MSAE E4215y "Mechanical behavior of materials")
4. Nanomaterials (MSAE E4090y "Nanotechnology")
5. Ceramics and Composites (MSAE E4250x)

Plasma Physics

(Students do all four problems.)

1. **Plasma A – MHD** (APPH E6101x "Plasma Physics I"/APPH E4301y "Introduction to plasma physics")
2. **Plasma B – Two fluid theory** (APPH E6101x "Plasma Physics I"/APPH E4301y "Introduction to plasma physics")
3. **Plasma C - Kinetic theory** (APPH E6102y "Plasma physics II")
4. **Advanced EM** (APPH E4300x "Applied electrodynamics")

Solid State and Optical Physics

(Students choose four of the six problems.)

1. Solid state I (APPH E6081x "Solid state physics I")
2. Solid state II (PHYS G6082y "Solid state physics II")
3. Semiconductor physics (ELEN E4301y "Introduction to semiconductor devices")
4. Laser physics (APPH E4112y "Laser physics")
5. Optical physics (APPH E4110x "Modern Optics")
6. Statistical mechanics (CHAP E4120y "Statistical mechanics")

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 full-time 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.