COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

DEPARTMENT OF APPLIED PHYSICS AND APPLIED MATHEMATICS

September 1, 2010

To: All Applied Physics (AP), Applied Mathematics (AM), and Materials Science and Engineering (MSE) students entering the doctoral program

From: Professor I. P. Herman

Subject: Information Packet for New Graduate Students

This packet has been prepared to familiarize all entering graduate students with the Department of Applied Physics and Applied Mathematics. The information should be useful to you during your first year here, as well as afterwards.

In this packet you will find discussions of:

- Welcome letter and overview
- General department information
- Doctoral grad calendar
- Requirements, timetable and evaluation procedures for doctoral students
- Doctoral program committee chairs
- Written qualifying examination
- Colloquia and the Department Research Conference
- Lab safety memo and schedules
- Each of the specialty programs
- Faculty research interests
- Advisor form

Please feel free to come to me, other faculty, or office staff with any questions you may have about the department.

200 Seeley W. Mudd Building Mail Code 4701 500 West 120th Street New York, NY 10027 212-854-4458 Fax 212-854-8257

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DEPARTMENT OF APPLIED PHYSICS AND APPLIED MATHEMATICS

September 1, 2010

Dear New Graduate Students:

Welcome to Columbia University and to the Department of Applied Physics and Applied Mathematics. You have been accepted into an intellectually exciting and rewarding program of study leading to the doctoral degree. I am writing to you to describe how our doctoral program (Ph.D. and Eng.Sc.D. degrees) works and to offer advice on planning your academic program, securing financial aid to continue your studies, and finding a research advisor.

Of those first-year students receiving financial aid, most will have appointments from the APAM Department in the form of a Teaching Assistantship, or a Research Assistantship. For both supported and unsupported students this first year of study is a critical one for determining your future success in the doctoral program. With the exception of MS students who are not doctoral track, and 4-2 Combined Plan students, you will be evaluated at the end of your first year in three areas:

1) Academic performance in course work.
2) Performance on the written qualifying examination given annually in May.
3) Potential for carrying out original research.
4) Research and professional ethics.

This evaluation takes place in late May when the written qualifying examination results are reviewed by the entire APAM faculty. For first-year students there are three outcomes possible: Pass and admission to the Ph.D. program as soon as MS degree requirements are met; Failed but encouraged to take the examination again next year; and Failed and discouraged from continuing studies in the program. You may repeat the qualifying examination only once, the next time it is given. The purpose of this evaluation is to provide students with a clear signal about their chances for success at an early point in graduate studies.

For all students, whether receiving financial aid in the first year or not, **passing the written qualifying exam does not guarantee continued financial aid in the second year of graduate study.** While the Department supports incoming graduate students, we expect students in the second and subsequent years of study to be supported by their research supervisor through a Graduate Research Assistantship. **It is, therefore, very important for new graduate students to take steps during their first year of study to make arrangements for continuing support with a research sponsor.** [Several second-year students who have joined a research group will be asked to TA for a term.]

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I will conclude this letter with some advice for success in each of these three areas: academic performance, qualifying examination, and research support.

Academic performance. While there are no specific course requirements for the MS degree in Applied Physics, we do have seven doctoral research specialties which are represented in the seven specialty exams offered as part of the written qualifying examination: Applied Analysis, Atmospheric Science, Computational Math, Materials Science, Medical Physics, Plasma Physics, and Solid State & Optical Physics. A new student should review the content of these exams and also any recommended courses for a given program. Previous exams are available for inspection and copying in the Department Office. Program descriptions of the seven specialty areas are included in this packet. As soon as possible during the first year of study, you should choose which specialty you will prepare for in the qualifying examination. The courses you select for your first-year program should prepare you for this exam. The first-year APAM doctoral advisor, Prof. Michael Mauel (AP), assisted by Prof. Simon Billinge (MSE) and Prof. Michael Weinstein (AM), will help you with this and approve your program. You can also discuss your plans with the other members of the faculty or the chairperson of the doctoral program committee for your specialty. These are:

Applied Mathematics :	Prof. L. M. Polvani
Atmospheric Science:	Prof. L. M. Polvani
Materials Science:	Prof. I. C. Noyan
Medical Physics:	Prof. I. C. Noyan
Plasma Physics:	Prof. G.A. Navratil
Solid State and Optical Physics:	Prof. A. Pinczuk

Qualifying Examination. In addition to properly planning your first-year program discussed above, you should read the description of the qualifying examination format (included in this packet) and look at past examinations. Practice taking one or more of these exams at home without use of any reference material. Students who have had difficulty with this exam have afterward expressed surprise at the type of questions that were asked on the exam because they never examined previous exams. Practice! Get used to answering questions without your books and notes available.

Research Support. There are many ways of finding a research supervisor and financial support so it is difficult to generalize. Except for those few students who have already made arrangements with a research sponsor prior to starting their first-year studies, a very important objective during your first year is to identify faculty members who conduct research in an area of interest and to make yourself known to them as a candidate for support. Your research sponsor may be APAM faculty, joint faculty, adjunct APAM faculty, or faculty outside of APAM doing research in one of the seven department specialties. One of the best ways to find out who does what kind of research is to **attend the <u>mandatory</u> weekly Department Research Conference** on Friday mornings at 9:15 a.m. in Room 214 Mudd. At this meeting, faculty, research staff, and graduate students describe their research and faculty members occasionally describe research opportunities for new students. Another method to become better known to a faculty member you would like to work with is to offer to work

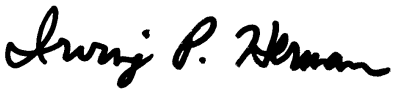
during your first year on a research project as part of APAM E6650. This has the great advantage of giving you actual experience in that research area while permitting better evaluation of your potential by the prospective sponsor. Short of this, you may take a course being taught by a prospective sponsor and do well in it. Another source of advice on possible research sponsors in a given area is to consult the program chairman listed above for advice. **It is important to talk to faculty and let them know you are interested. Start to do this during the fall term, even though some faculty will decide on supporting students only after the qualifying examination exam.**

Research and professional ethics. Starting with students entering in the 2010-2011 academic year, APAM doctoral students will be required to take and pass the physical sciences course on Responsible Conduct of Research online at citiprogram.org http://citiprogram.org before the end of their first Fall semester. A completion report documenting the student has taken and passed the course should be turned into the Department for record-keeping. In addition, doctoral students must attend the Research and Professional Ethics Seminar offered annually in May during the first **AND** second year of their doctoral program.

Finally, I would like to offer personal advice and encouragement. During the next years, take full advantage of the opportunities presented to you by Columbia University. Explore, interact, and learn. While it is true that students admitted to the doctoral program are not guaranteed support by the department, almost without exception, students who pass our qualifying examination do find a research sponsor and support. To optimize your chances to find a position in the area or with the sponsor of greatest interest to you, plan your first year with care and work hard.

Good luck to you all! In addition to the sources of information listed above, feel free to make an appointment to see me if you have questions or need advice.

Sincerely,



Irving P. Herman
Chair and Professor of Applied Physics

Enclosures

General Department Information

1. Contact Information:

Department of Applied Physics and Applied Mathematics
500 West 120th Street, Room 200 Mudd, MC 4701
Columbia University
New York, NY 10027
212-854-4457 (phone) 212-854-8257 (fax)
http://www.apam.columbia.edu

2. Office Staff:

Administrative Staff

Dina Amin, *Department Administrator*	dea1@columbia.edu	212-854-2696
Marlene Arbo, *Medical Physics Program Coordinator*	mja2@columbia.edu	212 854-8434
Wesley Hattan, *Assistant to the MSE Director*	wjh2121@columbia.edu	212-854-7860
Maggie Betancourt, *Administrative Coordinator/GISS*	mlb99@columbia.edu	212-678-5620
Montserrat Fernandez-Pinkley, *Student Coordinator*	mf2157@columbia.edu	212-854-4457/58
Christina Rohm, *Administrative Assistant*	cr2090@columbia.edu	212-854-1586

Business Office Staff

Constantine Chernyavsky, *Business Manager*	kc2402@columbia.edu	212-854-6669
Darya Dotsenko, *Financial Analyst*	ds2783@columbia.edu	212-854-7482
Michael Garcia, *Financial Assistant*	mag2@columbia.edu	212-854-5257

3. References: (if and when you need them) Available:

• SEAS Bulletins	Room 200 Mudd and online
• GSAS Bulletins	Online only
• F.A.C.E.T.S. (Facts About Columbia Essential to Students)	Online only http://facets.columbia.edu/
• The Ph.D. Dissertation	Room 107 Low
• International Student & Scholars (ISSO) Handbook	525 Riverside Drive

4. Useful Information:

• **Desks:** Shared desks and lockers are available for first year students in 292 Engineering Terrace and other locations. Key card access to the student room will be set up approximately two weeks after registration.

• **Bulletin Boards:** Located in the corridor outside of Room 200 Mudd, the bulletin boards provide notice of departmental seminars, colloquia, the weekly research conference, and announcements from other CU departments. Course offerings and general notices are posted each term. Clipboards provide information about conferences, job opportunities, and graduate schools. Resources relating to fellowships and job opportunities are to be found in the department office as well.

General Information, cont.

• **Student mail:** Graduate student mail (received c/o the department) is sorted alphabetically by last name into mailboxes in Room 200 Mudd. Please collect your mail regularly.

• **Copier:** As a general rule, the copier is reserved for faculty and staff use. Student use is restricted to authorized TAs and GRAs; copying by GRAs is charged to research contracts. Occasionally, permission may be given for personal copies, at a charge of 10¢ per page, 50¢ per transparency.

• **Computers and Printers:** Student may use computers in the many computer labs and kiosks located throughout the campus. The closest computer lab to our department is in 251 Engineering Terrace. With permission from Dina Amin, students may also use the computers and printers in the APAM office, 200 Mudd (please keep the use of color printing to a minimum.) Students may also use the office typewriters and telephones, in special circumstances.

• **Maintenance Control:** Columbia has a centralized custodial service, Maintenance Control, x4-2222. Students may call Maintenance directly or report problems (light bulb missing, room temperature, etc.) to the office staff.

• **Fire Alarms:** If there is a fire alarm, you MUST evacuate the building as soon as possible. Please note that if the alarm stops, IT DOES NOT mean the situation is under control. You must stay outside until instructed by a fire marshall or public safety officer that it is safe to go back inside.

• **"No Smoking" policy:** Columbia prohibits smoking in any shared enclosed work area, including corridors. For more specific information, see the posting on the bulletin boards.

• **Coffee (and tea):** Students are welcome to make coffee or hot water for tea using the coffee supplies provided by the Department. Full coffee pots should be emptied into the thermos and the hot plate turned off. **People who make use of the coffee area are expected to keep it clean**. If supplies are running low, please inform the staff.

• **APAM Department Tea:** Every Friday during the term coffee, tea and pastries are available at 9am in the department reception area in Room 200 Mudd before the department research conference. Later on at 2:45 p.m., tea and cookies are served. All students, research scientists, post docs, and faculty are invited to attend.

• **APAM Friday Social Hour:** Every month during the term, usually on the first Friday, snacks and beverages (both alcoholic and non-alcoholic) are served in the reception area at 4:30pm. All students, research scientists, post docs, and faculty are invited to attend. Anyone under 21 years of age will NOT be permitted to consume alcoholic beverages. This rule will be STRICTLY enforced.

• **Special Events:** All students, faculty, and staff are invited to attend.
  - First APAM Friday Social Hour: **Friday, September 3**
  - Welcoming Party: **Tuesday, September 14**
  - Holiday Party: **Friday, December 10**

APAM Doctoral Grad Calendar
2010-2011

Fall 2010

August 23-27	English Placement Test
August 27	ISSO Orientation
September 1	APAM Department Orientation and TA Training
September 3	Lab Safety Training for 1st year students 309 Havemeyer 1st APAM FRIDAY!
September 7	First Day of Classes
September 14	Certificate of Fitness Exam offered every Tuesday in Fall and Spring semesters; required for all non-theorist 2nd year grad. students, must re-certify every 3 years.
September 14	APAM Welcome Party!
October TBA	Chat with the Chair
November 1	General deadline to have taken the oral exam for the first time for 3rd year students who passed the written quals in their 2nd year.
November TBA	Choosing a Research Advisor Talk (REQUIRED FOR 1ST YEAR DOCTORAL STUDENTS)
December 3	Advisor search form due for all 1st year students
December 10	APAM Holiday Party!
December 13	Last Day of Classes
December 16-23	Final Examinations

Spring 2011

January 18	First Day of Classes
February 1	General deadline to have passed the oral exam for 3rd year students who passed the written quals in their 2nd year.
March 1	General deadline to have taken the oral exam for the first time for 2nd year students (who passed the written quals in their 1st year) and the thesis proposal for the first time for ALL 3rd year students.
March TBA	Chat with the Chair
April 1	APAM Department Open House for Prospective Doctoral Students
May 1	General deadline to have passed the oral exam for 2nd year students (who passed the written quals in their 1st year) and the thesis proposal for ALL 3rd year students.
May 3	Last Day of Classes
May 5	Deadline to submit FINAL summer and future research plans to Department for 1st year Doctoral students
May 6	Professional and Research Ethics Seminar (REQUIRED FOR 1ST AND 2ND YEAR DOCTORAL STUDENTS)
May 6-13	Final Examinations
May TBA	SEAS Class Day
May TBA	PhD Convocation
May TBA	Simon Prize Reception
May 18	Commencement and APAM Reception
May 19-20	Doctoral Qualifying Examination (2 Days)
May 23	Doctoral Qualifying Examination results (afternoon)
End of May/June	Academic review of doctoral students

University Holidays

September 6 Labor Day

November 1 Academic Holiday

November 2 University Holiday

November 25 Thanksgiving

November 26 University Holiday

January 17 Martin Luther King Jr. Day

March 14-18 Spring Break

May 30 Memorial Day

Requirements and Timetable for Masters/Doctoral APAM/MSE Students
July 26, 2010

1. Requirements for PhD
    a. Year 1: Pass the Written Qualifying Exam in May
        i. If you do not pass it, you can retake it only in Year 2
        ii. If you do not take it in Year 1, you then get only one chance to take the exam; that chance is in Year 2.
    b. Year 2: Pass the Oral Exam
        i. You must pass it by May 1 of Year 2
        ii. You must take it for the first time by March 1 of Year 2
        iii. You must take it in the specialty area you chose on the second day of the Written Qualifying Exam
        iv. Department arranges a three person Oral Exam committee (suggested by your advisor and approved by the doctoral program committee chair; the department starts the process in September of Year 2)
            1. Usually all three faculty members are from APAM
            2. It includes your Advisor
        v. Department sets the actual exam time in consultation with the committee and you
        vi. If you do not pass it, you can retake it
        vii. If you do not pass the Written Qualifying Exam in Year 1, you should delay taking the Oral Exam to Year 3 (instead you must take it by Nov. 1, and pass it by Feb. 1 of Year 3; the department starts the process in September of Year 3)
    c. Year 3: Pass the Thesis Proposal Exam
        i. You must pass it by May 1 of Year 3
        ii. You must take it for the first time by March 1 of Year 3
        iii. Department arranges a three person Thesis Proposal committee (suggested by your advisor and approved by the doctoral program committee chair; the department starts the process in September of Year 3)
            1. May be the same as the Orals Exam Committee
            2. Includes your Advisor
        iv. Department sets the actual exam time in consultation with the committee and you
        v. If you do not pass it, you can retake it
    d. Years 1 and 2: Fulfill the Ethics Requirement
        i. You must take and pass the online ethics course before the fall term of Year 1 ends, and submit the certification form to the department. (This is a new requirement, beginning with students entering in 2010-2011.)
        ii. You must attend the Research and Professional Ethics Seminar, given in May, in both Year 1 and Year 2.

e. Year "as soon as possible": Attain a Level 10 in the ALP English Exam (only for those from non-English speaking universities)
f. Year x: Submit your Doctoral Thesis and then pass the Thesis Defense
    i. In consultation with your thesis Advisor, the chair of the Doctoral Committee selects the five members of the Defense Committee
        1. It will include three or four faculty inside the thesis specialty area and two or one faculty, respectively, outside this area
        2. It will likely include the members of the three-person Thesis Proposal Committee
        3. It will definitely include your Advisor
    ii. Department sets the actual exam time in consultation with the committee and you, but you must start the process with the APAM office
    iii. You submit the Advisor-approved thesis to each committee member at least three weeks before the exam (University rules)
        1. Must be within University style guidelines
    iv. After the defense, you must make all corrections, officially deposit the thesis with the University, and provide a hard copy for the Department
    v. You are allowed to be in the doctoral program for no more than seven years

2. Exams
    a. In the Written Qualifying Exam, you answer general questions and more specialized questions in your discipline over a two-day period. More details about this exam are provided in departmental handouts.
    b. In the Oral Exam you are questioned by a three-faculty-member committee about general topics in your specialty area (e.g. Applied Math, Atmospheric Science, Plasma Physics, Solid State Physics, Optical and Laser Physics, Materials Science and Engineering, Medical Physics), unless the student is given more specific guidelines (more specific field in specialty area, based on reading material, …) in an e-mail or letter by the committee when the exam is scheduled (at least a month before the exam).
    c. In the Thesis Proposal Exam you make a 20-30 min presentation to a three-faculty-member committee about your proposed work and then the committee questions you about it. You submit to each committee member a one-page thesis overview at least one week before the exam, unless the student is given more specific guidelines (regarding the length of the overview, …) in an e-mail or letter by the committee when the exam is scheduled (at least a month before the exam).
    d. In the Thesis Defense you make a ~30 min presentation to a five-faculty-member committee about the novelty, results and impact of your thesis work---with you either surveying your thesis or emphasizing some aspects of it---and then the committee questions you about it. The alternative "open defense" can occur if both you and your advisor agree to it, in which you make your presentation before your committee and other guests

(fellow students who want to attend, …), during which time all present except the committee is permitted to ask you questions; the formal defense then begins with questioning by the committee only after other guests have left the room.

3. Doctoral thesis
    a. Criteria for evaluation
        i. Does it present new and original work?
        ii. Is it a significant body of work and are the results significant?
        iii. Is it predominantly the work of the candidate, albeit in collaboration with the advisor and with minor collaborations with others?
        iv. Is it presented in a thorough, careful, and scholarly way?
    b. A doctoral thesis represents a significantly higher and more extensive level of scholarship than does a Masters thesis
    c. Different advisors may have different styles, but all are looking for the same substance in a thesis
    d. You should consult earlier theses in your research group for examples of style and criteria deemed acceptable by your Advisor
    e. Consult the official university guidelines for the doctoral thesis format (Arts and Sciences for PhD and SEAS for DES), which are available in the APAM office and online
    f. Your Advisor should have a nearly complete draft of your thesis at least two months before you can defend your thesis
    g. Your Advisor may want to see all individual chapters earlier

4. Advisors
    a. Your Advisor must approve all of your courses
    b. Your Advisor provides you general advice on all academic matters
        i. You may consult other faculty (especially your orals committee) and other experts as well
    c. Your Thesis Advisor must pre-approve any vacation time you want
        i. It must be at a mutually agreeable time and for a mutually agreeable duration
        ii. If you want to be away for an extended time in the summer, your Thesis Advisor must agree with your plans and your summertime appointment may be shortened to reflect your time off
    d. Who is it?
        i. Year 1: First Year Department Graduate Advisor
        ii. Years 2-x: Your Thesis (Research) Advisor
            1. You must complete and submit the Advisor Search Form to the APAM office by Dec. 1 of Year 1
            2. If you are not on a fellowship, your advisor must start supporting you after May 31 of Year 1
                a. You must give the APAM Student Coordinator details of your support by May 1 of Year 1; this

support will be confirmed as soon as the results of the Written Qualifying Exam are disseminated

3. If your advisor is outside of APAM, the Department will appoint an internal Co-Advisor (who will help coordinate your oral, thesis proposal, and thesis defense exams)

5. Degrees awarded
    a. MS (if in MS/PhD): You must complete 30 Department-approved graduate points
        i. You can receive this degree at the end of Year 1, but it is totally acceptable if your receive it in the Fall or Spring of Year 2 (especially if any research course points are pending or if you need to take English courses—because these courses do not count to the degree)
        ii. You must apply to APAM for this degree by the University designated date in a given term
    b. MPhil: You must finish all the PhD requirements except for the thesis submission/defense; the University requires you being awarded the MPhil at least one term before you finish the PhD
    c. PhD or DES: You must finish all the PhD or DES requirements successfully

6. Evaluation Procedures by the Department
(in consultation with your Advisor and Exam Committees, with written notification to you from the Department Chair)

    [Your evaluation will also reflect your status in required training; notably, you must have taken the end-of-academic year Ethics Seminar in both of your first two years, and, for experimentalists, you must have taken and be up-to-date on all safety training courses and certifications (FDNY Certificate of Fitness, Columbia safety courses and refresher courses, an so on).]

    a. May, Year 1: You receive the qualifying Exam results notification
    b. May, Year 2-x: You receive an evaluation letter
        i. The letter states that you have been making either satisfactory or unsatisfactory progress toward the Doctoral degree
            1. Your progress can be judged unsatisfactory if you have not passed the oral and thesis proposal exams in time or if you have not been making satisfactory progress in your thesis research
        ii. If your performance has been judged unsatisfactory for two years in a row, you must leave the program. (Please speak with your faculty advisor long before you get to this stage. No one should be judged unsatisfactory for two years!)

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DEPARTMENT OF APPLIED PHYSICS AND APPLIED MATHEMATICS

Doctoral Program Committee Chairs
Academic Year 2010-2011

Applied Mathematics and Atmospheric Science Doctoral Committee	L. Polvani
Materials Science and Engineering Doctoral Committee	I. C. Noyan
Plasma Physics Doctoral Committee	G. Navratil
Solid State and Optical Physics Doctoral Committee	A. Pinczuk

General Departmental

Chair	I. P. Herman
Vice-Chair	I. C. Noyan
Department Conciliators	D. Amin M. E. Mauel
Doctoral Student First-Year and General Advisor	M. E. Mauel
Doctoral Qualifying Exam Coordinator	L. Polvani

Department of Applied Physics and Applied Mathematics

Doctoral Qualifying Examination 2010-2011

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 and *Medical Physics* 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 E4101y "Introduction to dynamical systems")

* Plasma Physics, or Solid State and Optical Physics
** Applied Analysis or Computational Math
***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. **Structural analysis of materials** (MSAE E4101x, "Structural analysis of materials)
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/Computational Math

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

1. Numerical methods for PDEs (APMA E4301x "Numerical methods for partial differential equations")
2. Applied functional analysis (APMA E4150x "Applied functional analysis")
3. Parallel scientific computation (AMCS E4302x "Parallel scientific computing")
4. Applied real and complex analysis (APMA E4204x* "Functions of a complex variable")
5. Partial differential equations (APMA E6301y "Analytic methods for partial differential equations")
6. Physics of fluids (APPH E4200x "Physics of fluids")

* 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. Parallel scientific computation (AMCS E4302x "Parallel scientific computing")

* 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. **Lattice vibrations and crystal defects** (MSAE E4207y "Lattice vibrations and crystal defects")
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 E4090x "Nanotechnology")
5. Magnetic materials (MSAE E6091x "Magnetism and magnetic materials")

Doctoral Qualifying Examination, cont.

Medical Physics
(Students do all four problems.)
1. **Nuclear medicine physics** (EHSC P9319 "Nuclear medicine")
2. **Radiation science** (EHSC P6330 "Radiation science")
3. **Diagnostic radiological physics** (EHSC P9330 "Diagnostic radiological physics")
4. **Radiation therapy physics** (EHSC P9335 "Radiation therapy physics")

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 (APPH E6082y "Solid state physics II")
3. Semiconductor physics (ELEN E4301y "Introduction to semiconductor devices")
4. Laser physics (APPH E4112y* "Laser physics")
5. Optical physics (APPH E4112y* "Laser physics")
6. Statistical mechanics (CHAP E4120x "Statistical mechanics")

* For 2010-2011, take ELEN E4411x Fundamentals of photonics

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.

Attendance at Colloquia & the Department Research Conference

Regular attendance at colloquia is very important for professional growth during your graduate school years and for continued growth afterwards. In your first year here, seminars will introduce you to the range of research activities in the research areas spanned by applied physics, applied mathematics, and materials science. In later years, seminars will broaden your knowledge and interests, counteracting the common tendency of thesis research to narrow the range of your professional activities.

The Department Research Conference is held every **Friday at 9:15 a.m.** in room 214 Mudd. In the fall, faculty or research staff will present overviews of their current research or some recent new developments in their field. In the spring, two graduate students will each give a 30-minute overview of their thesis work. These research seminars are expected to be comprehensible to all attendees. All department specialty areas contribute to this series. ***It is mandatory for first-year graduate students who intend to pursue doctoral studies to attend the Department Research Conference.***

Each specialty area also has its own colloquia in which outside speakers are invited to present their research. All seminars are held in room 214 Mudd (unless otherwise noted).

- Plasma Physics Colloquium: Fridays at 3:10 p.m.
- Applied Mathematics Colloquium: Tuesdays at 2:45 p.m. (210 Mudd)
- Materials Science & Engineering Colloquium: Every other Friday at 2:00 p.m.
- SEAS Colloquium in Climate Science: Thursdays at 3:00 p.m.
- Medical Physics Seminar: Thursdays at 4:10 p.m. (spring semester only)

Optical & Laser Physics and Solid State Physics research is presented in several seminar series, some of which are jointly promoted by Applied Physics & Applied Mathematics faculty. The Nanocenter/Condensed Matter (NSEC) Seminar also deals with research of interest to Applied Physics. This seminar meets on Wednesdays at 4 p.m. in the Interschool Lab, 7th floor of the Schapiro, CEPSR building.

Upcoming presentations in these and other colloquia are posted on bulletin boards near Room 200 Mudd.

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

DEPARTMENT OF APPLIED PHYSICS AND APPLIED MATHEMATICS

DEPARTMENT POLICY ON THE NEW YORK CITY FIRE DEPARTMENT CERTIFICATE OF FITNESS REQUIREMENT AND LABORATORY SAFETY TRAINING

NYC Fire Department Certificate of Fitness

All 2nd year and later non-theory APAM graduate students who do not yet have a NYC Fire Department Certificate of Fitness card MUST take and pass the Certificate of Fitness Exam by the last day of October. The Certificate of Fitness must be renewed every 3 years.

There are two ways to obtain a Certificate of Fitness:

- In person at FDNY headquarters (which is the only way for 1st year students who may want to fulfill this requirement early)
- a Self-Certification program given here at CU

Please check additional handouts for requirements or visit the Environment Health and Safety website.

The Certificate of Fitness test is given on site:

Morningside - every Tuesday @ 2 pm in Mudd 351
CUMC - every Wednesday @ 12 noon in EHS Suite #63 (Building 601 West 168th Street)

Certificate of Fitness Renewals:

If your Certificate of Fitness is expired for more than 1 year, you will be required to retake the C-14 test. If you have any questions, please contact the EH&S office 1 at (212)854-8749 (Morningside) or (212)305-6780 (CUMC) http://ehs.columbia.edu/index.html

Laboratory Safety Training

All 2nd year and later non-theory APAM graduate students who are doing experimental research and have not yet received the initial training session specific to their laboratory activities MUST attend a safety training session each Fall term. This training is beyond the laboratory fire safety training given during 1st year orientation. Please check additional handouts for safety training schedules or visit the EH&S website.

In addition, any student requiring refresher training has the option each Fall term of attending a classroom session or going on-line, which includes a post-test administered by RASCAL @https://www.rascal.columbia.edu.

If you have any questions, please contact the EH&S office 1 at (212)854-8749 (Morningside) or (212)305-6780 (CUMC) http://ehs.columbia.edu/index.html

COLUMBIA UNIVERSITY
Department of Applied Physics and Applied Mathematics

GRADUATE PROGRAM IN APPLIED MATHEMATICS

Columbia University offers an exceptional environment for graduate study in applied mathematics leading to the M.S., M.Phil., and Ph.D. degrees. The applied mathematics faculty in the Department of Applied Physics and Applied Mathematics are expert in a wide variety of application areas and perform multidisciplinary research spanning atmospheric, oceanic, & climate science; geophysics & solid-earth dynamics; waves in fluids, optics & quantum systems; imaging & image processing; inverse problems, inference & machine learning; bioinformatics & systems biology. Close collaborations exist with Columbia's Lamont Doherty Earth Observatory and Columbia's medical school.

Applied Physics and Applied Mathematics Faculty

David Keyes	Fu Foundation Professor of Applied Mathematics
Guillaume Bal	Professor of Applied Physics and Applied Mathematics
Mark A. Cane	G. Unger Vetlesen Professor of Earth & Environmental Sciences and Professor of Applied Mathematics
C.K. Chu	Fu Foundation Professor of Applied Mathematics *Emeritus*
Daniel Beinstock	Professor of Applied Mathematics and Professor of Industrial Engineering and Operations Research
Pierre Gentine	Assistant Professor of Applied Physics and Applied Mathematics
Lorenzo Polvani	Professor of Applied Physics and Applied Mathematics and Earth & Environmental Sciences
Christopher Scholz	Professor of Earth & Environmental Sciences and Professor of Applied Mathematics
Adam Sobel	Associate Professor of Applied Physics and Applied Mathematics Earth & Environmental Sciences
Marc Spiegelman	Professor of Applied Physics and Applied Mathematics Earth & Environmental Sciences
Michael Weinstein	Professor of Applied Physics and Applied Mathematics
Chris Wiggins	Associate Professor of Applied Physics and Applied Mathematics

Admission

A bachelor's or master's degree in mathematics, engineering, or one of the physical sciences is required for admission.

Degrees

Degrees awarded are Master of Science (M.S.), Master of Philosophy (M.Phil.), and Doctor of Philosophy (Ph.D.)

Financial Aid

Financial Aid is available. Fellowships, scholarships, teaching assistantships, and graduate research assistantships are awarded on a competitive basis. Applications (with GRE test scores) must be submitted by December 1 to be considered for the following academic year.

Degree Requirements

The M.S. degree requires the successful completion of 30 points of approved course work in basic and applied mathematics. Requirements for the M.Phil. degree include successful

completion of a 30 point program beyond the M.S., a written qualifying examination, an oral exam and a thesis proposal evaluation. In addition to fulfilling the M.Phil. requirements, Ph.D. candidates must submit an approved dissertation, and complete the University residence requirements.

Specific course requirements are determined in consultation with the program advisor. Courses suggested for preparation at the level of the general, and subspecialty parts of the written qualifying examination are listed in the qualifying examination memorandum. Students interested in Atmospheric Science should consult with Professors Polvani or Sobel for additional course suggestions not listed below.

Core Courses
APMA E4001: Principles of applied mathematics
APMA E4101: Dynamical systems
APMA E4150: Applied functional analysis
APPH E4200: Physics of fluids
APMA E4200: Partial differential equations
APMA E4204: Functions of a complex variable
APMA E4300: Introduction to numerical methods
APMA E4301: Numerical methods for partial differential equations
APMA E4400: Introduction to biophysical modeling
APMA E6301: Analytic methods for partial differential equations
APMA E6302: Numerical analysis of partial differential equations

Related Courses of Specialization
AMCS E4302: Parallel scientific computing
APMA E6901: Special topics in applied mathematics
APMA E8308: Asymptotic methods in applied mathematics
APPH E4210: Geophysical fluid dynamics
APMA E9815: Geophysical fluid dynamics seminar
COMS W4205: Combinatorial theory
COMS W4241: Numerical algorithms and complexity
EESC W4008: Introduction to atmospheric science
PHYS G4019: Mathematical methods in physics
SIEO W4105: Probability
MATH W4032: Fourier analysis
MATH G4151/4152: Analysis and probability/Analysis II
MATH G6351-G6352: Applications of harmonic analysis
MATH G6430-G6431: Mathematical physics

Multidisciplinary and External Advisors

Admitted students may work with scientific advisors external to the applied mathematics faculty. Examples of other faculty in areas closely related to applied mathematics include:

Larry Abbott, Neuroscience
Brian Cairns, NASA/GISS
Rama Cont, IEOR
Panagiota Daskalopoulos, Mathematics
Anthony Del Genio, NASA/GISS
Julien Dubedat, Mathematics
Donald Goldfarb, IEOR
Eitan Grinspun, Computer Science
Timothy Hall, NASA/GISS
Ron Miller, NASA/GISS
Ovidiu Savin, Mathematics
Bruce Shaw, LDEO
Edward A. Spiegel, Astronomy

COLUMBIA UNIVERSITY

Department of Applied Physics and Applied Mathematics

GRADUATE PROGRAM IN APPLIED PHYSICS
OPTION IN PLASMA PHYSICS

Columbia, one of the leading university centers for training in plasma physics, offers a graduate program leading to the M.S., M.Phil., and Ph.D. degrees. The program builds a foundation in the science and application of plasma physics and features a specialty in the high-temperature plasma physics needed for controlled fusion energy. Besides a sound basic training in relevant areas of applied physics, students develop expertise in experimental, theoretical, and computational plasma physics. This instruction provides the background needed to conduct research in Columbia University's Plasma Research Laboratory and in other national plasma research facilities. Since its inception in 1960, the program at Columbia has granted more than 110 doctoral degrees with many of our graduates playing leading roles in all phases of plasma physics, including, in particular, the worldwide program to develop controlled fusion energy.

Applied Physics and Applied Mathematics Faculty

Michael E. Mauel	Professor of Applied Physics
Allen H. Boozer	Professor of Applied Physics
Gerald A. Navratil	Thomas Alva Edison Professor of Applied Physics
Thomas S. Pedersen	Professor of Applied Physics
Amiya K. Sen	Professor of Applied Physics and Electrical Engineering

Admission

A bachelor's or master's degree in engineering, mathematics, or one of the physical sciences is required for admission.

Degrees

Degrees awarded are Master of Science (M.S.), Master of Philosophy (M.Phil.), and Doctor of Philosophy (Ph.D.)

Financial Aid

Financial Aid is available. Fellowships, scholarships, teaching assistantships, and graduate research assistantships are awarded on a competitive basis. Applications (with GRE test scores) must be submitted by December 1 to be considered for the following academic year.

Degree Requirements

The M.S. degree requires the successful completion of 30 points of approved course work in basic and applied physics. Requirements for the M.Phil. degree include successful completion of a 30 point program beyond the M.S. which includes APPH E4018, APPH E4200, APPH E4300, APPH E6101, APPH E6102, and APPH E9142 or E9143 or their equivalent, a written qualifying examination, an oral exam and a thesis proposal evaluation. In addition to fulfilling the M.Phil. requirements, Ph.D. candidates must submit an approved dissertation, and complete the University residence requirements.

Core Courses
APPH E4018: Applied physics laboratory
APPH E4100: Quantum physics of matter
APPH E4112: Laser physics
APPH E4200: Physics of fluids
APPH E4300: Applied electrodynamics
APPH E4301: Introduction to plasma physics
APPH E6101: Plasma physics I
APPH E6102: Plasma physics II
APPH E9142-E9143: Applied physics seminar
APAM E6650: Research project
APMA E4200: Partial differential equations
CHEM G4230: Statistical thermodynamics
ELEN E6403 or
PHYS G6092-G6093: Electromagnetic theory
PHYS G4003: Advanced mechanics

Related Courses of Specialization
APPH E4110: Modern optics
APPH E6110: Laser interactions with matter
APPH E4010: Introduction to nuclear science
APMA E4204: Functions of a complex variable
APMA E6209: Approximation theory
APMA E6301: Analytic methods for PDE's
APMA E6302: Numerical methods for PDE's
APMA E6304: Integral analysis of transforms
APMA E6901: Special topics in applied math
APMA E8308: Asymptotic methods in applied math
ASTR G4001: Stellar Structure & Evolution
ASTR G4002: Astrophysics II
ELEN E4405: Classical nonlinear optics
ELEN E4420: Topics in electromagnetics
ELEN E4501: Electromagnetic devices and energy conversion
PHYS G4019: Mathematical methods in physics
PHYS G6036: Statistical mechanics
PHYS G6037-G6038: Quantum mechanics

Research Scientists and External Advisors

Admitted students may work with scientific advisors external to the applied physics faculty. Examples of other researchers or faculty external to the department include:

Dr. Mark Adams, Research Scientist
Dr. James Bialek, PPPL
Dr. D. Garnier, MIT
Dr. Andreas Garofalo, General Atomics
Dr. David Maurer, Research Scientist
Dr. H. Reimerdes, General Atomics
Dr. Steven Sabbagh, PPPL

COLUMBIA UNIVERSITY

Department of Applied Physics and Applied Mathematics

GRADUATE PROGRAM IN MATERIALS SCIENCE AND ENGINEERING

Columbia's program in Materials Science and Engineering is concerned with the synthesis, processing, structure, and properties of metals, ceramics, polymers, and other materials, with emphasis on understanding and exploiting relationships among structure, properties, and application requirements.

Applied Physics and Applied Mathematics Faculty

James Im	Professor of Materials Science and Engineering
William E. Bailey	Associate Professor of Materials Science and Engineering
Simon Billinge	Professor of Materials Science and Applied Physics and Applied Mathematics
Siu-Wai Chan	Professor of Materials Science and Engineering
Irving P. Herman	Professor of Applied Physics
Chris Marianetti	Assistant Professor of Materials Science and Engineering
Gertrude F. Neumark	Howe Professor of Materials Science and Engineering and Professor of Applied Physics and Applied Mathematics *Emerita*
I. Cedvet Noyan	Professor of Materials Science and Engineering
Aron Pinczuk	Professor of Applied Physics and Professor of Physics
Horst Stormer	Professor of Applied Physics and Professor of Physics
Latha Venkataraman	Assistant Professor of Applied Physics
Weng I. Wang	Professor of Applied Physics and Professor of Electrical Engineering

Admission

A bachelor's or master's degree in one of the physical sciences, typically materials science, metallurgy, physics, or chemistry, or other science and engineering disciplines.

Degrees

Degrees awarded are Master of Science (M.S.), Master of Philosophy (M.Phil.), Doctor of Philosophy (Ph.D.), and Doctor of Engineering Science (Eng.Sc.D.)

Financial Aid

Financial aid is available. Fellowships, scholarships, teaching assistantships, and graduate research assistantships are awarded on a competitive basis. Applications (with GRE test scores) must be submitted by December 1 to be considered for the following academic year.

Degree Requirements

The M.S. degree can be awarded after one year residency and 30 points. A master's thesis is required. Requirements for the M.Phil. degree include successful completion of a 30 point program, a written qualifying examination, an oral exam and a thesis proposal evaluation. In addition to fulfilling the M.Phil. requirements, Ph.D. and Eng.Sc.D. candidates must submit an approved dissertation, and complete the University residence requirements.

Specific course requirements are determined in consultation with the program adviser. Courses suggested for preparation at the level of the general and materials science parts of the written qualifying examination are listed in the qualifying examination memorandum.

Core Courses

MSAE E4101: Structural analysis of materials
MSAE E4132: Fundamentals of polymers and ceramics
MSAE E4202: Thermodynamics and reactions in solids
MSAE E4206: Electronic and magnetic properties of solids
MSAE E4207: Lattice vibrations and crystal defects
MSAE E4215: Mechanical behavior of materials
MSAE E4250: Ceramics and composites
MSAE E4301: Materials science laboratory
MSAE E6020: Electronic ceramics
MSAE E6081: Solid state physics, I
MSAE E6082: Solid state physics, II
MSAE E6090: Nanotechnology
MSAE E6120: Grain boundaries and interfaces
MSAE E6220: Crystal physics
MSAE E6221: Introduction to dislocation theory
MSAE E6225: Techniques in x-ray and neutron diffraction
MSAE E6229: Energy and particle beam processing of materials
MSAE E6230: Kinetics of phase transformations
MSAE E6240: Impurities and defects in semiconductor materials
MSAE E6241: Theory of solids
MSAE E6251: Thin films and layers
MSAE E8236: Anelastic relaxations in crystals

Related Courses of Specialization

CHEE E4050: Principles of industrial electrochemistry
CHEN E4201: Engineering applications of electrochemistry
CHEE E4252: Introduction to surface and colloid chemistry
CHEE E4530: Corrosion of metals
CHEN E4620: Introduction to polymer science
CHEN E4630: Computational laboratory for synthetic and biological polymers
CIEN E4212: Structural assessment and failure
CIEN E4332: Finite element analysis, I
EAEE E4004: Physical processing and recovery of solids
EAEE E4011: Industrial ecology for manufacturing
EAEE E4160: Solid and hazardous waste management
EAEE E4900: Applied transport and chemical rate phenomena
EAEE E6228: Theory of flotation

Multidisciplinary and External Advisors

Admitted students may work with scientific advisors external to the applied physics faculty. Examples of other faculty in areas closely related to applied physics include:

Louis Brus, Chemical Eng. and Chemistry
Paul F. Duby, Earth and Environmental Eng.
C. J. Durning, Chemical Eng.
Yasutomo Uemura, Physics

Columbia University

Department of Applied Physics and Applied Mathematics

GRADUATE PROGRAM IN APPLIED PHYSICS
OPTION IN SOLID STATE AND OPTICAL PHYSICS

Columbia's program in solid state physics spans a wide range of experimental and theoretical fields, including nanocrystals, electronic transport in molecular nanostructures, optical spectroscopy, and fabrication of semiconductors; semiconductor superlattices; molecular electronics; surface and interface physics; solid state physics at high pressure and defects. In many of these endeavors the program maintains close ties with the Columbia Center for Integrated Science and Engineering, the Columbia NSF Center for Electronic Transport in Molecular Nanostructures (Nanocenter), and the Interdepartmental Committee on Materials Science and Engineering/Solid State Science and Engineering.

Columbia's program in optical physics emphasizes both theoretical and experimental studies of lasers and laser applications within applied physics and related disciplines. Areas of interest include laser spectroscopy; laser- assisted diagnostics and modifications in semiconductor processing; inelastic light scattering; and photonic devices. In several of these endeavors the program maintains close ties with the Columbia Center for Integrated Science and Engineering.

Applied Physics and Applied Mathematics Faculty

Aron Pinczuk	Professor of Applied Physics and Professor of Physics
William Bailey	Associate Professor of Materials Science and Engineering
Simon Billinge	Professor of Materials Science and Applied Physics and Applied Mathematics
Siu-Wai Chan	Professor of Materials Science and Engineering
Dirk Englund	Assistant Professor of Applied Physics and Electrical Engineering
Irving P. Herman	Professor of Applied Physics
James Im	Professor of Materials Science and Engineering
Philip Kim	Professor of Applied Physics and Professor of Physics
Chris Marianetti	Assistant Professor of Materials Science and Engineering
Gertrude F. Neumark	Howe Professor of Materials Science and Engineering and Professor of Applied Physics and Applied Mathematics *Emerita*
I. Cedvet Noyan	Professor of Materials Science and Engineering
Richard M. Osgood, Jr.	Professor of Applied Physics and Applied Mathematics and Higgins Professor of Electrical Engineering
Horst Stormer	Professor of Applied Physics and Professor of Physics
Latha Venkataraman	Assistant Professor of Applied Physics
Weng I. Wang	Professor of Applied Physics and Professor of Electrical Engineering

Admission

A bachelor's or master's degree in one of the physical sciences, engineering or mathematics.

Degrees

Degrees awarded are Master of Science (M.S.), Master of Philosophy (M.Phil.), Doctor of Philosophy (Ph.D.), and Doctor of Engineering Science (Eng.Sc.D.)

Courses, cont.

Financial Aid

Financial aid is available. Fellowships, scholarships, teaching assistantships, and graduate research assistantships are awarded on a competitive basis. Applications (with GRE test scores) must be submitted by December 1 to be considered for the following academic year.

Degree Requirements

The M.S. degree can be awarded after one year of residency and 30 points in studies in basic and applied physics. Requirements for the M.Phil. degree include successful completion of a 30 point program which includes relevant technical courses, such as APPH E4018, APPH E4112, ELEN E4301, ELEN E6331-2, MSAE E4205, MSAE E4206 or their equivalent for solid state; APPH E4018, APPH E4100, APPH E4110, APPH E4112, APPH E6110, and ELEN E9402 or their equivalent for optical physics, a written qualifying examination in the solid state and optical physics specialty option, an oral exam, and a thesis proposal evaluation. In addition to fulfilling the M.Phil. requirements, Ph.D. and Eng.Sc.D. candidates must submit an approved dissertation and complete the University residence requirements.

Specific course requirements are determined in consultation with the program advisor. Courses suggested for preparation at the level of the general, and solid state and optical physics parts of the written qualifying examination are listed in the qualifying examination memorandum.

Core Courses

APPH E4018: Applied physics laboratory
APPH E4100: Quantum physics of matter
APPH E4110: Modern optics
APPH E4112: Laser physics
APPH E6081-6082: Solid state physics, I, II
APPH E6110: Laser interactions with matter
APAM E6650: Research project
CHAP E4120: Statistical mechanics
or CHEM G4230: Statistical thermodynamics
ELEN E4301: Introduction to semiconductor devices
ELEN E4405: Classical nonlinear optics
ELEN E4411: Fundamentals of photonics
ELEN E6331-6332: Principles of semiconductor physics, I, II
ELEN E6403 or
PHYS G6092-6093: Electromagnetic theory
ELEN E6412: Lightwave devices
ELEN E9402: Seminar in quantum electronics
ELEN E9403: Seminar in photonics
MSAE E6220: Crystal physics
MSAE E6241: Theory of solids
PHYS G4018: Physics of the solid state
PHYS G4019: Mathematical methods in physics
PHYS G6036: Statistical mechanics
PHYS G6037-6038: Quantum mechanics

Related Courses of Specialization

APMA E4204: Functions of a complex variable
APMA E630l: Analytic methods for PDE's
APMA E6302: Numerical analysis of PDE's

Graduate Program in Applied Physics - Option in Solid State and Optical Physics, cont.
Courses, cont.
CHEM G4230: Statistical thermodynamics
CHEM G423l: Chemical kinetics
CHEM G6222: Quantum chemistry, II
CHEM G8223: Quantum chemistry, III
ELEN E4401: Wave transmission and fiber optics
ELEN E4944: Principles of device microfabrication
ELEN E6140: Gallium arsenide materials processing
ELEN E6151: Surface physics and analysis of electronic materials
ELEN E6331-6332: Principles of semiconductor physics
ELEN E6413: Lightwave systems
ELEN E6414: Photonic integrated circuits
ELEN E910l: Seminar in physical electronics
ELEN E9402: Seminar in quantum electronics
ELEN E9404: Seminar in lightwave communications
MSAE E6090: Nanotechnology
MSAE E6221: Introduction to dislocation theory
MSAE E6225: Techniques in x-ray and neutron diffraction
MSAE E6229: Energy and particle beam processing of materials
MSAE E6230: Kinetics of phase transformations
MSAE E6240: Impurities and defects in semiconductor materials
MSAE E625l: Thin films and layers
MSAE E8235: Selected topics in materials science
MSAE E8236: Anelastic relaxations in crystals
PHYS G8048: Adv. quantum mechanics, II
PHYS G8050: Adv. mathematical methods in physics
PHYS G8066: Theoretical solid state physics, I

Multidisciplinary and External Advisors

Admitted students may work with scientific advisors external to the applied physics faculty. Examples of other faculty in areas closely related to applied physics include:

Louis Brus, Chemical Engineering and Chemistry
Kenneth Eisenthal, Chemistry
Richard Friesner, Chemistry
Tony Heinz, Physics and Electrical Engineering
Yasutomo Uemura, Physics
Shalom Wind, Applied Physics and Electrical Engineering
Chee-Wei Wong, Mechanical Engineering

DEPARTMENT of APPLIED PHYSICS and APPLIED MATHEMATICS

at COLUMBIA UNIVERSITY

FACULTY	AREAS OF RESEARCH
WILLIAM BAILEY	nanoscale magnetic films & heterostructures, materials issues in spin-polarized transport, materials engineering of magnetic dynamics
GUILLAUME BAL	applied mathematics, partial differential equations with random coefficients, high frequency waves in random media, theory of inverse transport and applications in medical and geophysical imaging
DANIEL BIENSTOCK	applied mathematics, methodology and high-performance implementation of optimization algorithms, applications of optimization: preventing national-scale blackouts, emergency management, approximate solution of massively large optimization problems, higher-dimensional reformulation techniques for integer programming, robust optimization
SIMON BILLINGE	nanoscale structure-property relationships in functional nanomaterials studied using novel x-ray and neutron scattering techniques coupled with advanced computing; solving the nanostructure problem
ALLEN H. BOOZER	plasma theory, theory of magnetic confinement for fusion energy, nonlinear dynamics
MARK A. CANE (DEES)	climate dynamics, physical oceanography, geophysical fluid dynamics, computational fluid dynamics, impacts of climate on society, El Niño forecasting
VITTORIO CANUTO (Adj.)	fluid dynamics, turbulence theory, ocean & atmospheric mixing processes
BARBARA E. CARLSON (Adj.)	radiative transfer modeling, analysis & interpretation of remote sensing data, cloud physics, & tropospheric chemistry
SIU-WAI CHAN	nanoparticles, electronic ceramics, grain boundaries & interfaces, oxide thin films
C. K. CHU (Emeritus)	applied mathematics
ANTHONY DEL GENIO (Adj.)	dynamics of planetary atmospheres, parameterization of clouds & cumulus convection, climate change, general circulation
MORTON B. FRIEDMAN (CE)	applied mathematics & mechanics, numerical analysis, parallel computing
PIERRE GENTINE	applied mathematics, land-atmosphere interactions, soil-vegetation-transfer-atmosphere models, applications of stochastic processes to hydrology and atmospheric boundary-layer, stochastic rainfall and soil moisture, data-assimilation (filtering) of remote sensing measurements to estimate land-surface variables
TIMOTHY M. HALL (Adj.)	atmosphere & ocean dynamics, transport of geophysical tracers, ocean carbon uptake
IRVING P. HERMAN	nanocrystals, optical spectroscopy of nanostructured materials, laser diagnostics of thin film processing, mechanical properties of nanomaterials
JAMES S. IM	laser-induced crystallization of thin films, phase transformations & nucleation in condensed systems
DAVID E. KEYES	applied & computational mathematics for PDEs, computational science, parallel numerical algorithms, parallel performance analysis, PDE-constrained optimization
PHILIP KIM	experimental condensed matter physics, physical properties and applications of nanoscale low-dimensional materials; quantum thermal transport phenomena in 1-dimensional nanoscaled materials, mesoscopic thermoelectricity and thermoelectric applications of nanoscale materials, quantum transport in novel 2-dimensional materials, mesoscopic electron transport and thermodynamic processes for sensors and electric devices

CHRIS A. MARIANETTI	predicting materials properties from first-principles computations; materials with energy related applications; density-functional theory; dynamical mean-field theory; transition-metal oxides; actinides, energy storage and conversion materials
THOMAS C. MARSHALL (Emeritus)	accelerator concepts, relativistic beams & radiation, free-electron lasers
MICHAEL E. MAUEL	plasma physics, waves & instabilities, fusion & equilibrium control; space physics; plasma processing, international energy policy
RON L. MILLER (Adj.)	climate dynamics, aerosols & climate
GERALD A. NAVRATIL	plasma physics, plasma diagnostics, fusion energy science
GERTRUDE NEUMARK	material science & physics of semiconductors, with emphasis on optical & electrical properties of wide bandgap semiconductors & their light emitting devices
I. CEVDET NOYAN	characterization & modeling of mechanical & micromechanical deformation; residual stress analysis & nondestructive testing; x-ray & neutron diffraction, microdiffraction analysis
RICHARD M. OSGOOD (EE)	nanoscale optical and electronic phenomena (experimental & computational), femtosecond lasers and laser probing, low-dimensional physics, integrated optics, nanofabrication and materials growth
THOMAS S. PEDERSEN	plasma physics, magnetic confinement, fusion energy, plasma turbulence, non-neutral plasmas, positron-electron plasmas
ARON PINCZUK	spectroscopy of semiconductors & insulators, quantum structures, systems of reduced dimensions, atomic layers of graphene, electron quantum fluids
LORENZO M. POLVANI	atmospheric and climate dynamics, geophysical fluid dynamics, numerical methods for weather and climate modeling, planetary atmospheres
MALVIN A. RUDERMAN (Physics)	theoretical astrophysics, neutron stars, pulsars, early universe, cosmic gamma rays
STEVEN A. SABBAGH (Adj.)	plasma physics, experimental MHD equilibrium reconstruction & stability analysis, passive & active global MHD mode stabilization physics, plasma rotation in toroidal devices
CHRISTOPHER H. SCHOLZ (DEES)	experimental & theoretical rock mechanics, especially friction, fracture & hydraulic transport properties, nonlinear systems, mechanics of earthquakes & faulting
AMIYA K. SEN (EE)	plasma physics, fluctuations & anomalous transport in plasmas, control of plasma instabilities, plasma transport
ADAM SOBEL	atmospheric science, geophysical fluid dynamics, tropical meteorology, climate dynamics
MARC SPIEGELMAN	coupled fluid/solid mechanics, reactive fluid flow, solid earth & magma dynamics, scientific computation/modeling
HORST STORMER	semiconductors, electronic transport, lower-dimensional physics, transport in nanostructures
LATHA VENKATARAMAN	single-molecule transport, single-molecule-force spectroscopy, electron transport in nanowires, scanning tunneling microscopy and spectroscopy.
WEN I. WANG (EE)	heterostructure devices & physics, materials properties, molecular beam epitaxy
MICHAEL WEINSTEIN	applied mathematics, partial differential equations, dynamical systems, waves in nonlinear, inhomogeneous & random media; multi-scale phenomena, applications to nonlinear optics, quantum systems and fluid dynamics

CHRIS H. WIGGINS	applied mathematics, mathematical biology, biopolymer dynamics, soft condensed matter, genetic networks & network inference, machine learning
CHENG SHIE WUU (P&S)	microdosimetry, biophysical modeling, dosimetry of brachytherapy, gel dosimetry, second cancers induced by radiotherapy, medical physics
YIMEI ZHU (Adj.)	solid-state physics, materials science, nano-science and engineering, advanced electron microscopy

8/28/09

Name _____ *Form is due in APAM office by Dec. 3.*

Date _____

1. List the faculty members with whom you have discussed thesis research opportunities sometime this current fall term.

_____ _____

_____ _____

_____ _____

_____ _____

2. Of these, list those you are still seriously considering as a potential thesis advisor.

_____ _____

_____ _____

3. Who else are you are seriously considering as a potential thesis advisor? **(Talk to them immediately!)**

_____ _____

_____ _____

Remember, it is your responsibility to initiate further contact with these faculty members to secure a research advisor. Your departmental support ends at the end of the spring term, and you need to find research support that starts this coming summer term.