AUBURN UNIVERSITY

COLLEGE OF SCIENCES
AND MATHEMATICS

Department of Physics

Graduate Student Handbook

Updated September 2, 2022

1 Introduction and Overview

Welcome to the Department of Physics at Auburn University. We take pride in our long tradition of fostering a collegial, collaborative, and supportive academic environment, with departmental faculty, staff, and administration strongly committed to excellence in graduate education and research.

This handbook is an informational resource to both graduate students and faculty, outlining the procedures and paperwork needed to satisfy both Department and Graduate School requirements for a graduate degree. In addition, the handbook outlines the guidelines and standard practices of the Department, College and Graduate School as students proceed through their graduate school career in the Auburn Department of Physics. For exceptional cases, modifications to these guidelines for individual students are possible, subject to approval of the Department Chair in consultation with advising faculty and the Graduate Program Officer. We encourage any faculty, staff or students to contact the Graduate Program Officer with comments or questions regarding this handbook or the program in general.

1.1 Overview

With more than 20 full-time faculty members, approximately 50 graduate students, and approximately 60 undergraduate physics majors, each student in the department receives the sort of individual attention that is usually only available at much smaller universities. Meanwhile, the department maintains a variety of vibrant research groups, currently clustered in five major areas:

1. Plasma physics with an emphasis on magnetic fusion related plasma physics and dusty plasmas,

2. Condensed matter physics with an emphasis on semiconductors, novel low-dimensional materials and electronic devices,

3. Atomic, Molecular, Optical (AMO) physics with an emphasis on interactions with ionizing radiation and ultra-fast laser pulses as well as AMO processes in space,

4. Space physics exploring the Earth's magnetosphere with an emphasis on computational methods applied to space plasma dynamics and satellite data,

5. Biophysics with an emphasis on the physics of molecular transport systems within and among cells and computational biophysics, particularly on mechanobiology.

In recent years, the department has invested heavily in state-of-the-art laboratory equipment and computational facilities, and most recently the Department has moved to a new Physics building. Our graduate students have an opportunity to choose among a wide range of research projects to pursue a graduate degree through collaboration with teams of fellow graduate students, post-doctoral researchers and faculty members, both on campus and across the globe.

To serve our graduate students with diverse academic and personal backgrounds, exceptions to some guidelines in this handbook are possible. All requests for exceptions should be made directly to the Department Chair and/or Graduate Program Officer, who will consult with the student's advisor, committee and additional faculty members as needed. It is also important to emphasize that not all exception requests are approved. The Graduate Program Officer (GPO) will review this Handbook annually by the end of each Spring semester, and recommend revisions for approval by the Physics Graduate Faculty, if needed.

1.2 Financial Support

Financial stipends are provided for both graduate teaching assistants (GTAs) and research assistants (GRAs). The teaching assistantships are awarded by the Department Chair, and the research assistantships are awarded by the individual faculty members. All prospective Ph.D. students will be automatically considered for the full-time GTA support. No separate application for financial aid is required. Tuition waivers will be issued by the Graduate School for full-time GTAs or GRAs. A graduate student is allowed to take graduate-level hours without paying tuition for his/her degree study up to 110% of degree requirements. Therefore, up to 33 credit hours for the M.S. degree and 66 credit hours for the Ph.D. degree are included in this tuition waiver. Note that students not on assistantships during the semester of their graduation will not receive the waiver for that semester, so it is strongly encouraged to schedule a final defense to take place before beginning employment outside of Auburn University.

Graduate students in the department typically begin their graduate career as Graduate Teaching Assistants (GTAs). When the student begins research in earnest, a graduate research assistantship (GRA) will usually be offered. However, when a GRA is not available, the department may offer a teaching assistantship to a graduate student who is making adequate academic progress toward his/her degree. GTAs will lead laboratory/activity classes in the 1000- and 2000-level introductory physics courses, or perform other comparable duties in support of the Department's teaching effort. As detailed below, once the student matriculates into the Ph.D. program, they become eligible for a stipend increase of $1000/year.

In order to maintain a graduate assistantship, it is expected that a student continues to make adequate progress toward a degree. During PhD studies,this includes the following:

1. Maintain a minimum 3.0 GPA.

2. Maintain a level of performance deemed acceptable by the major professor while active in a research program.

Failure to meet any of these expectations may result in the withdrawal of financial support. If this situation should arise, the student and the advisor will meet with the GPO and Department Chair, and an appropriate course of action will be determined.

1.3 Department Contact Information

Administration

Department Chair:	Prof. Allen Landers	4-4264	landeal@auburn.edu
Office Supervisor:	Ms. Mary Prater	4-4614	mlp0077@auburn.edu
Accountant:	Ms. Jennifer Morris	4-4626	jcm0028@auburn.edu
Administrative Assistant:	Ms. Glenda Stroud	4-4264	gms0015@auburn.edu

Graduate Admissions Committee

Prof. David Ennis	4-4366	dae0005@auburn.edu
Prof. Guillaume Laurent	4-8712	glaurent@auburn.edu
Prof. Yu Lin	4-4683	linyu01@auburn.edu
Prof. David Maurer (as Graduate Program Officer)	4-7809	damaurer@auburn.edu

General Doctoral Examination Committee

Prof. Stuart Loch, Chair	4-5154	lochstu@auburn.edu
Prof. Jianjun Dong	4-2943	dongjia@auburn.edu
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Prof. Yu Lin	4-4683	linyu01@auburn.edu
Prof. David Maurer (as Graduate Program Officer)	4-7809	damaurer@auburn.edu

Graduate Teaching Assistant Coordinator

Mr. David Patrick	4-2950	patridm@auburn.edu

1.4 Useful Weblinks

The Graduate School Bulletin is a resource for all graduate students at Auburn University and the Physics Graduate Study page describes the graduate program specific to Physics. Additional useful information can also be found at the websites for both the Department of Physics and the Graduate School.

Auburn University Bulletin:
http://bulletin.auburn.edu

Graduate School Policies:
http://grad.auburn.edu/students.html

Department of Physics Homepage:
http://www.auburn.edu/cosam/departments/physics/index.htm

Department of Physics Graduate Study:
http://www.auburn.edu/academic/cosam/departments/physics/grad/

Accelerated Masters Program:
http://grad.auburn.edu/abm.html

Doctoral Completion Checklist:
http://graduate.auburn.edu/current-students/doctoral-completion-checklist/

Master's Completion Checklist:
http://graduate.auburn.edu/current-students/masters-completion-checklist/

University Counseling Services:
http://wp.auburn.edu/scs/

2 Admissions

The Department of Physics welcomes applications from prospective students with an interest in our graduate and research programs. Prospective students should have a bachelor's (or equivalent) degree in physics or a related field and should apply online at the Auburn University Graduate School webpage.

Detailed application instructions can be found at

Application Instructions:
http://graduate.auburn.edu/prospective-students/application-instructions/

Under the category Admissions Information, applicants should select Physics/PHD as their Planned Course of Study.

The following information is required for a complete application:

1. Undergraduate and graduate transcripts
2. The names and contact information for three Recommendation Providers
3. General GRE scores (international students only)
4. TOEFL scores (international students only)

Applications submitted by January 15 will receive full consideration for the upcoming academic year that begins August 15. In special cases, the Department will accept mid-year applications.

3 Graduate Course Work

For all graduate degrees in the Department of Physics, 18 credit hours of core courses are required:

Core Courses (18 hrs)		
Course #	Course Title	Hrs
PHYS 7100*	Classical Mechanics	3
PHYS 7200*	Electricity and Magnetism I	3
PHYS 7250	Electricity and Magnetism II	3
PHYS 7300*	Quantum Mechanics I	3
PHYS 7350	Quantum Mechanics II	3
PHYS 7400*	Statistical Physics	3

Table 1: Core graduate physics courses required for M.S and Ph.D., among which the four core courses labeled with * are prerequisites for taking the General Doctoral Examination.

Thirty (30) hours of Coursework are required for the M.S. degree, and sixty (60) hours of coursework are required for the Ph.D. degrees. During the first two years of study, the following is a typical course schedule for both degrees:

Typical Starting Schedule				
Year	Semester	Course #	Course Title	Hrs
1	Fall	PHYS 7100	Classical Mechanics	3
1	Fall	PHYS 7400	Statistical Physics	3
1	Fall	PHYS XXXX	Elective (typically Math Methods 1)	3
1	Fall	PHYS 7950	Colloquium	1
1	Fall	PHYS 6900	Physics Teaching Seminar	1
1	Spring	PHYS 7200	Electricity and Magnetism I	3
1	Spring	PHYS 7300	Quantum Mechanics I	3
1	Spring	PHYS XXXX	Elective (typically Math Methods 2)	3
1	Spring	PHYS 7950	Colloquium	1
1	Spring	PHYS 7850	Graduate Physics Research Seminar	1
1	Summer	PHYS 8990	Research and Dissertation	1
2	Fall	PHYS 7250	Electricity and Magnetism II	3
2	Fall	PHYS 7350	Quantum Mechanics II	3
2	Fall	PHYS XXXX	Elective	3
2	Fall	PHYS 7950	Colloquium	1

Table 2: Typical schedule for first three semesters, including summer research, with total credit hours of 33.

During the first year, common elective choices include two semesters of Math Methods or equivalent, or a special topics course in one of the Department's primary research areas (Plasma, Condensed Matter, AMO, Space, or Biophysics). Additional courses taken throughout a student's graduate career are chosen through guidance from the Graduate Program Officer and/or the the student's advisor.

4 Degree Programs and Requirements

Auburn University's Department of Physics Graduate Program offers the Master of Science (M.S.) degree and the Doctor of Philosophy (Ph.D.) degree in physics. The majority of physics graduate students enter our graduate program as Ph.D. students. During the first two years, the initial course requirements for the Ph.D. degree complete the course requirements for the M.S. degree. As a result, Ph.D. students are awarded an M.S., when the requirements of the M.S. degree have been met. This also allows for a high level of flexibility should the student decide to switch to a terminal M.S. program during the first two years.

The department also offers an Accelerated Bachelor's / Master's (ABM) Degree Program to outstanding Auburn undergraduates, to allow them to earn both the Bachelor's and Master's degrees in less time and at less cost. Interested Auburn undergraduate students should contact the Physics Graduate Program Officer for more information.

4.1 Master's Programs

A Master of Science Degree in Physics is often required for entry level teaching positions in junior colleges and for many research-related positions at government and industrial laboratories. For students who are planning a teaching career or who are on their way to a Ph.D., the M.S. with the non-thesis option is recommended. It requires about two years of coursework and provides an excellent grounding in fundamental physics at the advanced level. Thirty (30) credit hours of coursework are required for the M.S. degree as listed below:

M.S. Required Courses	
Courses	Total Hrs
Core Courses	18
Colloquium	3
Electives	9
Total	30

Table 3: M.S. Course requirements. For the M.S. Thesis option, 4-6 credit hours of Research and Thesis (PHYS 7990) replace elective credits.

Advisory Committee

The Master's candidate works under the direction of an advisory committee through the completion of their M.S. degree. For a Non-Thesis M.S. degree, which is the most common path in Physics, only a major professor (often the GPO) is required. For a Thesis M.S. degree, the advisory committee is composed of three members recommended by the Graduate Program Officer in collaboration with the major professor (committee chair) and Department Chair. Two must be members of the Auburn University graduate faculty. The committee chair (or one of the co-chairs) must be a graduate faculty member in the Department of Physics. This committee will approve the student's program of study, conduct required examinations and direct the required field project or thesis. The names of the committee member(s) are submitted to the Graduate School by filing a Committee Selection Form available at

Committee Selection Form:
https://gradforms.auburn.edu/forms/CommitteeSelection.aspx

M.S. Non-Thesis Option

At least nine (9) credit hours of 6000-, 7000-, or 8000-level physics courses may be applied as electives to complete the required 30 credit hours. Up to three (3) credit hours of Independent Study in Physics (PHYS7900) and Independent Study in Advanced Physics (PHYS8900) can be included as allowed electives. Requests for substituting one physics elective course with a graduate level course from other Auburn University departments should be made to the GPO. In addition to the Graduate School requirement of a minimum 3.0 cumulative GPA in all graduate level course, a student must further achieve a minimum 2.8 GPA in the six physics graduate core courses (total 18 credit hours) to receive a non-thesis or accelerated M.S. degree. Students may re-take one or more core courses in order to improve their GPA, but no substitutions to any of the six core courses are allowed. A student who has a 3.0 and above cumulative graduate GPA, yet does not achieve the 2.8 GPA requirement in the six core courses might still be awarded a non-thesis or accelerated M.S. degree if he/she takes the GDE and achieves a qualifying score on each of the four parts of the GDE.

It is expected that a student will complete the non-thesis option within two years of entering the graduate program. In rare cases, extensions may be granted following a request in writing submitted to the Graduate Program Officer and Department Chair.

M.S. Thesis Option

A student must conduct a thesis research project under the guidance of a major professor and Research Committee, and successfully defend his/her thesis. A Master's thesis fully details the research performed under the direction of the major professor, and must be approved by the advisory committee before graduation. Four to six (4-6) credit hours of Research and Thesis (PHYS 7990) are required for the thesis option. The rest of the required thirty (30) credit hours may be fulfilled with graduate level physics electives or substituting non-physics courses approved by the GPO. PHYS 7900 or PHYS 8900 are not counted as

the allowed electives for the thesis option. This is no minimum core-course GPA requirement for the thesis option.

It is expected that a student will complete the thesis option within three years of entering the graduate program. In rare cases, extensions may be granted following a request in writing submitted to the Graduate Program Officer and Department Chair.
The steps for completing a Physics M.S. with Thesis include:

1. Establish an advisory committee through the Department Chair and Graduate Program Officer
2. Request a graduation application through AU Access no later than mid-term of the semester prior to the semester of graduation.
3. Arrange for a final oral examination. For students proceeding to the Ph.D. program, this examination may also serve as the General Oral Examination (see Ph.D. Program below).

Detailed instructions for can be found at the Graduate School Webpage.

4.2 Ph.D. Program

There are two primary stages pursuing a Ph.D. degree. First is the mastery of the basic principles of physics and the development of a broad understanding of all the major areas of physics. This is normally acquired through coursework and demonstrated by passing the General Doctoral Examination (GDE). Second is the performance of original research in a specialized area of physics that culminates in the successful defense of a Ph.D. dissertation.

Course Requirements for the Ph.D. Degree

Sixty (60) credit hours of coursework beyond a Bachelor's degree are required for a Ph.D. degree as listed below:

Ph.D. Required Courses	
Courses	Total Hrs
Core Courses	18
Graded Courses at 8000-level	9
Graded Elective	3
Colloquium	6
Research and Dissertation (PHYS 8990)	10
Additional Approved Electives (graded or ungraded)	14
Total	60

Table 4: Ph.D. Course requirements.

In summary, of the 60 required credit hours, 30 must be graded coursework with at least 9 being at the 8000-level. Ten (10) credit hours of Research and Dissertation (PHYS8990)

are required. Table 5 lists some of the additional courses that are typically offered to meet the additional graded course requirements.

Additional Courses Offered	
Course #	Course Title
PHYS 6100	Applications of Quantum Mechanics
PHYS 6500	Fundamentals of Physics
PHYS 6600	Frontiers of Physics
PHYS 6610	Introduction to Solid State Physics
PHYS 6620	Survey of Plasma Physics
PHYS 7520	Nonlinear Dynamics
PHYS 7540	Nonlinear Statistical Mechanics
PHYS 8100	Relativistic Quantum Mechanics
PHYS 8200	Introduction to Atomic Physics
PHYS 8600	Plasma Physics
PHYS 8700	Solid State Physics
PHYS 8970	Special Topics in Advanced Physics

Table 5: Examples of additional graduate courses, typically taught on a 2 year cycle.

Summary of steps to a Ph.D. from Auburn Physics

There are a number of necessary steps to obtain a Ph.D. in physics from Auburn University, required by the Department of Physics, the Auburn University Graduate School, or both. Below is an outline of those steps, along with some useful links. Note that some of these steps happen concurrently (e.g. as the student takes required courses). The Graduate School also has a useful checklist.
(http://graduate.auburn.edu/current-students/doctoral-completion-checklist/)

1. Meet requirements for admission to Ph.D. Candidacy (first 2-3 years)
   (a) Perform at a satisfactory level in all six physics graduate core courses.
   (b) Pass General Doctoral Examination.
   (c) Determine major professor and form Research Committee.
   (d) Student files Application for General Oral Exam with Graduate School.
   (e) Student passes General Oral Exam. The timing and nature of this exam will be determined by the student's research committee (see below).
   (f) Major Professor files Report of General Oral Exam with Graduate School.
   (g) Student obtains M.S. degree or meets equivalent requirements. We encourage graduate students to accept MS degree, but it is not required.
2. Perform independent dissertation research guided by major professor and research committee.

3. Complete remaining required coursework.
4. Request graduation check in the Graduate School no later than the last day of the semester (graduation day) prior to the semester of graduation.
5. Write a research dissertation using the electronic dissertation guide provided by the Graduate School.
6. Submit Graduate Application through AU Access.
7. Submit signed First Submission Approval Form to the Graduate School.
8. Submit PDF of your dissertation to doctoral@auburn.edu for Format Check.
9. When notified by the Graduate School, complete your Application for Final Oral Exam using the link that will be emailed to you.
10. Student completes final oral exam (dissertation defense). Once completed, submit the signed Report on Final Oral Examination to the Graduate School. Important: All committee members including the University Reader MUST be present at the Defense.
11. Submit signed Electronic Thesis/Dissertation Final Approval Form to the Graduate School.

Students admitted to PhD candidacy (including passing the GDE, forming dissertation committee, passing Oral exam, and maintaining good academic standing) are eligible for a stipend increase to begin at the beginning of the next full Fall/Spring semester. The current stipend increase is $1000/year. To apply for this stipend increase, please send a copy of submitted Report on General Oral Exam to Mary Prater and the Graduate Program Officer.

General Doctoral Examination

The General Doctoral Examination (GDE) is given once a year at the beginning of the Fall semester. It consists of four written exams on Classical Mechanics, Statistical Mechanics, Quantum Mechanics, and Electricity & Magnetism. The student is expected to demonstrate the ability to solve complex physics problems at the advanced undergraduate level and the graduate level covered by the four core physics courses (PHYS 7100, PHYS 7200, PHYS 7300, and PHYS 7400). Each subject exam consists of five problems, and students are free to choose to work on any four out of the five problems. Only four of the five problems will be graded, or counted for the grade.

After the written examination has been graded, a meeting of the graduate faculty will be held to decide whether the student's performance on each of the four exams is "Satisfactory" or "Unsatisfactory". Students must receive "Satisfactory" grades on all four exams in order to pass the GDE. Students who do not pass the GDE on the first attempt will be given a second examination within three to six months of the first examination, typically at the beginning of the following Spring semester. At the second examination, students will be required to retake only those subject exams with "Unsatisfactory" grades from the first examination.

After the second examination, the graduate faculty will again meet to decide whether the student's performance on the individual subject exams is "Satisfactory" or "Unsatisfactory". Students who do not pass the GDE after the second examination will not be admitted to candidacy for the Ph.D. degree.

Students are encouraged to attempt the GDE as soon as they have finished taking the first four core graduate physics courses (the courses labeled with * in table 1), whose contents are covered in the GDE. Students who enter with a Bachelor's or a Master's degree in physics are expected to take the GDE no later than the beginning of their second year of study. Under special circumstances, a student may apply for a one-year postponement of the GDE; this request must be approved by the Chair of the Department.

The Chair of the GDE committee is in charge of communication with the graduate students on the topics related to the GDE. A call for registration for the coming Fall GDE is usually issued to all pre-GDE Ph.D. students at the end of spring semester or the beginning of summer semester each year. The exact exam schedule will be announced at least two weeks in advance of each examination period.

Research Committee

Once a student passes the GDE and successfully finds a research advisor (major professor), a Research Committee will be formed by the student and major professor, with approval of the Department Chair. The Research Committee is responsible for developing the student's Plan of Study and conducting the General Oral and Final Oral Examinations. The AU Graduate School requires that the Research Committee consist of at least four members of the Auburn University Graduate Faculty. The major professor must be a member of the Department of Physics. The major professor and at least two additional faculty members must also be members of the university graduate faculty at Level 2.

As a general guideline, the committee should include members from the Ph.D. student's chosen subfield along with at least one member outside the chosen subfield in order to assess the breadth of the dissertation work. Additional voting members may be appointed to the committee including non-Auburn University faculty who hold the terminal degree in the field. The formal appointment of the research committee occurs when the committee selection form is approved by the Graduate School as well as the Graduate Program Officer and/or Department Chair.

The Research Committee will be responsible for the following:

1. Give an Oral Examination in a format of their choosing following successful completion of the GDE (generally as soon as possible). Possible examples include presentation of student's previous work, a literature review in the relevant field, and/or a dissertation proposal. This is an opportunity for the committee to get to know the student and begin the student's research career with clear expectations.

2. Provide annual feedback to both the student and GPO of progress towards a degree. This reporting serves as an important oversight mechanism for both the student and major professor to ensure that the student is making adequate progress towards a degree. Brief annual reports noting satisfactory or unsatisfactory progress should be filed with the Graduate Program officer by the end of Summer term each year so that the GPO can in turn file an annual report with the graduate school in early Fall.

3. Give a final oral examination (dissertation defense) during the student's final semester. Because the committee has met at least annually with the student, they can fully appreciate and assess the student's research efforts presented in this final defense.

Details of Oral Examination content, timeline and the student's research path will vary to some extent based upon physics sub-field and whether the student is pursuing an experimental or theory degree. These details will be determined by the major professor in consultation with the Research Committee.

5 Additional Information

5.1 Annual Evaluations

Annual evaluations of all graduate students are reported to the AU Graduate School. Monitoring the academic progress of graduate students and Graduate Teaching Assistants (GTAs) on a regular basis is critical to their success and to the success of Auburn's graduate programs. Evaluation reports are due to the Graduate School early in the Fall term each year and will be coordinated by the GPO. Evaluations will be determined by either the Undergraduate Laboratory Coordinator (for pre-GDE TA's), or by the student's Research Committee through an annual report submitted to the GPO. Reports of Satisfactory or Unsatisfactory will be submitted to the GPO by the end of the academic summer term every year.

At any stage of graduate study, if a physics graduate student is placed on Academic Probation (GPA < 3.0) or Academic Suspension (GPA <3.0 after probation period) by the Graduate School, he/she will need to meet with the Department Chair, Graduate Program Officer and their research advisor. In the case of Suspension, a Remediation Plan must be filed with the Graduate School. All reappointments as a GTA or GRA are contingent upon the student making adequate progress toward a degree.

5.2 Physics Graduate Course Catalogue

The full official course listing for the Department may be found in the Auburn Bulletin.

- PHYS 6100 APPLICATIONS OF QUANTUM MECHANICS (3). LEC. 3. Pr., PHYS 4100. Quantum mechanics applied to atomic physics, solid state physics, nuclear physics, particle physics, electrodynamics, and cosmology.
- PHYS 6500 FUNDAMENTALS OF PHYSICS (3). LEC. 3. Pr., departmental approval. A subject such as Wave Mechanics, Mathematical Physics, Nonlinear Dynamics, Optics, Nuclear Physics, Elementary Particles, Relativity, or Electrodynamics. Course may be repeated for a maximum of 12 credit hours.
- PHYS 6600 FRONTIERS OF PHYSICS (3). LEC. 3. Pr., PHYS 4100 or PHYS 3100 or departmental approval. A subject from the research areas in the Department such as Solid State, Atomic, Plasma, Space, or Computational Physics will be selected by the lecturer. Course may be repeated for a maximum of 9 credit hours.
- PHYS 6610 INTRODUCTION TO SOLID STATE PHYSICS (3). LEC. 3. Pr., PHYS 6100 or departmental approval. Lattice Vibrations, band desctiption of electronic states in metals, semiconductors and insulators, and magnetic, super-conducting and defect properties of solids.

- PHYS 6620 SURVEY OF PLASMA PHYSICS (3). LEC. 3. Pr., PHYS 3100 or departmental approval. Single particle motions: fluid description of a plasma; plasma waves and oscillations; kinetic description, diffusion, and resistivity; non-linear effects.
- PHYS 6900 PHYSICS TEACHING SEMINAR (1) LEC. 1. LAB. 0. SU. Graduate Students in Physics or Departmental Approval. Introduction to issues, resources and best practices related to the teaching of physics.
- PHYS 7100 CLASSICAL MECHANICS (3). LEC. 3. Legrangian and Hamiltonian formulations of mechanics, canconical transforms. Hamilton-Jacobi theories, action angle variables, rigid rotators, normal modes, and mechanics of continuous media.
- PHYSICS 7200 ELECTRICITY AND MAGNETISM I (3). LEC. 3. Electrostatics. special function expansions, magnetostatics, linear media and Maxwell's equations.
- PHYS 7250 ELECTRICITY AND MAGNETISM II (3). LEC. 3. Pr. PHYS 7200 or departmental approval. Time dependent Maxwell theory, wave propagation and dispersion, diffraction, scattering, radiation, relativistic covariance and applications.
- PHYS 7300 QUANTUM MECHANICS I (3). LEC. 3. Schrődinger wave equation, discrete and continuous spectra, matrix formulation, perturbation theory.
- PHYS 7350 QUANTUM MECHANICS II (3). LEC. 3.Pr., PHYS 7300 or departmental approval. Time-dependent approximation methods, relativistic wave equation, and second quantization.
- PHYS 7400 STATISTICAL PHYSICS (3). LEC. 3. Thermodynamic quantities, equilibrium ensambles for classical and quantum systems, fluctuations, phase transitions and critical phenomena.
- PHYS 7520 NONLINEAR DYNAMICS (3). LEC. 3. Pr., PHYS 7100 or departmental approval. Dynamical systems, maps, flows, fixed points and neighborhoods, chaos, fractals and fractal dimensions. Lyapunov exponents, strange attractors, dissipative and Hamiltonian systems, controlling chaos.
- PHYS 7540 NON-EQUILIBRIUM STATISTICAL MECHANICS (3). LEC. 3. Pr., PHYS 7400 or departmental approval. Introduces the fundamental concepts of non-equilibrium statistical mechanics, develops basic transport theories, and simulates statistic properties with Monte-Carlo and molecular dynamic methods.
- PHYS 7850 GRADUATE PHYSICS RESEARCH SEMINAR (1) LEC. 1. LAB. 0. SU. This course is designed to develop and expand incoming graduate student's knowledge and experience with state-of-the-art research as it is done in the Auburn University Department of Physics.
- PHYS 7900 INDEPENDENT STUDY IN PHYSICS (1-5). IND. SU. Pr., Student will work with a faculty member to study a topic of interest. Course may be repeated for a maximum of 6 credit hours.

- PHYS 7930 DIRECTED READING IN PHYSICS (1-5) IND. Pr., departmental approval. Student will work with a faculty member to study a topic of interest. Course may be repeated for a maximum of 6 credit hours.
- PHYS 7950 PHYSICS COLLOQUIUM (1) SEM. SU. Offers a series of talks presented by invited speakers on broad fields of physics. Check with graduate advisor for credit allowed. Course may be repeated for a maximum of 6 credit hours.
- PHYS 7970 SPECIAL TOPICS IN PHYSICS (1-5). SEM. Pr., departmental approval. Seminar or lecture series in a rapidly advancing specialty of physics. Course may be repeated for a maximum of 6 credit hours.
- PHYS 7990 RESEARCH AND THESIS(1-10). MST. TD. course may be repeated as often as is appropriate.
- PHYS 8100 RELATIVISTIC QUANTUM MECHANICS (3). LEC. 3. Pr., PHYS 7350 or departmental approval. Dirac equation, 1D barrier scattering, 3D central potentials, S-matrix theory, Feynman diagrams, quantum electrodynamics, renormalization, tree and loop level problems.
- PHYS 8200 INTRODUCTION TO ATOMIC PHYSICS (3). LEC. 3. PR., PHYS 7350 or departmental approval. Hydrogen atom Hartree-Fock theory, radiative transitions, photoionization, autoionization, electron-atom scattering.
- PHYS 8600 PLASMA PHYSICS (3). LEC. 3. Pr., PHYS 6620 or departmental approval. A detailed study of plasma physics including particle orbit theory, magnetohydrodynamics, plasma waves and transport phenomena.
- PHYS 8700 SOLID STATE PHYSICS (3). LEC. 3. Pr., PHYS 6610 or departmental approval. Atomic and electronic structures of solids and the associated electrical, optical and transport properties.
- PHYS 8970 Special Topics in Advanced Physics