MASTER OF SCIENCE (M.S.) MAJOR IN PHYSICS (THEESIS OPTION)

A solid physics foundation combined with extensive, hands-on training in state-of-the art nanofabrication and characterization facilities prepares students for careers in the local high-tech industry, science education or advanced studies. Students are engaged in research and gain superior graduate education with individual faculty attention and mentoring.

Application Requirements

The items listed below are required for admission consideration for applicable semesters of entry during the current academic year. Submission instructions, additional details, and changes to admission requirements for semesters other than the current academic year can be found on The Graduate College's website (http://www.gradcollege.txstate.edu). International students should review the International Admission Documents webpage (http://mycatalog.txstate.edu/graduate/admission-documents/international) for additional requirements.

- completed online ApplyTexas application
- $40 nonrefundable application fee
- $50 nonrefundable international evaluation fee (if applicable)
- baccalaureate degree from a regionally accredited university
- official transcripts required from each four-year institution where course credit was granted
- minimum 2.75 GPA in your last 60 hours of undergraduate course work (plus any completed graduate courses)
- minimum 3.0 GPA in junior and senior level physics courses in modern physics, mathematical physics or equivalent, classical mechanics, electromagnetic field theory, and quantum mechanics*
- official GRE scores not required*
- resume/CV
- statement of purpose
- three letters of recommendation

TOEFL or IELTS Scores

Non-native English speakers who do not qualify for an English proficiency waiver:

- official TOEFL iBT scores required with a 78 overall
- official IELTS (academic) scores required with a 6.5 overall and
  - minimum individual module scores of 6.0

This program does not offer admission if the scores above are not met.

*Additional Information

If your physics GPA falls below the minimum requirement of 3.0, please submit the following:

- official GRE scores with a preferred minimum of 302 (verbal and quantitative sections combined)

Degree Requirements

The Master of Science (M.S.) degree with a major in Physics requires 30 semester credit hours, including a thesis. Students who do not have the appropriate background course work may be required to complete leveling courses.

Course Requirements

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>PHYS 5312</td>
<td>ADVANCED QUANTUM MECHANICS</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5313</td>
<td>Mathematical Methods of Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5314</td>
<td>Statistical Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5331</td>
<td>Electromagnetic Field Theory</td>
<td>3</td>
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Electives

Choose 9 hours from the following:

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<tr>
<th>Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>PHYS 5110</td>
<td>Seminar in Physics</td>
</tr>
<tr>
<td>PHYS 5195</td>
<td>Fundamentals of Research</td>
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<tr>
<td>PHYS 5295</td>
<td>Fundamentals of Research</td>
</tr>
<tr>
<td>PHYS 5320</td>
<td>Solid State Physics</td>
</tr>
<tr>
<td>PHYS 5322</td>
<td>Semiconductor Device Microfabrication</td>
</tr>
<tr>
<td>PHYS 5324</td>
<td>Thin Film Synthesis and Characterization Laboratory</td>
</tr>
<tr>
<td>PHYS 5326</td>
<td>Electrical Characterization of Materials and Devices</td>
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<tr>
<td>PHYS 5327</td>
<td>Semiconductor Device Physics</td>
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<tr>
<td>PHYS 5328</td>
<td>Advance Solid State Physics</td>
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<tr>
<td>PHYS 5329</td>
<td>Physics of Materials Degradation and Reliability</td>
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<tr>
<td>PHYS 5340</td>
<td>Advanced Dynamics</td>
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<tr>
<td>PHYS 5350A</td>
<td>Thin Film Photovoltaic Devices</td>
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<tr>
<td>PHYS 5350B</td>
<td>Relativity</td>
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<tr>
<td>PHYS 5350C</td>
<td>Characterization of Materials</td>
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<tr>
<td>PHYS 5350D</td>
<td>Cognitive Foundations of Physics Education Research</td>
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<td>PHYS 5404</td>
<td>Experimental Methods</td>
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<tr>
<td>PHYS 5370</td>
<td>Problems in Advanced Physics</td>
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<tr>
<td>PHYS 5395</td>
<td>Fundamentals of Research</td>
</tr>
<tr>
<td>PHYS 5398</td>
<td>Industry Internship</td>
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Free Electives

Choose 3 hours of advisor-approved electives

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<tr>
<th>Code</th>
<th>Title</th>
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<tr>
<td>PHYS 5399A</td>
<td>Thesis</td>
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Choose a minimum of 3 hours from the following:

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<tr>
<td>PHYS 5199B</td>
<td>Thesis</td>
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<tr>
<td>PHYS 5299B</td>
<td>Thesis</td>
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<td>PHYS 5599B</td>
<td>Thesis</td>
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<tr>
<td>PHYS 5999B</td>
<td>Thesis</td>
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Total Hours 30

Comprehensive Examination Requirements

All candidates for graduate degrees must pass one or more comprehensive examinations.

If a student elects to follow the thesis option for the degree, a committee to direct the written thesis will be established. The thesis must
demonstrate the student’s capability for research and independent thought. Preparation of the thesis must be in conformity with the Graduate College Guide to Preparing and Submitting a Thesis or Dissertation.

**Thesis Proposal**

The student must submit an official Thesis Proposal Form from the Graduate College website before proceeding with research on the thesis. If the thesis research involves human subjects, the student must obtain exemption or approval from the Texas State Institutional Review Board. The IRB approval letter should be included with the proposal form. If the thesis research involves vertebrate animals, the proposal form must include the Texas State IACUC approval code. It is recommended that the thesis proposal form be submitted to the dean of The Graduate College by the end of the student’s enrollment in 5399A. Failure to submit the thesis proposal in a timely fashion may result in delayed graduation.

**Thesis Committee**

The thesis committee must be composed of a minimum of three approved graduate faculty members.

**Thesis Enrollment and Credit**

The completion of a minimum of six hours of thesis enrollment is required. For a student’s initial thesis course enrollment, the student will need to register for thesis course number 5399A. After that, the student will enroll in thesis B courses, in each subsequent semester until the thesis is defended with the department and approved by The Graduate College. Preliminary discussions regarding the selection of a topic and assignment to a research supervisor will not require enrollment for the thesis course.

Students must be enrolled in thesis credits if they are receiving supervision and/or are using university resources related to their thesis work. The number of thesis credit hours students enroll in must reflect the amount of work being done on the thesis that semester. It is the responsibility of the committee chair to ensure that students are making adequate progress toward their degree throughout the thesis process. Failure to register for the thesis course during a term in which supervision is received may result in postponement of graduation. After initial enrollment in 5399A, the student will continue to enroll in a thesis B course as long as it takes to complete the thesis. Thesis projects are by definition original and individualized projects. As such, depending on the topic, methodology, and other factors, some projects may take longer than others to complete. If the thesis requires work beyond the minimum number of thesis credits needed for the degree, the student may enroll in additional thesis credits at the committee chair’s discretion. In the rare case when a student has not previously enrolled in thesis and plans to work on and complete the thesis in one term, the student will enroll in both 5399A and 5399B.

The only grades assigned for thesis courses are PR (progress), CR (credit), W (withdraw), and F (failing). If acceptable progress is not being made in a thesis course, the instructor may issue a grade of F. If the student is making acceptable progress, a grade of PR is assigned until the thesis is completed. The minimum number of hours of thesis credit (“CR”) will be awarded only after the thesis has been both approved by The Graduate College and released to Alkek Library.

A student who has selected the thesis option must be registered for the thesis course during the term or Summer I (during the summer, the thesis course runs ten weeks for both sessions) in which the degree will be conferred.

**Thesis Deadlines and Approval Process**

Thesis deadlines are posted on The Graduate College website. The completed thesis must be submitted to the chair of the thesis committee on or before the deadlines listed on The Graduate College website. The following must be submitted to The Graduate College by the thesis deadline listed on The Graduate College website:

1. The Thesis Submission Approval Form bearing original (wet) and/or electronic signatures of the student and all committee members.
2. One (1) PDF of the thesis in final form, approved by all committee members, uploaded in the online Vireo submission system.

After the dean of The Graduate College approves the thesis, Alkek Library will harvest the document from the Vireo submission system for publishing in the Digital Collections database (according to the student’s embargo selection). NOTE: MFA Creative Writing theses will have a permanent embargo and will never be published to Digital Collections.

While original (wet) signatures are preferred, there may be situations as determined by the chair of the committee in which obtaining original signatures is inefficient or has the potential to delay the student’s progress. In those situations, the following methods of signing are acceptable:

- signing and faxing the form
- signing, scanning, and emailing the form
- notifying the department in an email from their university’s or institution’s email account that the committee chair can sign the form on their behalf
- electronically signing the form using the university’s licensed signature platform.

If this process results in more than one document with signatures, all documents need to be submitted to The Graduate College together.

No copies are required to be submitted to Alkek Library. However, the library will bind copies submitted that the student wants bound for personal use. Personal copies are not required to be printed on archival quality paper. The student will take the personal copies to Alkek Library and pay the binding fee for personal copies.

Master’s level courses in Physics: PHYS
## Courses Offered

### Physics (PHYS)

#### PHYS 1110. Elementary Physics Laboratory.
This course explores and illustrates some of the basic principles covered in PHYS 1310 and PHYS 1320. This lab should be taken as the second of two courses, PHYS 1310 and PHYS 1320.

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<td>TCCN: PHYS 1105</td>
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#### PHYS 1115. General Physics I Laboratory.
First of two laboratory courses in General Physics for science-related majors. Course introduces students to the basics of measurement. Topics cover mechanics and heat. Prerequisite or Corequisite: PHYS 1315.

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#### PHYS 1125. General Physics II Laboratory.
Second of two laboratory courses in general Physics. Course introduces the students to experimental measurements and demonstration of principles of electricity, magnetism, optics, modern physics, electromagnetic waves.

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#### PHYS 1140. Introductory Laboratory in Astronomy.
An introduction to the constellations, the uses of telescopes, and other material relating to the study of stars and planets. This course is designed to be taken with PHYS 1340 or PHYS 1350 or those students desiring a laboratory course.

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#### PHYS 1310. Elementary Physics.
A non-mathematical survey of mechanics, properties of matter, heat and sound. These topics are described in a conceptual way with applications relating to the world around us. The laboratory experience may be obtained in a separate one-hour credit lab (PHYS 1110). PHYS 1310 and PHYS 1320 are designed for the liberal arts student. The order in which they are taken is not important. They are not recommended for pre-engineering students or majors and minors in science. The laboratory experience is recommended with the second course.

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<td>TCCN: PHYS 1305</td>
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#### PHYS 1315. General Physics I.
The first course in a two semester sequence which is a survey of the basic laws and principles of physics and includes the topics of mechanics and heat. Designed for students whose program requires technical physics, but who are not pre-engineering students or majors or minors in physics. Credit for both (PHYS 1315 and PHYS 1115) and PHYS 1430 cannot be given. Prerequisite: MATH 1315 with a grade of "C" or higher. Prerequisite or Corequisite: PHYS 1115. MATH 1317 is recommended.

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<td>TCCN: PHYS 1301</td>
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#### PHYS 1320. Elementary Physics.
A non-mathematical survey of electricity, magnetism, light, relativity, and atomic and nuclear physics. These topics are described in a conceptual way with applications relating to the world around us. The laboratory experience may be obtained in a separate one-hour credit lab (PHYS 1110). PHYS 1310 and PHYS 1320 are designed for the liberal arts student. The order in which they are taken is not important. They are not recommended for pre-engineering students or majors and minors in science. The laboratory experience is recommended with the second course.

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<td>TCCN: PHYS 1302</td>
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#### PHYS 1325. General Physics II.
Second course in a two semester sequence which is a survey of the basic laws and principles of physics and includes the topics of waves, light, electricity and magnetism. Designed for students whose program requires technical physics, but who are not pre-engineering students or majors or minors in physics. Prerequisites: PHYS 1315 and MATH 1315 with a grade of "C" or higher. MATH 1317 and concurrent enrollment in PHYS 1125 are recommended.

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A study of the solar system. Topics included are a study of the sun, the planets and their satellites, the comets, and other components of the solar system. Some aspects of telescopes and ancient astronomy will be included also.

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PHYS 1350. Astronomy: Stars and Galaxies.
A study of the universe beyond the solar system. Topics included are a study of the stars and star clusters, nebulae, galaxies, and an introduction to some aspects of cosmology.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Life & Phys Sciences Core 030
Grade Mode: Standard Letter
TCCN: PHYS 1311

This studio-style course introduces physics concepts through active exploration and discussion of physical phenomena. Course content includes developing concepts of electricity, magnetism, and energy, and research on physics learning. Focus is on how physics helps make sense of everyday experience. It’s the first in a sequence of two courses.

3 Credit Hours. 4 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Life & Phys Sciences Core 030
Grade Mode: Standard Letter

PHYS 1370. Development of Concepts in Physics II.
This studio-style course introduces physics concepts through active exploration and discussion of physical phenomena. Course content includes concepts of force, motion, waves, light, and matter, and research on physics learning. Focus is on how physics helps make sense of everyday experience. It’s the second in a sequence of two courses. Prerequisite: PHYS 1360.

3 Credit Hours. 4 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Life & Phys Sciences Core 030
Grade Mode: Standard Letter

This course covers the principles of classical mechanics through problem solving and laboratory investigations. PHYS 1430, PHYS 2425, and PHYS 2435 are designed for students majoring and minoring in physics and/or other disciplines within the college of science and engineering. Credit for both (PHYS 1315 and PHYS 1115) and PHYS 1430 cannot be given. Pre or Co-requisite: MATH 2471 with a "C" or better or concurrent enrollment in MATH 2471.

4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.
Course Attribute(s): Life & Phys Sciences Core 030|Lab Required
Grade Mode: Standard Letter
TCCN: PHYS 2425

PHYS 2425. Electricity and Magnetism.
This course is a study of the field of electricity and magnetism for physics majors and minors. PHYS 1430, PHYS 2425, and PHYS 2435 are designed for those students majoring in physics and for pre-engineering students. Credit in both PHYS 1325 and PHYS 1125 and PHYS 2425 cannot be given. Prerequisites: PHYS 1430 and MATH 2472, all with a grade of "C" or better.

4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.
Course Attribute(s): Life & Phys Sciences Core 030|Lab Required
Grade Mode: Standard Letter
TCCN: PHYS 2426

PHYS 2427. Waves and Heat.
This course is a study of the fields of wave motion, sound, light, and heat at a beginning level for physics majors and minors. Prerequisites: PHYS 1430 and MATH 2471 with grades of "C" or better. Co-requisite: MATH 2472.

4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.
Course Attribute(s): Lab Required
Grade Mode: Standard Letter

PHYS 33210. Physics Cognition and Pedagogy.
This course is an introduction to physics-specific pedagogy and the methods and results of physics education research (PER). Students will investigate relevant literature in PER and cognitive science, engage in discussions about physics teaching and learning, and reflect on their own teaching practice in the role of Physics Learning Assistants. (WI).

2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Writing Intensive
Grade Mode: Standard Letter

PHYS 3311. Mechanics I.
This course discusses the fundamentals of classical mechanics focusing on the physical description of the behavior of single and multiple particle systems. Topics included are advanced problem solving strategies for systems with position and velocity dependent forces, simple harmonic oscillators, and non-inertial reference frames. Prerequisite: PHYS 2435 with a "C" or better. Co-requisite: PHYS 3320.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 3312. Modern Physics.
This course is an introduction to the foundations of modern physics, including the following topics: relativistic mechanics, kinetic theory of matter, quantization of charge, light and energy, the atom, wave nature of particles, and the Schroedinger equation. Prerequisite: PHYS 2435 with a "C" or better. PHYS 2425 with a grade of "C" or better, or concurrent enrollment allowed.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter
PHYS 3313. Astrophysics.
This course surveys a variety of issues in astrophysics through problem solving, quantitative measurements, and theoretical reasoning. Topics include celestial mechanics, stellar dynamics and evolution, galaxy evolution, and cosmology. Corequisite: PHYS 3312 with a grade of "D" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 3315. Thermodynamics.
This course is a fundamental study of thermodynamics and statistical mechanics. Prerequisites: MATH 3323 and PHYS 2435 or PHYS 1325 and PHYS 1125 or PHYS 2425 and ENGR 2300, all with a grade of "D" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 3320. Introduction to Mathematical Physics.
An introduction to the mathematical methods of theoretical physics with emphasis on the vectorial-functional approach emphasized in current research literature. Applications will be made to certain fundamental problems of mechanics and electromagnetic field theory. Prerequisites: PHYS 2425 with a grade of "C" or better; PHYS 3323 with grades of "C" or better; or concurrent enrollment.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 3411. Advanced Physics Laboratory.
Experiments in modern physics, with emphasis on demonstrating quantum effects and introducing nuclear physics. Prerequisites: PHYS 2425 with a grade of "C" or better; PHYS 3312 with a grade of "C" or better, or concurrent enrollment. (WI).
4 Credit Hours. 2 Lecture Contact Hours. 6 Lab Contact Hours.
Course Attribute(s): Lab Required|Writing Intensive
Grade Mode: Standard Letter

This Laboratory/lecture course is an introduction to electronic test bench methods for the construction, operation and analysis of important DC/AC circuits utilizing resistors, capacitors, diodes, BJTs, FETs, and OpAmps. The behavior of the circuits will be modeled in SPICE. Elementary semiconductor device physics and microfabrication methods will be discussed. Prerequisites: PHYS 2425 and PHYS 2435, all with a grade of "C" or better. (WI).
4 Credit Hours. 3 Lecture Contact Hours. 4 Lab Contact Hours.
Course Attribute(s): Lab Required|Writing Intensive
Grade Mode: Standard Letter

PHYS 4121. Undergraduate Research.
This course represents a student's research project in physics to be carried out under the supervision of a faculty member. The student must contact a faculty member in advance to arrange the topic and specific course objectives. This course may be repeated for credit. Instructor's approval required.
1 Credit Hour. 0 Lecture Contact Hours. 3 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 4150A. Physics Cognition and Pedagogy Lab.
In this lab course, students will apply principles introduced in PHYS 3210, which include observation of student interactions, reflection on the process of learning and the use of evidence based reasoning, metacognition, and facilitation, of discourse around difficult concepts. Co-requisite: PHYS 3210. Prerequisite: PHYS 1430 with grade of "C" or better, or Instructor approval.
1 Credit Hour. 0 Lecture Contact Hours. 4 Lab Contact Hours.
Course Attribute(s): Topics
Grade Mode: Standard Letter

PHYS 4150B. Computational Modeling Lab: Mechanics.
This lab provides experience in computational modeling of problems in classical mechanics. Students design and code computer programs to simulate physical dynamics and analyze data. Co-requisite: PHYS 3311. Prerequisite: PHYS 3310. Corequisite: PHYS 3320 and MATH 3323, all with a grade of "C" or better.
1 Credit Hour. 0 Lecture Contact Hours. 4 Lab Contact Hours.
Course Attribute(s): Topics
Grade Mode: Standard Letter

PHYS 4221. Undergraduate Research.
This course represents a student's research project in physics to be carried out under the supervision of a faculty member. The student must contact a faculty member in advance to arrange the topic and specific course objectives. This course may be repeated for credit. Instructor's approval required.
2 Credit Hours. 0 Lecture Contact Hours. 6 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 4305. Statistical Physics.
This course will examine the physics that describes the equilibrium thermal properties of systems. Statistical physics explains the microscopic properties of systems that give rise to their measureable macroscopic behavior. This includes thermodynamic properties, transport processes, fluctuations from equilibrium, phase transitions and critical phenomena, and quantum fluids. Prerequisites: PHYS 3312 and MATH 3323, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 4310. Electromagnetic Field Theory I.
An introduction to the electromagnetic field theory of classical physics for static fields. Topics included will be the electrostatic field, polarization and dielectrics, electrostatic energy, magnetic field of steady currents, magneto static energy, and magnetic properties of matter. Prerequisites: MATH 3323 and MATH 3373 and PHYS 3320, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter
Application of physics principles to solid materials. Topics include crystal structure and the reciprocal lattice, including x-ray diffraction, crystal binding and elastic properties, lattice vibrations, energy bands, semiconductors and metals. Prerequisites: PHYS 3312 and PHYS 3320, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 4312. Quantum Mechanics I.
An introductory course in quantum mechanics. Topics include mathematical foundations, fundamental postulates, time development, and one dimensional problems. Prerequisites: MATH 3323 and PHYS 3312 and PHYS 3320, all with a grade of "C" or better; and six additional hours of advanced physics.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 4313. Quantum Mechanics II.
An advanced course in quantum mechanics intended as an elective for students intending to pursue graduate study in physics. Topics include angular momentum, three dimensional problems, matrix mechanics, and perturbation theory. Prerequisite: PHYS 4312 with a "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 4314. Mechanics II.
Fundamentals of Classical Mechanics focusing on the physical description of the behavior of single and multiple particle systems. Topics include central force motion, rigid body rotation, and coupled oscillations. This course is intended as an elective for students intending to pursue graduate study in physics. Prerequisites: PHYS 3311 and MATH 3323, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 4315. Electromagnetic Field Theory II.
An introduction to the electromagnetic field theory of classical physics for time varying fields. Topics included will be electromagnetic induction, time varying electric and magnetic fields, Maxwell's equations, electromagnetic energy, electromagnetic waves and radiation, and a brief introduction to some specialized topics. Prerequisite: PHYS 4310 with a "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 4317. Computational Physics.
Introduction to computational techniques for problem-solving and research beyond the standard techniques of most physics courses. Numerical, symbolic, and simulation methods applied to modern physics using advanced mathematical software and a high level programming language. Prerequisites: PHYS 3320 with a grade of "D" or better and six additional hours of advanced physics or instructor approval.
3 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.
Course Attribute(s): Writing Intensive
Grade Mode: Standard Letter

PHYS 4320. Selected Study in Physics.
Topics are chosen in theoretical and experimental areas of current interest in physics with specific topic to be discussed agreed upon prior to registration. May be repeated once with different emphasis and professor for additional credit. Prerequisite: Instructor approval.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 4321. Undergraduate Research.
A research project in physics to be carried out under the supervision of a faculty member by upper division physics majors. Student must contact a faculty member in advance to arrange topic and specific course objective. Course may be repeated only as an elective towards the BS or BA in physics. Prerequisite: Instructor approval.
3 Credit Hours. 0 Lecture Contact Hours. 9 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 4340. Materials Physics Laboratory.
A laboratory based course introducing a broad array of materials synthesis and characterization methods. The specific subjects will be coordinated with topics of current interest in the literature and will be chosen by mutual consent of the student and faculty advisor. Prerequisites: PHYS 3416 and PHYS 3411 and PHYS 4311, all with a grade of "D" or better. (WI).
3 Credit Hours. 0 Lecture Contact Hours. 9 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Writing Intensive

PHYS 4350A. Thin Film Photovoltaic Devices.
This course is a survey of the Physics of photovoltaic devices with emphasis on device physics including the photovoltaic effect, photon absorption, electrons and holes, generation and recombination, the pn-junction, charge separation, monocrystalline solar cells, thin film solar cells, and losses. Prerequisites: PHYS 2425 and PHYS 2435, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Writing Intensive

PHYS 4350B. Relativity.
This course includes a review of Special Relativity, an introduction to the mathematics of tensor calculus and differential geometry, and such topics from General Relativity as the Schwarzschild solution and black holes, tests of General Relativity, cosmological models, and applications of relativity in the Global Positioning System (GPS). Prerequisites: PHYS 2425 and PHYS 2435, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter
PHYS 4350D. Biophysics.
This course applies the principles of physics to the study of living organisms. An emphasis will be placed on the topics of structure, fluids, diffusion, entropy, stochastic processes, and probabilities, and on scientific modes of thinking including modeling, estimation, and data analysis. Prerequisite: PHYS 1430, PHYS 2425, and PHYS 2435, all with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing|Topics
Grade Mode: Standard Letter

PHYS 4360. Physics Cognition and Pedagogy II.
This course addresses historical, philosophical, and cognitive perspectives on the learning, teaching, and discovery of physics, including results from contemporary research on learning. It is recommended for students pursuing teacher certification. Prerequisites: PHYS 3210 and PHYS 3312 with a grade of "C" or better.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5100. Professional Development.
This course covers topics related to teaching, research, and employment responsibilities. The completion of this course is required as a condition of employment for graduate assistants. This course does not earn graduate degree credit. Course is repeatable with different emphasis.
1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing|Graduate Assistantship|Exclude from Graduate GPA
Grade Mode: Leveling/Assistantships

PHYS 5110. Seminar in Physics.
A course designed to acquaint the graduate student with current research areas in physics. May be repeated twice for total of three semester hour's credit.
1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5195. Fundamentals of Research.
This course is designed to acquaint the graduate student with materials and methods of physics research. It is open to graduate students on an individual basis by arrangement with the department of Physics. This course may be repeated with prior approval of the department. Instructor's approval required.
1 Credit Hour. 0 Lecture Contact Hours. 3 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5199B. Thesis.
This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.
1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit

PHYS 5200. Professional Development.
This course covers topics related to teaching, research, and employment rights and responsibilities. It provides a brief background on teaching and learning theories and consists of organized practice teaching. Completion is required as a condition of employment for graduate instructional and teaching assistants. This course does not earn graduate degree credit.
2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Graduate Assistantship|Exclude from Graduate GPA
Grade Mode: Leveling/Assistantships

PHYS 5295. Fundamentals of Research.
This course is designed to acquaint the graduate student with materials and methods of physics research. It is open to graduate students on an individual basis by arrangement with the department of Physics. This course may be repeated with prior approval of the department. Instructor's approval required.
2 Credit Hours. 0 Lecture Contact Hours. 6 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5299B. Thesis.
This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.
2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit

This course discusses the fundamentals of classical mechanics focusing on the physical description of the behavior of single and multiple particle systems. This course does not earn graduate degree credit.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from Graduate GPA
Grade Mode: Leveling/Assistantships

PHYS 5302. Electricity and Magnetism.
An introduction to the electromagnetic field theory of classical physics for static fields. Topics included will be the electrostatic field, polarization and dielectrics, electrostatic energy, magnetic field of steady currents, magneto static energy, and magnetic properties of matter. This is a graduate leveling course in Electricity and Magnetism (stacked with PHYS 4310). This course does not earn graduate degree credit.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from Graduate GPA
Grade Mode: Leveling/Assistantships

PHYS 5303. Quantum Mechanics.
This course is an introduction to quantum mechanics. Topics include mathematical foundations, fundamental postulates, time development, and one dimensional problems. This is a graduate leveling course in Quantum Mechanics (stacked with PHYS 4312). This course does not earn graduate degree credit.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from Graduate GPA
Grade Mode: Leveling/Assistantships
PHYS 5312. Advanced Quantum Mechanics.
This course is a study of quantum mechanics including combination of two or more quantum mechanical systems, addition of angular momentum, time independent perturbation theory, and time dependent perturbation theory.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5313. Mathematical Methods of Physics.
This course is a survey of mathematical methods of physics at the graduate level focusing on complex analysis of analytic functions (Laurent expansions and evaluation of residues) and methods of solving both ordinary and partial differential equations (Frobenius’ method and Sturm-Liouville theory) with applications to mechanics and electromagnetic theory.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5314. Statistical Physics.
This course is an introduction to the laws of statistical physics and their application to realistic problems at the graduate level. The topics include a brief review of equilibrium thermodynamics, Gibbs distribution, Fermi-Dirac and Bose-Einstein statistics, derivation of Planck’s Law and black-body radiation, and heat capacity of solids.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

This is an introductory course at the graduate level intended for students who have not had a previous course in Solid State Physics. Topics covered include crystal structure, the reciprocal lattice, x-ray diffraction, lattice vibrations, electronic band structure, and optical, transport and magnetic properties of metals and semiconductors including applications. Prerequisite: PHYS 5312 with a grade of "C" or better.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5322. Semiconductor Device Microfabrication.
An in-depth overview of the physics and technology of semiconductor device micro and nano fabrication. Topics include materials used in electronic devices, thin film deposition, wet and dry etching, lithography processing, and topics relevant to semiconductor research and devices. Fabrication and characterization techniques will be covered. Prerequisite: PHYS 5404 or equivalent and Instructor’s approval required.

3 Credit Hours. 2 Lecture Contact Hours. 1 Lab Contact Hour.
Grade Mode: Standard Letter

PHYS 5324. Thin Film Synthesis and Characterization Laboratory.
Advanced experimental course designed as research group project experience with emphasis on nanoscale device fabrication. All projects are conducted in university facilities with state-of-the-art thin film growth, processing, and characterization facilities. Prerequisites: PHYS 5404 with grade of C or better or equivalent and Instructor’s permission required.

3 Credit Hours. 0 Lecture Contact Hours. 9 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5326. Electrical Characterization of Materials and Devices.
A laboratory/lecture course introducing electric characterization methods important to semiconductor materials and devices. Various measurement techniques and methods will be reviewed. Students will learn to work with industrial equipment. Prerequisite: PHYS 5404 or equivalent and Instructor’s approval required.

3 Credit Hours. 0 Lecture Contact Hours. 9 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5327. Semiconductor Device Physics.
The application of solid state physics for describing important examples of thin film device operation with a special emphasis on semiconductor devices. Additional topics may include photon and phonon effects on electronic properties, quantum phenomena, many body effects in solids, carrier transport properties, micro-electromechanical systems, and materials interface issues.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

Review of models of a solid and energy band theory. Additional topics may include interaction of electromagnetic waves with solids, lattice vibrations and phonons, many body effects in solids, device physics, quantum phenomena, carrier transport properties, current device configurations, and materials interface problems. Prerequisite: PHYS 5320.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

This course examines the material science of physical mechanisms governing the fundamental failure modes of materials, and particularly thin films. The application of materials physics characterization techniques for detecting the signatures of failure mechanisms will also be presented. Prerequisites: PHYS 5328.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5331. Electromagnetic Field Theory.
This course is an introduction to electrodynamics at the graduate level using rigorous mathematical formulation. Topics include methods of solving problems in electrostatics and magnetostatics, boundary value problems and Green’s Functions, fields in media, and Maxwell’s Equations and time varying fields.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5340. Advanced Dynamics.
Classical mechanics at an advanced level. Topics covered may include special relativity in classical mechanics, Hamilton equation of motion, canonical transformations, and Hamilton-Jacobi theory.

3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter
PHYS 5350A. Thin Film Photovoltaic Devices.
This course is a survey of the Physics of photovoltaic devices with emphasis on device physics including the photovoltaic effect, photon absorption, electrons and holes, generation and recombination, the pn-junction, charge separation, monocrystalline solar cells, thin film solar cells, and losses.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5350B. Relativity.
This course includes a review of Special Relativity, an introduction to the mathematics of tensor calculus and differential geometry, and such topics from General Relativity as the Schwarzschild solution and black holes, tests of General Relativity, cosmological models, and applications of relativity in the Global Positioning System (GPS).
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5350C. Characterization of Materials.
This course covers skills and knowledge required for microscopy methods including optical microscopy, scanning electron microscopy, scanning tunneling electron microscopy, atomic force microscopy, and confocal microscopy. It covers x-ray and neutron diffraction techniques including structure analysis, powder and glancing angle diffraction, pole figure, texture analysis, and small angle scattering.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5350D. Cognitive Foundations of Physics Education Research.
This course is an introduction to research methods and theories in physics education research. Topics include conceptual metaphor and blending, cognitive linguistics, dual-process theory, and historical issues from the intellectual development of physics.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Exclude from 3-peat Processing
Grade Mode: Standard Letter

PHYS 5370. Problems in Advanced Physics.
Open to graduate students on an individual basis by arrangement with the Department of Physics. May be repeated with prior approval of the department.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5395. Fundamentals of Research.
Course is available to graduate students only at the invitation of the department. May be repeated with prior approval of the department.
3 Credit Hours. 0 Lecture Contact Hours. 6 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5398. Industry Internship.
Supervised work experience in an appropriate high tech industry. Students will be required to keep a daily journal and make a final presentation (both written and oral) describing their accomplishments.
3 Credit Hours. 0 Lecture Contact Hours. 40 Lab Contact Hours.
Grade Mode: Credit/No Credit

PHYS 5399A. Thesis.
This course represents a student's initial thesis enrollment. No thesis credit is awarded until student has completed the thesis in PHYS 5399B.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit

PHYS 5399B. Thesis.
This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding. Graded on a credit (CR), progress (PR), no-credit (F) basis.
3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit

PHYS 5404. Experimental Methods.
Experiments in modern physics, with emphasis on demonstrating quantum effects and introducing nuclear physics.
4 Credit Hours. 1 Lecture Contact Hour. 3 Lab Contact Hours.
Grade Mode: Standard Letter

PHYS 5599B. Thesis.
This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.
5 Credit Hours. 5 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit

PHYS 5999B. Thesis.
This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.
9 Credit Hours. 9 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit