MAJOR IN PHYSICS
(MATERIAL PHYSICS
CONCENTRATION THESIS
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 2018-2019 academic year. Submission instructions, additional details, and changes to admission requirements for semesters other than the 2018-2019 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 concentration in material 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>PHYS 5350C</td>
<td>Characterization of Materials</td>
<td></td>
</tr>
<tr>
<td>PHYS 5404</td>
<td>Experimental Methods</td>
<td></td>
</tr>
</tbody>
</table>

Electives
Choose 9 hours from the following:

- PHYS 5320 Solid State Physics
- PHYS 5322 Semiconductor Device Microfabrication
- PHYS 5324 Thin Film Synthesis and Characterization Laboratory
- PHYS 5327 Semiconductor Device Physics
- PHYS 5350C Characterization of Materials
- PHYS 5404 Experimental Methods

Free Electives
Choose 3 hours of advisor-approved electives

Thesis

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 5199A</td>
<td>Thesis</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5199B</td>
<td>Thesis</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5299B</td>
<td>Thesis</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5399B</td>
<td>Thesis</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5599B</td>
<td>Thesis</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5999B</td>
<td>Thesis</td>
<td>3</td>
</tr>
</tbody>
</table>

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.

The student must submit an official Thesis Proposal Form (http://www.gradcollege.txstate.edu/forms.html) and proposal to his or her
thesis committee. Thesis proposals vary by department and discipline. Please see your department for proposal guidelines and requirements. After signing the form and obtaining committee members’ signatures, the graduate advisor’s signature if required by the program and the department chair’s signature, the student must submit the Thesis Proposal Form with one copy of the proposal attached to the dean of The Graduate College for approval 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 prior to submitting the proposal form to The Graduate College. 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 (http://www.gradcollege.txstate.edu) website under “Current Students.” 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. 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 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|Leveling
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|Leveling
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|Leveling
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