MASTER OF SCIENCE (M.S.)
MAJOR IN MATERIALS PHYSICS

Major Program
The materials physics program stresses experimental materials physics primarily related to the semiconductor and other high tech materials industries.

Application Requirements
The items listed below are required for admission consideration for applicable semesters of entry during the 2017-2018 academic year. Submission instructions, additional details, and changes to admission requirements for semesters other than the 2017-2018 academic year can be found on the program’s web page (http://gradcollege.txstate.edu/programs). International students should review the International Admission Documents (http://mycatalog.txstate.edu/graduate/admission-documents/international) section of the catalog 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 in materials physics is a thesis-based program that stresses experimental materials physics primarily related to the semiconductor and other high tech materials industries. The program requires 35 graduate-level hours in materials physics.

Course Requirements

Required Course Work

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>PHYS 5110</td>
<td>Seminar in Physics (taken twice)</td>
<td>2</td>
</tr>
<tr>
<td>PHYS 5320</td>
<td>Solid State Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5324</td>
<td>Thin Film Synthesis and Characterization Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 5398</td>
<td>Industry Internship</td>
<td>3</td>
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Materials Physics Electives
Choose 18 hours from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>PHYS 5312</td>
<td>ADVANCED QUANTUM MECHANICS</td>
</tr>
<tr>
<td>PHYS 5314</td>
<td>Statistical Physics</td>
</tr>
<tr>
<td>PHYS 5322</td>
<td>Semiconductor Device Microfabrication</td>
</tr>
<tr>
<td>PHYS 5326</td>
<td>Electrical Characterization of Materials and Devices</td>
</tr>
<tr>
<td>PHYS 5327</td>
<td>Semiconductor Device Physics</td>
</tr>
<tr>
<td>PHYS 5328</td>
<td>Advance Solid State Physics</td>
</tr>
<tr>
<td>PHYS 5329</td>
<td>Physics of Materials Degradation and Reliability</td>
</tr>
<tr>
<td>PHYS 5331</td>
<td>Electromagnetic Field Theory</td>
</tr>
<tr>
<td>PHYS 5370</td>
<td>Problems in Advanced Physics</td>
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Thesis Course Work
Choose a minimum 6 hours

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>PHYS 5199B</td>
<td>Thesis</td>
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<tr>
<td>PHYS 5299B</td>
<td>Thesis</td>
</tr>
<tr>
<td>PHYS 5399A</td>
<td>Thesis</td>
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<tr>
<td>PHYS 5399B</td>
<td>Thesis</td>
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</table>

Total Hours 35

Research
Research is an important component of our graduate program. Faculty research interests include historical astronomy and astronomical computing, magnetic and semiconductor materials fabrication and analysis, thin film electrical characterization, scanning probe microscopy, and infrared spectroscopy. Major research instrumentation includes magnetron and dual ion beam sputtering vacuum systems, scanning electron microscope with energy dispersive spectroscopy capabilities, atomic force microscope, scanning tunneling microscope, thin film optical characterization equipment, high resolution x-ray analysis equipment, vibrating sample magnetometer, FTIR spectrometer, and a Molecular Beam Epitaxy thin film growth system. For the latest on research interests and activities, visit our website: http://www.txstate.edu/physics/.

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
both 5399A and 5399B.

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. 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 their field, e.g., ENG 5399A, ENG 5199B, ENG 5299B, ENG 5399B, ENG 5599B, and ENG 5999B, 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.

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.
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, is repeatable with different emphasis, and is graded on a credit (CR), no-credit (F) basis
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. Graded on a credit (CR), progress (PR), no-credit (F) basis
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 and is graded on a credit (CR), no-credit (F) basis
2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.
Course Attribute(s): Graduate Assistantship|Exclude from Graduate GPA
Grade Mode: Credit/No Credit

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. Graded on a credit (CR), progress (PR), no-credit (F) basis
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 is a graduate leveling course and 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
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 including materials used in electronic devices, thin film deposition, wet and dry etching, lithography processing, and related topics relevant to semiconductor research and device manufacturing. Fabrication and characterization topics techniques will be covered
3 Credit Hours. 2 Lecture Contact Hours. 1 Lab Contact Hour.
Grade Mode: Standard Letter

PHYS 5324. Thin Film Synthesis and Characterization Laboratory.
This course is an intensive laboratory introduction to the physics and materials fabrication and characterization. Laboratory projects introducing techniques such as sputtering, furnace/oven preparation, scanning probe microscopy, scanning electron microscopy, energy dispersive spectroscopy, four point probe transport methods, magnetometry and x-ray analysis may be offered
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 electronic 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 2425
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|Topics
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. Graded on a credit (CR), no credit (F) basis

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. 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 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. 3 Lecture Contact Hours. 1 Lab Contact Hour.
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. Graded on a credit (CR), progress (PR), no-credit (F) basis

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. Graded on a credit (CR), progress (PR), no-credit (F) basis

9 Credit Hours. 9 Lecture Contact Hours. 0 Lab Contact Hours.
Grade Mode: Credit/No Credit