# Master of Science in Physics

The broad goal of the degree programs in Physics and Astronomy is to understand the physical universe. The questions addressed by our department's research and education missions range from the applied, such as an improved understanding of the materials that can be used for solar cell energy production, to foundational questions about the nature of mass and space and how the Universe was formed and subsequently evolved, and how astrophysical phenomena affected the Earth and its evolution. The courses and laboratory/research experiences in the department's master of science program help students to hone their problem solving and analytical skills and thereby become broadly trained critical thinkers. This program more specifically prepares students for Ph.D. programs, for industry, or for work at government laboratories.

## Admission to Graduate Studies

## **Admission Requirements**

- All applicants must meet the requirements outlined in the Admission to Graduate Study (https://policy.ku.edu/graduate-studies/admission-to-graduate-study/) policy.
- Bachelor's degree: A copy of official transcripts showing proof of a bachelor's degree (and any post-bachelor's coursework or degrees) from a regionally accredited institution, or a foreign university with equivalent bachelor's degree requirements is required.
- English proficiency: Proof of English proficiency (https:// gradapply.ku.edu/english-requirements/) for non-native or non-nativelike English speakers is required. There are two bands of English proficiency, including Admission and Full proficiency. For applicants to online programs, Full proficiency is required.

# Admission to the Physics and Astronomy Graduate Program

Most admitted students have an undergraduate grade-point average of at least a B (3.0 on a 4.0 scale), overall and in the major. A baccalaureate degree with a major in physics is desirable but not required. Recommended preparation consists of courses in mechanics, electromagnetic theory, thermal physics, introductory quantum mechanics, advanced laboratory, and at least one course in mathematics beyond differential equations. Working knowledge of computers and of an advanced programming language is helpful. A student with less than the recommended preparation may enroll in these courses for graduate credit.

The following materials are required and must be submitted before the application deadline in order for the application to be considered:

- **Transcripts** A scanned version of the transcript from your undergraduate and any post-Bachelor institution(s). If admitted, you will be required to submit official transcripts by the end of your first semester at KU to avoid having a hold placed on your student account. Review the KU Transcript requirement for more information, especially for International Applicants who may need to provide additional documentation.
- Statement of Purpose A single document also including: academic interests and professional goals.
- Resume or Curriculum Vitae

• **Recommendations**. You will be asked for the names and email addresses of three people who can write a recommendation letter describing your qualifications for graduate school in physics and astronomy. Once you submit the application, an email will be sent to each recommender requesting a letter and electronic survey from each person that you name.

The General and Subject GRE are not required for admission to the Physics and Astronomy graduate program. Submit your graduate application online (https://gradapply.ku.edu/apply/). The deadline to apply for Fall 2025 admission is December 16th, 2024. The deadline to apply for Spring 2026 admission is October 1st, 2025.

### The University of Kansas Department of Physics and Astronomy Malott Hall

1251 Wescoe Hall Dr., Room 1082 Lawrence, KS 66045

## **M.S. Degree in Physics**

## Program requirements:

Within 12 months of entering the program the student must fulfill the requirements of the individualized plan of study (https://physics.ku.edu/ graduate-program/additional-requirements/) for all graduate degrees to certify an undergraduate knowledge of Physics. To develop the individualized plan of study, students will be required to attend an advising session with the Departmental Graduate Advisor. This session will include a discussion of the student's transcripts, potential course enrollment, and administration of a diagnostic exam. Results of this exam will help determine a suggested course schedule. Following the development of the individualized plan, the advising process will continue through regular check-ins and reviews of student progress. These reviews will include looking at student grades, research progress, and general progress toward meeting departmental milestones.

The Master of Science in Physics requires a total of 30 hours of coursework and allows for the following two degree completion options:

- 1. Master's Thesis Defense
- 2. Final Oral Examination

### **Course Requirements:**

Code	Title	Hours		
Core Courses				
PHSX 711	Quantum Mechanics I	3		
PHSX 718	Mathematical Methods in Physical Sciences	3		
PHSX 821	Classical Mechanics	3		
PHSX 831	Electrodynamics I	3		
Two additional	courses chosen from the following:	6		
PHSX 721	Chaotic Dynamics			
PHSX 741	Nuclear Physics I			
PHSX 761	Elementary Particles I			
PHSX 781	Solid State Physics I			
PHSX 792	Topics in Advanced Astrophysics			
PHSX 793	Physical Cosmology			
PHSX 795	Space Plasma Physics			
PHSX 815	Computational Methods in Physical Sciences			
Completion Opt	Completion Options			

	required to enroll in Research/Thesis hours.	
PHSX 899	Master's Research/Thesis	2
Students select total of 10 hours	one of the following degree completion options for a s:	10
	esis: PHSX 899 (Up to 4 additional hours) and ective courses chosen from the list below, up to 10	
OR		
Final Oral Ex	amination: 1 credit of PHSX 899 and 9 hours of	
	ective credits chosen from the list below, OR 10 hours elective courses.	
Advanced Elec	tive Courses	
PHSX 511	Introductory Quantum Mechanics	
PHSX 516	Physical Measurements	
PHSX 518	Mathematical Physics	
PHSX 521	Mechanics I	
PHSX 531	Electricity and Magnetism	
PHSX 536	Electronic Circuit Measurement and Design	
PHSX 594	Cosmology and Culture	
PHSX 598	Research Methods	
PHSX 600	Special Topics in Physics and Astrophysics:	
PHSX 601	Design of Physical and Electronic Systems	
PHSX 611	Introductory Quantum Mechanics	
PHSX 615	Numerical and Computational Methods in Physics	
PHSX 616	Physical Measurements	
PHSX 621	Mechanics II	
PHSX 631	Electromagnetic Theory	
PHSX 641	Introduction to Nuclear Physics	
PHSX 655	Optics	
PHSX 661	Introduction to Elementary Particle Physics	
PHSX 671	Thermal Physics	
PHSX 681	Introduction to Solid State Physics	
PHSX 691	Astrophysics I	
PHSX 693	Gravitation and Cosmology	
PHSX 721	Chaotic Dynamics	
PHSX 723	Seismology	
PHSX 727	Advanced Geophysics:	
PHSX 741	Nuclear Physics I	
PHSX 761	Elementary Particles I	
PHSX 781	Solid State Physics I	
PHSX 792	Topics in Advanced Astrophysics	
PHSX 793	Physical Cosmology	
PHSX 794	Interiors and Atmospheres	
PHSX 795	Space Plasma Physics	
PHSX 796	Radiation and the Interstellar Medium	
PHSX 797	Galaxies	
PHSX 798	High Energy Astrophysics	
PHSX 801	Advanced Topics	
PHSX 811	Quantum Mechanics II	
PHSX 815	Computational Methods in Physical Sciences	
PHSX 841	Nuclear Physics II	
PHSX 855	Advanced Optics	
PHSX 861	Elementary Particles II	
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Total Hours		
PHSX 971	Advanced Statistical Mechanics	
PHSX 931	Electrodynamics II	
PHSX 915	Relativity	
PHSX 912	Quantum Field Theory	
PHSX 911	Quantum Mechanics III	
PHSX 895	Plasma Physics	
PHSX 886	Materials Characterization	
PHSX 885	Materials Modeling	
PHSX 881	Solid State Physics II	
PHSX 871	Statistical Physics I	

Advanced lecture courses are those number 500 or above. At least 50% of coursework counted toward the degree must be at the 700 level or above. Credit toward the 30 required hours is not given to students who take courses at a lower level after having completed similar upper level courses (as determined by the department) with a grade of B- or higher.

#### **Oral Presentation Requirement**

All graduate students, after their first semester, will deliver at least one oral presentation (https://physics.ku.edu/graduate-program/additional-requirements/) per semester. Presentations must cover a topic in physics or astronomy and typically relate to the student's research.

#### **Completion Options**

#### **Thesis Option**

A master's thesis is not required but may be submitted if the candidate and the director of the candidate's research believe it to be appropriate. Students pursuing this option must complete an oral presentation and defense of a thesis to a faculty committee. A final comprehensive oral examination is given in conjunction with the thesis defense. Potential examination outcomes are Pass with Honors, Satisfactory, and Unsatisfactory.

A minimum of 2 hours of PHSX 899 is required for all M.S. students. No more than 3 hours will be allowed unless directed toward completion of a thesis on original research or a written report. Students must consult with their research advisor before enrolling in more than 3 credit hours of PHSX 899.

#### **Final Oral Examination Option**

If no thesis is presented, the student must still complete an exam project with an oral component, satisfied by the general oral examination in physics given to all M.S. students. The examination is given shortly before completion of other work for the degree. Potential examination outcomes are Pass with Honors, Satisfactory, and Unsatisfactory.

The master's degree can be completed as a terminal degree, or may be earned in addition to the Ph.D. if requirements for both are completed.

Please visit the departmental web page (https://physics.ku.edu/graduateprogram/) for additional information, and to access the graduate student handbook (https://physics.ku.edu/graduate-program/importantinformation/).

Please visit the Graduate Studies section of the University Policy Library (https://policy.ku.edu/office/Graduate-Studies/) for information on time constraints and other requirements which may apply.

## **Computational Physics and Astronomy Concentration**

This concentration of the M.S. degree is for students with a background in physics, astronomy, computer science, mathematics, or engineering who wish to become familiar with computer-based approaches to problems in these fields. This concentration is intended as a terminal M.S. that can be completed in two years. Minimum preparation expected includes a year's course in general physics, mathematics through differential equations, and a knowledge of python, FORTRAN, C++ or another programming language suited to scientific applications. Students pursuing this degree with an applied mathematics emphasis may wish to consider also earning a Graduate Certificate in Applied Mathematics (https://catalog.ku.edu/liberal-arts-sciences/math/applied-mathematics-gradcert/#text).

All non-coursework M.S. program requirements listed above also apply to this concentration.

#### **Course Requirements:**

Code	Title H	lours		
Core Courses				
PHSX/ASTR 815	Computational Methods in Physical Sciences	3		
PHSX 718	Mathematical Methods in Physical Sciences	3		
MATH/EECS 781	Numerical Analysis I	3		
or EECS 639	Introduction to Scientific Computing			
EECS Requireme	ent	3		
Choose one of the	e following:			
EECS 510	Introduction to the Theory of Computing			
EECS 512	Electronic Circuits III			
EECS 541	Computer Systems Design Laboratory I			
EECS 542	Computer Systems Design Laboratory II			
EECS 545	Electric Energy Production and Storage			
EECS 547	Power System Analysis			
<b>EECS 562</b>	Introduction to Communication Systems			
EECS 563	Introduction to Communication Networks			
EECS 565	Introduction to Information and Computer Security	/		
EECS 568	Introduction to Data Mining			
<b>EECS 569</b>	Computer Forensics			
EECS 581	Software Engineering II			
EECS 582	Computer Science and Interdisciplinary Computin Capstone	g		
EECS 592	Cybersecurity Design			
EECS 611	Electromagnetic Compatibility			
EECS 622	Microwave and Radio Transmission Systems			
EECS 623	Interdisciplinary Collaborations			
EECS 628	Fiber Optic Communication Systems			
EECS 630	Advanced Data Structures and Algorithms			
EECS 639	Introduction to Scientific Computing			
EECS 643	Computer Architecture			
EECS 644	Introduction to Digital Signal Processing			
EECS 645	Computer Systems Architecture			
EECS 649	Introduction to Artificial Intelligence			
EECS 658	Introduction to Machine Learning			
EECS 662	Programming Languages			

EECS 664	Introduction to Digital Communication Systems
EECS 665	Compiler Construction
EECS 666	Introduction to Network Security
EECS 670	Introduction to Semiconductor Processing
EECS 675	Multicore and GPU Programming
EECS 677	Advanced Software Security Evaluation
EECS 678 EECS 683	Introduction to Operating Systems
	Introduction to Hardware Security and Trust
EECS 685	Introduction to IoT Security
EECS 687	Mobile Security
EECS 690	Special Topics:
EECS 692	Directed Reading
EECS 695	Software Reverse Engineering
EECS 700	Special Topics:
EECS 710	Information Security and Assurance
EECS 712	Network Security and its Application
EECS 713	High-Speed Digital Circuit Design
EECS 721	Antennas
EECS 723	Microwave Engineering
EECS 725	Introduction to Radar Systems
EECS 727	Photonics
EECS 728	Fiber-optic Measurement and Sensors
EECS 730	Introduction to Bioinformatics
EECS 738	Machine Learning
EECS 739	Parallel Scientific Computing
EECS 740	Digital Image Processing
<b>EECS 743</b>	Advanced Computer Architecture
EECS 744	Digital Signal Processing Implementation in Programmable Logic Devices
EECS 746	Database Systems
EECS 750	Advanced Operating Systems
EECS 752	Modern Computer Organization and Design
EECS 753	Embedded and Real Time Computer Systems
EECS 755	Software Modeling and Analysis
EECS 759	Estimation and Control of Unmanned Autonomous Systems
EECS 762	Programming Language Foundation I
EECS 764	Analysis of Algorithms
EECS 765	Introduction to Cryptography and Computer Security
EECS 767	Information Retrieval
EECS 768	Virtual Machines
<b>EECS 769</b>	Information Theory
EECS 774	Geometric Modeling
EECS 776	Functional Programming and Domain Specific Languages
EECS 777	Advanced Software Security Auditing
EECS 780	Communication Networks
EECS 782	Numerical Analysis II
EECS 783	Hardware Security and Trust
EECS 785	Internet of Things Security
EECS 785	Digital Very-Large-Scale-Integration
EECS 787	Mobile Security
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EEC5 786 Software Reverse Engineering MATH 665 Stochastic Processes I   EEC5 810 Software Engineering and Management MATH 665 Stochastic Processes I   EEC5 811 Software Engineering and Management MATH 665 Stochastic Processes I   EEC5 811 Software Analytic Imments Engineering MATH 665 Stochastic Processes I   EEC5 812 Software Analytic Imments Engineering MATH 665 Stochastic Processes I   EEC5 812 Software Analytic Imments Engineering MATH 665 Stochastic Processes I   EEC5 812 Software Analytic Imments Engineering MATH 665 Stochastic Processes I   EEC5 813 Advanced Quality Assurance Equations Topics In Advanced Numerical Differential Equations   EEC5 824 Advanced Processing MATH 665 Topics In Advanced Proteobility   EEC5 863 Matchina Elemanig Functional Analysis MATH 665 Stochastic Processing I   EEC5 865 Wreites Communication Systems Functional Analysis MATH 665 Stochastic Proteobility   EEC5 865 Mathematical Optimization with Communications PHSX 516 Mathematical Projects   EEC5 865 Mathematical Optimization with Communications PHSX 516 Mathematical Projects   EEC5 865 Mathematical Optimization with Communications <td< th=""><th></th></td<>	
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MATH 850 Differential Equations and Dynamical Systems PHSX 795 Space Plasma Physics	
MATH 851 Topics in Dynamical Systems: PHSX 796 Radiation and the Interstellar Medium	

PHSX 797	Galaxies
PHSX 798	High Energy Astrophysics
PHSX 801	Advanced Topics
PHSX 811	Quantum Mechanics II
PHSX 821	Classical Mechanics
PHSX 831	Electrodynamics I
PHSX 841	Nuclear Physics II
PHSX 855	Advanced Optics
PHSX 861	Elementary Particles II
PHSX 871	Statistical Physics I
PHSX 881	Solid State Physics II
PHSX 885	Materials Modeling
PHSX 886	Materials Characterization
PHSX 895	Plasma Physics
PHSX 911	Quantum Mechanics III
PHSX 912	Quantum Field Theory
PHSX 915	Relativity
PHSX 931	Electrodynamics II
PHSX 971	Advanced Statistical Mechanics

Additional Electives: Nine or more credits from at least 3 lecture 9 or lab courses from the following list:

Students may also choose any PHSX/ASTR courses numbered 500 and above to fulfill this requirement. Please see above for full list

T	Total Hours		
Ρ	HSX 899	Master's Research/Thesis	6
Т	hesis Hours		
	MATH 783	Applied Numerical Methods for Partial Differential Equations	
	MATH/EECS 782	Numerical Analysis II	
	or MATH 62	28 Mathematical Theory of Statistics	
	MATH 728	Statistical Theory	
	or MATH 62	2 Probability	
	MATH 727	Probability Theory	
	MATH 650	Nonlinear Dynamical Systems <sup>(Cannot be counted along with PHSX 721)</sup>	
	MATH 647	Applied Partial Differential Equations	
	MATH 611	Time Series Analysis	
	EECS 868	Mathematical Optimization with Applications	
	EECS 836	Machine Learning	
	EECS 739	Parallel Scientific Computing	
	list.		

\*Note: Double counting of courses is not allowed, e.g. a course cannot be used to fulfill two requirements simultaneously.

Courses numbered 500 or above count for graduate credit, but at least 50% of credit hours must be at the 700 level or above.

#### Thesis

An important component of this concentration is the completion and documentation of a successful computer project. A thesis must be presented that describes the basic physics involved in the project, the method of implementing the project, and a discussion of the results. An oral defense of the thesis is required before a committee of at least 3

members of the graduate faculty. Potential examination outcomes are Pass with Honors, Satisfactory, and Unsatisfactory.

Please visit the departmental web page (https://physics.ku.edu/graduateprogram/) for additional information, and to access the graduate student handbook (https://physics.ku.edu/graduate-program/importantinformation/). Please visit the Graduate Studies policy library (https:// policy.ku.edu/office/Graduate-Studies/) for other requirements which may apply.

At the completion of this program, students will be able to:

- Display knowledge of graduate level physics and astronomy.
- Display successful (oral and written) communication of scientific results.
- Display acquisition of discipline specific research skill.
- Display ability of independent research in physics and astronomy.