

APPLIED AND ENGINEERING PHYSICS, MS

Banner Code: SC-MS-PHAE

Graduate Advisor

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This degree contains elements of traditional physics programs and the application of physics to a diversity of critical societal problems. The program is divided into concentrations; see the Requirements tab for details.

Many courses are offered during late afternoon or evening hours to allow students with full-time employment to easily attend. Students employed at area high-technology organizations may take up to 6 credits (out of 30) for work done on the job under the guidance of a faculty member. This employment-related research may be conducted under an optional 3-credit research project or an optional 6-credit master's thesis. Master's students who are not employed full time may apply for financial aid or a limited number of research assistantships.

Admissions & Policies

Admissions

University-wide admissions policies can be found in the Graduate Admissions Policies (<https://catalog.gmu.edu/admissions/graduate-policies/>) section of this catalog. International students and students having earned international degrees should also refer to Admission of International Students (<https://catalog.gmu.edu/admissions/international-students/>) for additional requirements.

Eligibility

Individuals holding a baccalaureate degree in physics or a related field from an institution of higher education accredited by a Mason-recognized U.S. institutional accrediting agency or international equivalent and who have earned a GPA of 3.00 (out of 4.00) are invited to apply for admission.

Applicants may be required to make up one or two course deficiencies, based on a graduate physics advisor's assessment, and be provisionally admitted into the program.

Application Requirements

To apply for this program, prospective students should submit the George Mason University Admissions Application (<https://www2.gmu.edu/admissions-aid/apply-now/>) and its required supplemental documentation, and three letters of recommendation, preferably from former professors.

The GRE general is optional.

Policies

For policies governing all graduate programs, see AP.6 Graduate Policies (<https://catalog.gmu.edu/policies/academic/graduate-policies/>).

Transferring Previous Graduate Credit into this Program

Previously earned and relevant graduate credits may be eligible for transfer into this program; details can be found in the Credit by Exam or Transfer (<https://catalog.gmu.edu/policies/academic/graduate-policies/>) section of this catalog.

Requirements

Degree Requirements

Total credits: 30

Students should refer to the Admissions & Policies tab for specific policies related to this program.

Students should complete the core courses and select one concentration, completing all of the requirements therein.

Plan of Study

Before the beginning of their first semester, students are advised to meet with their academic advisor and develop a preliminary plan of study for the concentration they are interested in pursuing. A final plan of study must be approved by the graduate coordinator at the start of the semester in which the student graduates.

Core Courses

Students should choose their core courses in consultation with an advisor.

Choose one course from each grouping:

Code	Title	Credits
Group One: Computational Physics/Astrophysics		3
ASTR 601	Computer Simulation in Astronomy	
PHYS 510	Computational Physics I	
PHYS 534	Introduction to Quantum Computation and Quantum Information	
Group Two: Mechanics		3
PHYS 502	Introduction to Quantum Mechanics and Atomic Physics	
PHYS 620	Continuum Mechanics	
PHYS 684	Quantum Mechanics I	
Group Three: Electricity and Magnetism		3
PHYS 513	Applied Electromagnetic Theory	
PHYS 685	Classical Electrodynamics I	
Group Four: Statistical and Thermal Mechanics		3
PHYS 690	Engineering Thermodynamics	
PHYS 711	Statistical Mechanics	
Group Five: Methods in Physics		3
PHYS 591	Systems for Quantum Scientists	
PHYS 613	Computational Physics II	

PHYS 683	Mathematical Methods in Physics
Total Credits	15

Standard Physics Concentration (STDP)

This concentration is intended for students who may wish to pursue further graduate study in physics or astrophysics or pursue graduate study following the Standard Physics concentration of the Physics PhD.

Code	Title	Credits
Core Course		3
PHYS 705	Classical Mechanics	
Concentration Electives		3
In consultation with an advisor, select 3 credits of graduate-level courses from the following course prefixes: ¹		
ASTR (https://catalog.gmu.edu/courses/astr/)		
PHYS (https://catalog.gmu.edu/courses/phys/)		
General Electives		9
In consultation with an advisor, select 9 credits of graduate-level science courses. ²		
Total Credits		15

- ¹
- Courses must be approved by an advisor.
 - Courses cannot be directed reading, research, or thesis credits.
- ²
- Courses must be approved by an advisor.
 - Students may take PHYS 796 Directed Reading and Research and up to 6 credits of PHYS 798 Research Project as general electives. PHYS 798 Research Project is conducted under the supervision of a faculty research advisor and may be based on work done as an intern. Up to 6 credits of PHYS 799 Master's Thesis may be taken as general electives by students pursuing the thesis option and may also be based on work completed as an intern.

Engineering Physics Concentration (ENGP)

This concentration is intended for students who may wish to pursue employment in an engineering-related field or pursue graduate study following the Engineering Physics concentration of the Physics PhD.

Code	Title	Credits
Core Course		3
PHYS 640	Finite Element Analysis of Solids and Fluids	
Concentration Electives		3
In consultation with an advisor, select 3 credits of graduate-level courses from the following course prefixes: ¹		
PHYS (https://catalog.gmu.edu/courses/phys/)		
MATH (https://catalog.gmu.edu/courses/math/)		
BENG (https://catalog.gmu.edu/courses/beng/)		
CEIE (https://catalog.gmu.edu/courses/ceie/)		
ECE (https://catalog.gmu.edu/courses/ece/)		
ME (https://catalog.gmu.edu/courses/me/)		
General Electives		9

In consultation with an advisor, select 9 credits of graduate-level science and engineering courses. ²	
Total Credits	15

- ¹
- Courses must be approved by an advisor.
 - These must be regular courses and not directed reading, research, or thesis credits.
- ²
- Courses must be approved by an advisor.
 - Students may take PHYS 796 Directed Reading and Research and up to 6 credits of PHYS 798 Research Project as general electives. PHYS 798 Research Project is conducted under the supervision of a faculty research advisor and may be based on work done as an intern. Up to 6 credits of PHYS 799 Master's Thesis may be taken as general electives by students pursuing the thesis option and may also be based on work done as an intern.

Applied Physics Concentration (APLP)

This concentration is intended for students who wish to pursue employment in an applied physics or engineering-related field.

Code	Title	Credits
Core Course		3
PHYS 533	Modern Instrumentation	
Concentration Electives		3
In consultation with an advisor, select 3 credits of graduate-level courses from the following course prefixes: ¹		
PHYS (https://catalog.gmu.edu/courses/phys/)		
BINF (https://catalog.gmu.edu/courses/binf/)		
CHEM (https://catalog.gmu.edu/courses/chem/)		
CLIM (https://catalog.gmu.edu/courses/clim/)		
MATH (https://catalog.gmu.edu/courses/math/)		
CSI (https://catalog.gmu.edu/courses/csi/)		
STAT (https://catalog.gmu.edu/courses/stat/)		
General Electives		9
In consultation with an advisor, select 9 credits of graduate-level science and engineering courses. ²		
Total Credits		15

- ¹
- Courses must be approved by an advisor.
 - These must be regular courses and not directed reading, research, or thesis credits.
- ²
- Courses must be approved by an advisor.
 - Students may take PHYS 796 Directed Reading and Research and up to 6 credits of PHYS 798 Research Project as general electives. PHYS 798 Research Project is conducted under the supervision of a faculty research advisor and may be based on work done as an intern. Up to 6 credits of PHYS 799 Master's Thesis may be taken as general electives by students pursuing the thesis option and may also be based on work done as an intern.

Quantum Information Science and Engineering Concentration (QISE)

This concentration prepares students for the quantum information workforce through study of physics and courses across mathematics,

computer science, electrical engineering, and mechanical engineering as appropriate for their career plans in this multidisciplinary field.

Code	Title	Credits
Core Course		3
Select a focus area and choose one course therein:		
Focus Area: Software		
PHYS 736	Computational Quantum Mechanics	
MATH 621	Algebra I	
MATH 641	Combinatorics and Graph Theory	
MATH 674	Stochastic Differential Equations	
CS 583	Analysis of Algorithms	
CS 587	Introduction to Cryptography	
CS 600	Theory of Computation	
CS 630	Advanced Algorithms	
CS 747	Deep Learning	
ECE 508	Internet of Things	
ECE 547	Applied Cryptography	
ECE 647	Post-Quantum Cryptography	
ECE 649	Side-Channel Security	
ECE 699	Advanced Topics in Electrical and Computer Engineering	
ECE 747	Cryptographic Engineering	
Focus Area: Hardware		
PHYS 512	Solid State Physics and Applications	
PHYS 533	Modern Instrumentation	
PHYS 611	Electro-optics	
PHYS 784	Quantum Mechanics II	
CHEM 579	Special Topics	
CHEM 736	Computational Quantum Mechanics	
ECE 685	Nanoelectronics	
ME 754	Introduction to Nano-Materials	
Research Project		3
Students in the QISE concentration are expected to gain hands-on experience either through an industry internship, externship research experience in a collaborating research laboratory, or research experience in a Mason research laboratory.		
PHYS 798	Research Project	
General Electives		9
Select 9 credits of graduate-level science and engineering courses approved by an academic advisor. ¹		
Total Credits		15

- ¹
- Courses must be approved by an advisor.
 - Students may take PHYS 796 (<https://catalog.gmu.edu/search/?P=PHYS%20796>) Directed Reading as a general elective. Up to 6 credits of PHYS 799 (<https://catalog.gmu.edu/search/?P=PHYS%20799>) Master's Thesis may be taken as general electives by students who would like a thesis option in addition to the research project.

Thesis Option

In preparation for this option, the student must form a committee comprising a chair and two other faculty members.

The student completes a thesis under the direction of the committee chair. The thesis work is typically completed while students are registered for 6 credits of PHYS 799 Master's Thesis. A thesis proposal and thesis are submitted in accordance with AP.6 Graduate Policies (<https://catalog.gmu.edu/policies/academic/graduate-policies/>). The student must give an oral defense of the thesis to the committee and the George Mason University community at large. Students are expected to respond to questions on the thesis and related material. The committee determines whether the defense is satisfactory.

Accelerated Master's

Physics, BS/Applied and Engineering Physics, Accelerated MS

Overview

This bachelor's/accelerated master's degree program allows academically strong undergraduates with a commitment to research to obtain both the Physics, BS (<https://catalog.gmu.edu/colleges-schools/science/physics-astronomy/physics-bs/>) and the Applied and Engineering Physics, MS (<https://catalog.gmu.edu/colleges-schools/science/physics-astronomy/applied-engineering-physics-ms/>) degrees within an accelerated timeframe. Upon completion of this 138 credit accelerated program, students will be exceptionally well prepared for entry into a professional school, or a physics doctoral program, or a related discipline's doctoral program.

Students are eligible to apply for this accelerated program once they have earned at least 60 undergraduate credits and can enroll in up to 18 credits of graduate coursework after successfully completing 75 undergraduate credits. This flexibility makes it possible for students to complete a bachelor's and a master's in five years.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (<https://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7>). For policies governing all graduate degrees, see AP.6 Graduate Policies (<https://catalog.gmu.edu/policies/academic/graduate-policies/>). For more information on undergraduates enrolling in graduate courses, see AP.1.4.4 Graduate Course Enrollment by Undergraduates (<https://catalog.gmu.edu/policies/academic/registration-attendance/#text>).

Application Requirements

Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in the Graduate Admission Policies (<https://catalog.gmu.edu/admissions/graduate-policies/>) section of this catalog.

Important application information and processes for this accelerated master's program can be found here (<https://www2.gmu.edu/admissions-aid/how-apply/accelerated-masters/>).

Additionally, interested applicants should submit a letter to the undergraduate physics coordinator requesting admission along with the aforementioned recommendation letter(s). Contact the physics undergraduate or graduate coordinator for further details.

Successful applicants will have earned 60 undergraduate credits and have an overall GPA of at least 3.00. Additionally, they will have completed 45 credits in physics-major coursework. The physics major GPA must be at least 3.50.

One or more recommendation letters from one or more research supervisors are also required.

Interested applicants should submit a letter to the undergraduate physics coordinator requesting admission along with the aforementioned recommendation letter(s). Contact the physics undergraduate or graduate coordinator for further details.

Accelerated Option Requirements

After the completion of 75 undergraduate credits, students may complete 3 to 12 credits of graduate coursework that can apply to both the undergraduate and graduate degrees.

In addition to applying to graduate from the undergraduate program, students in the accelerated program must submit a bachelor's/accelerated master's transition form (available from the Office of the University Registrar (<https://registrar.gmu.edu/forms/>)) to the College of Science's Office of Academic and Student Affairs (<https://cos.gmu.edu/about/contact-us/>) by the last day to add classes of their final undergraduate semester. Students should enroll for courses in the master's program in the fall or spring semester immediately following conferral of the bachelor's degree, but should contact an advisor if they would like to defer up to one semester.

Students must maintain an overall GPA of 3.00 or higher in all graduate coursework and should consult with their faculty advisor to coordinate their academic goals.

Reserve Graduate Credit

Accelerated master's students may also take up to 6 graduate credits as reserve graduate credits. These credits do not apply to the undergraduate degree, but will reduce the master's degree by up to 6 credits. With 12 graduate credits counted toward the undergraduate and graduate degrees plus the maximum 6 reserve graduate credits, the credits necessary for the graduate degree can be reduced by up to 18.

Graduate Course Suggestions

The following list of suggested courses, which may be taken while in undergraduate status, is provided for general reference. To ensure an efficient route to graduation and post-graduation readiness, students are strongly encouraged to meet with an advisor before registering for graduate-level courses.

Code	Title	Credits
ASTR 601	Computer Simulation in Astronomy	3
PHYS 502	Introduction to Quantum Mechanics and Atomic Physics	3
PHYS 510	Computational Physics I	3
PHYS 513	Applied Electromagnetic Theory	3
PHYS 534	Introduction to Quantum Computation and Quantum Information	3
PHYS 591	Systems for Quantum Scientists	3
PHYS 613	Computational Physics II	3
PHYS 620	Continuum Mechanics	3
PHYS 683	Mathematical Methods in Physics	3
PHYS 684	Quantum Mechanics I	3

PHYS 685	Classical Electrodynamics I	3
PHYS 690	Engineering Thermodynamics	3

Mechanical Engineering, BS/Applied and Engineering Physics, Accelerated MS Overview

This program allows academically strong undergraduates with a demonstrable commitment to research to obtain the Mechanical Engineering, BS (<https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/mechanical/mechanical-engineering-bs/>) and Applied and Engineering Physics, MS degrees by successfully completing 139 credits. Upon completion, students are well-prepared for entering into the professional workforce, or a PhD program in physics or a related engineering discipline.

Admitted students take selected graduate courses after having completed 75 undergraduate credits and are able to use 3-12 graduate credits in partial satisfaction of requirements for the undergraduate degree. Upon completion and conferral of the bachelor's degree and with satisfactory performance (grade of 'B' or better) in each of the graduate courses, students are given advanced standing in the master's program and complete an additional 18-27 credits to receive the master's degree.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (<https://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7>). For policies governing all graduate degrees, see AP.6 Graduate Policies (<https://catalog.gmu.edu/policies/academic/graduate-policies/>).

Application Requirements

Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in the Graduate Admission Policies (<https://catalog.gmu.edu/admissions/graduate-policies/>) section of this catalog.

Successful applicants majoring in Mechanical Engineering will have completed at least 60 credits toward their undergraduate degree with an overall GPA of at least 3.00, and the following courses with a GPA of 3.00 or better:

Code	Title	Credits
CS 112	Introduction to Computer Programming (Mason Core) (https://catalog.gmu.edu/mason-core/)	4
ME 212	Solid Mechanics	3
ME 231	Dynamics	3
ME 313	Material Science	3
ME 322	Fluid Mechanics	3
ME 323	Heat Transfer	3
ME 351	Analytical Methods in Engineering	3

One or more recommendation letters from one or more research supervisors are also required. Interested applicants majoring in Mechanical Engineering, BS (<https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/mechanical/mechanical-engineering-bs/>) should submit a letter to the undergraduate Mechanical Engineering coordinator and the Physics Graduate Coordinator, respectively, requesting admission along with the aforementioned

recommendation letter(s). Contact the Mechanical Engineering undergraduate and the Physics graduate coordinator for further details.

Students who are accepted into the BAM Pathway will be allowed to register for graduate level courses after successful completion of a minimum of 75 undergraduate credits and course-specific pre-requisites

Accelerated Option Requirements

At the beginning of the student's final undergraduate semester, students must submit a bachelor's/accelerated master's transition form (<http://registrar.gmu.edu/forms/>) to the College of Science's Office of Academic and Student Affairs (<https://cos.gmu.edu/about/contact-us/>). Students must begin their master's program in the semester immediately following conferral of the bachelor's degree.

Students must maintain an overall GPA of 3.00 or higher in graduate coursework.

Reserve Graduate Credit

While still in undergraduate status, a maximum of 6 additional graduate credits may be taken as reserve graduate credit and applied to the master's program. Reserve graduate credits do not apply to the undergraduate degree.

Graduate Course Suggestions

The following list of suggested courses is provided for general reference. To ensure an efficient route to graduation and career-readiness, students are strongly encouraged to meet with an advisor before registering for graduate-level courses.

Code	Title	Credits
PHYS 510	Computational Physics I	3
PHYS 613	Computational Physics II	3
PHYS 620	Continuum Mechanics	3
PHYS 690	Engineering Thermodynamics	3