APPLIED AND ENGINEERING PHYSICS, MS

Banner Code: SC-MS-PHAE

Graduate Advisor
203 Planetary Hall
Fairfax Campus
Phone: 703-993-5356
Email: gadvphys@gmu.edu
Website: physics.gmu.edu

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 (http://catalog.gmu.edu/admissions/graduate-policies/) section of this catalog.

To apply for this program, please complete the George Mason University Admissions Application (https://www2.gmu.edu/admissions-aid/apply-now/).

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) in their last 60 credits 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. Three letters of recommendation must be submitted, preferably from former professors. The general GRE and the GRE subject test in physics are recommended for applicants who received their baccalaureate degrees within the past five years.

Policies
For policies governing all graduate programs, see AP6 Graduate Policies (http://catalog.gmu.edu/policies/academic/graduate-policies/).

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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group One: Computational Physics/Astrophysics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ASTR 601</td>
<td>Computer Simulation in Astronomy</td>
<td></td>
</tr>
<tr>
<td>PHYS 510</td>
<td>Computational Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 534</td>
<td>Introduction to Quantum Computation and Quantum Information</td>
<td></td>
</tr>
</tbody>
</table>

| 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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 705</td>
<td>Classical Mechanics</td>
<td>3</td>
</tr>
</tbody>
</table>

Concentration Electives
In consultation with an advisor, select 3 credits of graduate-level courses from the following course prefixes: ASTR (http://catalog.gmu.edu/courses/astr/) or PHYS (http://catalog.gmu.edu/courses/phys/).
General Electives
In consultation with an advisor, select 9 credits of graduate-level science courses.

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
PHYS 640 Finite Element Analysis of Solids and Fluids 3

Concentration Electives
In consultation with an advisor, select 3 credits of graduate-level courses from the following course prefixes: 1

PHYS (http://catalog.gmu.edu/courses/phys/)
MATH (http://catalog.gmu.edu/courses/math/)
BENG (http://catalog.gmu.edu/courses/beng/)
CEIE (http://catalog.gmu.edu/courses/ceie/)
ECE (http://catalog.gmu.edu/courses/ece/)
ME (http://catalog.gmu.edu/courses/me/)

General Electives
In consultation with an advisor, select 9 credits of graduate-level science and engineering courses.

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 completed 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
PHYS 736 Computational Quantum Mechanics 3
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 646 Applied Cryptography
ECE 699 Advanced Topics in Electrical and Computer Engineering
ECE 746 Advanced Applied Cryptography
ECE 747 Cryptographic Engineering

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 646 Applied Cryptography
ECE 699 Advanced Topics in Electrical and Computer Engineering
ECE 746 Advanced Applied Cryptography
ECE 747 Cryptographic Engineering

Focus Area: Hardware
PHYS 512 Solid State Physics and Applications
PHYS 533 Modern Instrumentation

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
PHYS 533 Modern Instrumentation 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
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.
² 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 the University Registrar (https://www2.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.

**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.

**Apply for Accelerated MS in 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 (http://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7). For policies governing all graduate degrees, see AP.6 Graduate Policies (http://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 (http://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.

**Accomplished 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 (http://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7). For policies governing all graduate degrees, see AP.6 Graduate Policies (http://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 (http://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**

Accomplished 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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 601</td>
<td>Computer Simulation in Astronomy</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 502</td>
<td>Introduction to Quantum Mechanics and Atomic Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 510</td>
<td>Computational Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 513</td>
<td>Applied Electromagnetic Theory</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 534</td>
<td>Introduction to Quantum Computation and Quantum Information</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 591</td>
<td>Systems for Quantum Scientists</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 613</td>
<td>Computational Physics II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 620</td>
<td>Continuum Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 683</td>
<td>Mathematical Methods in Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 684</td>
<td>Quantum Mechanics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 685</td>
<td>Classical Electrodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 690</td>
<td>Engineering Thermodynamics</td>
<td>3</td>
</tr>
</tbody>
</table>

**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 (http://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 for 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 (http://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7). For policies governing all graduate degrees, see AP6 Graduate Policies (http://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 (http://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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 112</td>
<td>Introduction to Computer Programming (Mason Core) (<a href="http://catalog.gmu.edu/mason-core/">http://catalog.gmu.edu/mason-core/</a>)</td>
<td>4</td>
</tr>
<tr>
<td>ME 212</td>
<td>Solid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ME 231</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ME 313</td>
<td>Material Science</td>
<td>3</td>
</tr>
<tr>
<td>ME 322</td>
<td>Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ME 323</td>
<td>Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>ME 351</td>
<td>Analytical Methods in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

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.

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<tr>
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<tr>
<td>PHYS 510</td>
<td>Computational Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 613</td>
<td>Computational Physics II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 620</td>
<td>Continuum Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 690</td>
<td>Engineering Thermodynamics</td>
<td>3</td>
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</table>