Students should refer to the Admissions & Policies (p. 723) tab for specific policies related to this program.

Core Courses
Students must earn a grade of 'B' or better in each core course that counts towards the core requirement.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 675</td>
<td>Linear Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Select any three of the following:</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>MATH 621</td>
<td>Algebra I</td>
<td></td>
</tr>
<tr>
<td>MATH 631</td>
<td>Topology I: Topology of Metric Spaces</td>
<td></td>
</tr>
<tr>
<td>MATH 677</td>
<td>Ordinary Differential Equations</td>
<td></td>
</tr>
<tr>
<td>MATH 685</td>
<td>Numerical Analysis</td>
<td></td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

Preliminary Written Exam
Students are required to pass preliminary written exams after completing the core courses, usually by the end of their second year. These exams are based on material presented in three of the five core courses (the student may choose which topics to exclude). These exams are offered twice a year and students may take each exam up to three times. A grade of "pass" on three preliminary written exams is sufficient to satisfy the creative component of the master’s degree in mathematics.

Dissertation Advisor and Examination Committee
After passing the preliminary written exam, the student chooses a dissertation advisor and a three person examination committee. In consultation with the advisor and committee, the student chooses a major and a minor area of study (the major and minor areas are presumed to be in two different branches of mathematics).

Seminar
Students must register for a 1 credit seminar each semester until they advance to candidacy or have acquired at least 6 credits.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 795</td>
<td>Graduate Seminar</td>
<td>6</td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

1 A student entering without a master’s degree in mathematics should expect to take a total of 6 to 9 credits of MATH 795 Graduate Seminar.

Electives
Students complete 27-42 credits of approved MATH electives (p. 1717)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select 12-24 credits from the following:</td>
<td></td>
<td>12-24</td>
</tr>
<tr>
<td>MATH 998</td>
<td>Doctoral Dissertation Proposal</td>
<td></td>
</tr>
<tr>
<td>MATH 999</td>
<td>Doctoral Dissertation</td>
<td></td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>12-24</td>
</tr>
</tbody>
</table>

1 Courses not designated as MATH courses must be approved by the graduate committee.

Qualifying Examinations
Students are required to take a qualifying exam after passing the preliminary written exam. The qualifying exam will have oral and written components. In consultation with the advisor and committee, the student chooses a major and a minor area of study (the major and minor areas are presumed to be in two different branches of mathematics). The qualifying exam covers the equivalent of approximately four courses of material from the major area and three courses from the minor area.

Dissertation Proposal and Advancement to Candidacy
Approximately one semester after passing the qualifying exam, each doctoral student prepares a written dissertation proposal while taking MATH 998 Doctoral Dissertation Proposal. The proposal must be approved by the dissertation committee, which consists of the three qualifying exam committee members, plus a fourth member from outside the Department of Mathematical Sciences (p. 707). After successfully completing this requirement, the student advances to doctoral candidacy.

Dissertation Research
Select 12-24 credits from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 998</td>
<td>Doctoral Dissertation Proposal</td>
<td></td>
</tr>
<tr>
<td>MATH 999</td>
<td>Doctoral Dissertation</td>
<td></td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>12-24</td>
</tr>
</tbody>
</table>

Doctoral Dissertation
After advancing to candidacy, the student will work on a doctoral dissertation while enrolled in MATH 999 Doctoral Dissertation. The dissertation is a written piece of original mathematics that demonstrates a doctoral candidate's mastery of the subject matter. A student is expected to produce new and original research worthy of publication in a peer-reviewed journal. After the dissertation is completed, the committee will review the dissertation and examine the student in a public oral thesis defense.

Department of Physics and Astronomy
Phone: 703-993-1280
Email: physics@gmu.edu
Website: physics.gmu.edu

The Department of Physics and Astronomy is dedicated to the dissemination and advancement of physics and astronomy through instruction, research, and outreach.

The department provides rigorous training for physics and astronomy students and prepares them to be successful, confident, and versatile in their ability to apply physics and astronomy principles within any chosen field. The department also aims to deliver and instill a broad-based understanding of general physics and astronomy principles and practices to the wider university community through our Mason Core (p. 135) (general education) courses. Our student-centric curriculum and instruction use a mixture of traditional and current pedagogical techniques informed by on-going educational research. It is our goal to help students to develop versatility and creativity through repeated analytical practices and problem-solving training in their coursework and faculty-led research projects.

Research in the department focuses on pushing the frontiers of physics and astronomy in a broad range of topics using theoretical, experimental, observational, and computational approaches. The department maintains many active collaborations with scientists across different disciplines.
within the university community and with other national and international institutions. The department believes strongly in incorporating both graduate as well as undergraduate students in our research programs. It is our goal to see students arriving with an enthusiasm and curiosity for physics and astronomy and leaving as true scientists ready to conduct their own scientific investigations.

Undergraduate Programs

The department offers the Physics, BS (p. 731) and the Astronomy, BS (p. 729). Also available are the Physics Minor (p. 730), the Astronomy Minor (p. 728), and the Renewable Energy Interdisciplinary Minor (p. 736).

Undergraduate Research Opportunities

The department offers many opportunities for undergraduate students to get involved with research. Students should consult with faculty working on research topics of interest to them, based on their exploration of the department’s website (http://physics.gmu.edu).

Bachelor’s/Accelerated Master’s Degree

Information regarding this program can be found in the Physics, BS/Accelerated Masters section of this catalog.

Physics for Non-majors

PHYS 243 College Physics (Mason Core) (p. 135), PHYS 244 College Physics Lab (Mason Core) (p. 135), PHYS 245 College Physics (Mason Core) (p. 135), and PHYS 246 College Physics Lab (Mason Core) (p. 135) are recommended for biology, geology, and premedical students, and mathematics students who seek a BA degree. PHYS 101 Light and Sound in Our World, PHYS 102 Sports Physics, PHYS 103 Physics and Everyday Phenomena I (Mason Core) (p. 135), and PHYS 104 Physics and Everyday Phenomena II (Mason Core) (p. 135) are intended for non-science majors. PHYS 160 University Physics I (Mason Core) (p. 135), PHYS 161 University Physics I Laboratory (Mason Core) (p. 135), PHYS 260 University Physics II (Mason Core) (p. 135), PHYS 261 University Physics II Laboratory (Mason Core) (p. 135) or PHYS 265 Advanced University Physics II Laboratory, PHYS 262 University Physics III (Mason Core) (p. 135), and PHYS 263 University Physics III Laboratory (Mason Core) (p. 135) constitute a calculus-based sequence in general physics to be taken by physics and engineering majors, and chemistry, computer science, and mathematics students who are pursuing a BS degree. Students may receive credit for only one of the following three sequences:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Course Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 243 &amp; PHYS 244</td>
<td>College Physics (Mason Core) (p. 135) and College Physics Lab (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>PHYS 245 &amp; PHYS 246</td>
<td>College Physics (Mason Core) (p. 135) and College Physics Lab (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>PHYS 103 &amp; PHYS 104</td>
<td>Physics and Everyday Phenomena I (Mason Core) (p. 135) and Physics and Everyday Phenomena II (Mason Core) (p. 135)</td>
</tr>
</tbody>
</table>

PHYS 160 & PHYS 161 
PHYS 260 & PHYS 262 
PHYS 263 & University Physics I Laboratory (Mason Core) (p. 135) 
PHYS 260 & University Physics II Laboratory (Mason Core) (p. 135) 
PHYS 260 & University Physics III Laboratory (Mason Core) (p. 135)

Graduate Programs

This department offers the Applied and Engineering Physics, MS (p. 726). The department also supports the Energy and Sustainability concentration in the Interdisciplinary Studies, MAIS (p. 534). Additionally, the department offers a Physics, PhD (p. 735). These graduate programs are strongly supported by the extensive research activities of the faculty, including many collaborations with scientists and engineers at regional government laboratories.

Faculty

Department Faculty

Professors

Barroto, Becker, Dworzecka, Kan, Lohner, Mishin, Rubin, Satija, Satyapal, Sauer, So, Summers, Trefil, Yang, Zhang

Associate Professors

Camelli, Cressman, Marzoguig, Nikolic, Rosenberg, Sheng, Tian, Weigel, Weingartner, Zhao

Assistant Professors

Yigit, Vora

Term Associate Professor

Djordjevic, Geller, Gliozzi, Oerter, Wyczalkowski

Term Assistant Professors

Belle, Dreyfus, Ericson

Emeriti

Ceperley, Ehrlich, Ellsworth, Evans, Lieb, Mielczarek

Research Faculty

Bilitza, Dere, Duxbury, Huang, Mariska, Meier, Odstrcil, Poland, Purja Pun, Richards

Requirements & Policies

Writing Intensive Requirement

George Mason requires all undergraduate students to complete at least one course designated as “writing intensive” in their majors at the 300-level or above. Students majoring in physics fulfill this requirement by successfully completing PHYS 407 Senior Laboratory in Modern Physics (Mason Core) (p. 135). Astronomy majors fulfill the requirement by
completing ASTR 402 RS: Methods of Observational Astronomy (Mason Core) (p. 135).

**Teacher Licensure**

Students who wish to become teachers should consult the College of Education and Human Development (p. 154) section of this catalog and attend an information session early in their undergraduate career. For more information, visit the Graduate School of Education’s website (https://gse.gmu.edu).

**Programs**

- Applied and Engineering Physics, MS
- Astronomy Minor
- Astronomy, BS
- Physics Minor
- Physics, BS
- Physics, PhD
- Renewable Energy Interdisciplinary Minor

**Applied and Engineering Physics, MS**

**Banner Code:** SC-MS-PHAE

**Robert Weigel, Associate Professor**

Planetary Hall, Room 259
Fairfax Campus

Phone: 703-993-1361
Email: rweigel@gmu.edu
Website: physics.gmu.edu/applied-and-engineering-physics-ms/

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 three areas of emphasis; see Requirements (p. 726) 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 (p. 66) 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 a regionally accredited institution and who have earned a GPA of 3.00 (out of 4.00) in their last 60 credits are invited to apply for admission. If the baccalaureate degree is in a field other than physics, applicants should have taken several courses beyond the introductory physics courses, such as junior-level classical mechanics, electricity and magnetism, or electronics. Applicants may be required to make up one or two 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 AP.6 Graduate Policies (p. 87).

**Requirements**

**Degree Requirements**

Total credits: 30

Students should refer to the Admissions & Policies (p. 726) tab for specific policies related to this program.

**Emphasis Requirement**

Select one emphasis and complete all the requirements therein.

**Standard Emphasis**

This emphasis is intended for students who may wish to pursue further graduate study in physics leading to a PhD degree in preparation for a career in basic research.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<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 705</td>
<td>Classical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 711</td>
<td>Statistical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>Select 9 credits from the following: 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTR 532</td>
<td>Phys Interplanetary Med</td>
<td></td>
</tr>
<tr>
<td>ASTR 602</td>
<td>Methods of Observational Astronomy</td>
<td></td>
</tr>
<tr>
<td>ASTR 603</td>
<td>Planetary Sciences</td>
<td></td>
</tr>
<tr>
<td>ASTR 604</td>
<td>Galaxies and Cosmology</td>
<td></td>
</tr>
<tr>
<td>ASTR 660</td>
<td>Plasma Physics for Space and Astrophysics</td>
<td></td>
</tr>
<tr>
<td>ASTR 680</td>
<td>Physics of Interstellar Media</td>
<td></td>
</tr>
<tr>
<td>ASTR 730</td>
<td>Stellar Astrophysics</td>
<td></td>
</tr>
<tr>
<td>ASTR 764</td>
<td>Computational Astrophysics</td>
<td></td>
</tr>
<tr>
<td>ASTR 765</td>
<td>High-Energy and Accretion Astrophysics</td>
<td></td>
</tr>
<tr>
<td>ASTR 790</td>
<td>Topics in Astronomy and Astrophysics</td>
<td></td>
</tr>
<tr>
<td>PHYS 510</td>
<td>Computational Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 512</td>
<td>Solid State Physics and Applications</td>
<td></td>
</tr>
<tr>
<td>PHYS 533</td>
<td>Modern Instrumentation</td>
<td></td>
</tr>
<tr>
<td>PHYS 540</td>
<td>Nuclear and Particle Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 575</td>
<td>Atmospheric Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 611</td>
<td>Electro-optics</td>
<td></td>
</tr>
<tr>
<td>PHYS 612</td>
<td>Physics of Modern Imaging</td>
<td></td>
</tr>
<tr>
<td>PHYS 613</td>
<td>Computational Physics II</td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>Title</td>
<td>Credits</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>PHYS 614</td>
<td>Thermodynamics and Kinetics of Materials</td>
<td></td>
</tr>
<tr>
<td>PHYS 615</td>
<td>Fundamentals of Materials Science</td>
<td></td>
</tr>
<tr>
<td>PHYS 620</td>
<td>Continuum Mechanics</td>
<td></td>
</tr>
<tr>
<td>PHYS 628</td>
<td>Relativity</td>
<td></td>
</tr>
<tr>
<td>PHYS 630</td>
<td>Introduction to Biophysics</td>
<td></td>
</tr>
<tr>
<td>PHYS 660</td>
<td>Space Weather</td>
<td></td>
</tr>
<tr>
<td>PHYS 684</td>
<td>Quantum Mechanics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 685</td>
<td>Classical Electrodynamics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 701</td>
<td>Theoretical Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 736</td>
<td>Computational Quantum Mechanics</td>
<td></td>
</tr>
<tr>
<td>PHYS 760</td>
<td>Space Plasma Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 780</td>
<td>Advanced Selected Topics in Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 784</td>
<td>Quantum Mechanics II</td>
<td></td>
</tr>
<tr>
<td>PHYS 785</td>
<td>Classical Electrodynamics II</td>
<td></td>
</tr>
<tr>
<td>CSI 720</td>
<td>Fluid Mechanics</td>
<td></td>
</tr>
<tr>
<td>CSI 721</td>
<td>Computational Fluid Dynamics I</td>
<td></td>
</tr>
<tr>
<td>CSI 722</td>
<td>Computational Fluid Dynamics II</td>
<td></td>
</tr>
<tr>
<td>CSI 786</td>
<td>Molecular Dynamics Modeling</td>
<td></td>
</tr>
<tr>
<td>CSI 787</td>
<td>Computational Materials Science</td>
<td></td>
</tr>
<tr>
<td>CSI 788</td>
<td>Simulation of Large Scale Systems</td>
<td></td>
</tr>
</tbody>
</table>

**Total Credits: 21**

### Engineering Physics Emphasis

This emphasis allows students to select a larger number of courses from electrical engineering and other areas.

Choose one of the following: 3
- PHYS 684 Quantum Mechanics I
- PHYS 502 Introduction to Quantum Mechanics and Atomic Physics
- PHYS 690 Engineering Thermodynamics

Choose one of the following: 3
- PHYS 685 Classical Electrodynamics I
- PHYS 513 Applied Electromagnetic Theory
- PHYS 620 Continuum Mechanics
- PHYS 510 Computational Physics I
- PHYS 533 Modern Instrumentation
- or PHYS 613 Computational Physics II

Select 9 credits of graduate-level PHYS, ECE, CEIE, or MATH courses 1

**Total Credits: 21**

1 Advisor approval required

### Applied Physics Emphasis

This emphasis is intended for those who wish to apply the techniques and subject areas of physics to multifaceted problems encountered in the workplace, particularly in physics, engineering, computational science, and other related areas.

- PHYS 510 Computational Physics I 3
- PHYS 533 Modern Instrumentation 3
- PHYS 684 Quantum Mechanics I 3
- or PHYS 502 Introduction to Quantum Mechanics and Atomic Physics 3

**Total Credits: 21**

1 No more than 6 credits may be chosen from areas outside ASTR, CSI, ECE, NANO, and PHYS.

### Electives

Select nine elective credits from the following: 1 9
- PHYS (p. 1828)
- CHEM (p. 1244)
- MATH (p. 1717)
- ECE (p. 1456)
- CSI (p. 1302)
- PHYS 798 Research Project
- PHYS 799 Master’s Thesis
- ECE 798 Research Project
- ECE 799 Master’s Thesis

**Total Credits: 9**

Notes:
- Students may choose to take either PHYS 798 Research Project/ECE 798 Research Project or PHYS 799 Master’s Thesis/ECE 799 Master’s Thesis (6 credits), but not both. The research project may be conducted at a student’s place of employment with the concurrence of a faculty advisor.
- The thesis is a more substantial piece of work performed under the supervision of a faculty member and requires students to make
an oral defense. PHYS 798 Research Project/ECE 798 Research Project may be taken only once. No more than 6 credits of PHYS 799 Master’s Thesis may be applied to the degree.

- Students in the master’s degree program can earn the Data Science Graduate Certificate (p. 659) from the Department of Computational and Data Sciences (p. 650) by choosing an approved sequence of courses.

### Accelerated Master’s

### Physics, BS/Applied and Engineering Physics, Accelerated MS

**Overview**

This program allows academically strong undergraduates with a demonstrable commitment to research to obtain the Physics, BS (p. 731) and Applied and Engineering Physics, MS (p. 726) degrees by successfully completing 144 credits. Upon completion, students are well-prepared for entry into a professional school or a PhD program in physics or a related discipline.

Admitted students take selected graduate courses during their senior year and are able to use up to 6 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 24 credits to receive the master’s degree.

For more detailed information, see AP.6.7 Bachelor’s/Accelerated Master’s Degrees (p. 89). For policies governing all graduate degrees, see AP.6 Graduate Policies (p. 87).

**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 (p. 66) section of this catalog.

Successful applicants will have completed at least 90 credits toward their undergraduate degree and 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**

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.

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### 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.

### Astronomy Minor

**Banner Code:** ASTR

**Joseph Weingartner, Undergraduate Astronomy Advisor**

Planetary Hall, Room 231
Fairfax Campus

Phone: 703-993-4596
Email: jweinga1@gmu.edu
Website: physics.gmu.edu/minor-in-astronomy/

### Admissions & Policies

**Policies**

Eight credits of coursework must be unique to the minor. For policies governing all minors, see AP.5.3.4 Minors (p. 86).

### Requirements

**Minor Requirements**

Total credits: 18 or 20

Students should refer to the Admissions & Policies (p. 728) tab for specific policies related to this program.

The minor requires completion of all coursework with a minimum GPA of 2.00.

**Core Courses**

Select one from the following sequences:

<table>
<thead>
<tr>
<th>Sequence One:</th>
<th>12-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 243 &amp; PHYS 245</td>
<td>College Physics (Mason Core) (p. 135) and College Physics (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>or PHYS 160 &amp; PHYS 260</td>
<td>University Physics I (Mason Core) (p. 135) and University Physics II (Mason Core) (p. 135)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PHYS 243</th>
<th>College Physics (Mason Core) (p. 135)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 111</td>
<td>Introductory Astronomy: The Solar System (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>ASTR 112</td>
<td>Introductory Astronomy Lab: The Solar System (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>ASTR 113</td>
<td>Introductory Astronomy: Stars, Galaxies, and the Universe (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>ASTR 114</td>
<td>Introductory Astronomy Lab: Stars, Galaxies, and the Universe (Mason Core) (p. 135)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequence Two:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 160</td>
<td>University Physics I (Mason Core) (p. 135)</td>
</tr>
<tr>
<td>PHYS 260</td>
<td>University Physics II (Mason Core) (p. 135)</td>
</tr>
</tbody>
</table>
Astronomy Electives

Select 6 credits from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 301</td>
<td>Astrobiology</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 302</td>
<td>Foundations of Cosmological Thought</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 328</td>
<td>Stars and Interstellar Medium</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 402</td>
<td>RS: Methods of Observational Astronomy</td>
<td>4</td>
</tr>
<tr>
<td>ASTR 403</td>
<td>Planetary Sciences</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 404</td>
<td>Galaxies and Cosmology</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 428</td>
<td>Relativity</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credits: 12-14

The program prepares students for graduate school, a career in research or teaching, or employment in industry, business, or education fields where analytical skills and a scientific background are advantageous. Students who are considering a double major should talk to the undergraduate coordinator.

Admissions & Policies

Admissions

University-wide admissions policies can be found in Undergraduate Admissions Policies (p. 63).

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

Policies

Students must fulfill all Requirements for Bachelor’s Degrees (p. 86) including the Mason Core (p. 135).

At least 18 credits used to fulfill an Astronomy, BS cannot be used to fulfill another major or minor. Some course substitutions are allowed for double majors, subject to approval from the Department of Physics and Astronomy (p. 724).
MATH 214 Elementary Differential Equations 3

Astronomy and Physics Courses
Select 15 credits from the following (at least 12 credits must be from upper-level courses):

- ASTR 301 Astrobiology
- ASTR 408 Senior Research
- PHYS 306 Wave Motion and Electromagnetic Radiation
- PHYS 307 Thermal Physics
- PHYS 402 Introduction to Quantum Mechanics and Atomic Physics
- ASTR 403 Planetary Sciences 1 or ASTR 404 Galaxies and Cosmology or PHYS 428 Relativity

Total Credits 15

1 PHYS 428 Relativity, if not taken as part of additional astronomy course requirement above, may be used here.

Mason Core and Elective Credits
In order to meet a minimum of 120 credits, this degree requires an additional 54 credits, which may be applied toward any remaining Mason Core (p. 135) requirements (outlined below), Requirements for Bachelor’s Degrees (p. 86), and electives. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all requirements.

Mason Core
Note: Some Mason Core (p. 135) requirements may already be fulfilled by the major requirements listed above. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all remaining Mason Core (p. 135) requirements.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foun. Req.</td>
<td>Written Communication (p. 135)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Oral Communication (p. 136)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Quantitative Reasoning (p. 136)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Information Technology (p. 136)</td>
<td>3-7</td>
</tr>
</tbody>
</table>

| Core Req.   | Arts (p. 137)                              | 3       |
|             | Global Understanding (p. 139)              | 3       |
|             | Literature (p. 140)                        | 3       |
|             | Natural Science (p. 141)                   | 7       |
|             | Social and Behavioral Sciences (p. 142)    | 3       |
|             | Western Civilization/World History (p. 143)| 3       |

| Synthesis/Capstone Requirement 1 | Synthesis/Capstone (p. 143) | 3     |

Total Credits 40

1 minimum 3 credits

Honors
Honors in the Major
Eligibility
Astronomy majors who have completed the prerequisites for ASTR 405 Honors Thesis in Astronomy I, have a GPA of at least 3.50 in ASTR and PHYS courses taken at Mason, and have a GPA of at least 3.50 in all courses taken at Mason may apply for admission to the astronomy honors program.

Honors Requirements
To graduate with honors in astronomy, a student must maintain a GPA of at least 3.50 in their ASTR/PHYS courses. Students accepted into the honors program must complete ASTR 405 Honors Thesis in Astronomy I and ASTR 406 Honors Thesis in Astronomy II with a GPA of at least 3.50 and a grade of ‘A’ or better in ASTR 406 Honors Thesis in Astronomy II. Students in ASTR 405 Honors Thesis in Astronomy I/ASTR 406 Honors Thesis in Astronomy II will complete a research project and write a thesis working under the supervision of a faculty member. At the end of ASTR 406 Honors Thesis in Astronomy II, the student will write a substantial thesis paper and make a presentation of results to their honors committee.

Physics Minor
Banner Code: PHYS
Stephanie Kuhta, Academic Administrative Specialist
203 Planetary Hall
Fairfax Campus
Phone: 703-993-5356
Email: smonk@gmu.edu
Website: physics.gmu.edu/minor-in-physics/

Admissions & Policies
Policies
Eight credits of coursework must be unique to the minor with a minimum GPA of 2.00. For policies governing all minors, see AP.5.3.4 Minors (p. 86).

Requirements
Minor Requirements
Total credits: 18
Students should refer to the Admissions & Policies (p. 730) tab for specific policies related to this program.

Coursework
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 160</td>
<td>University Physics I (Mason Core) (p. 135)</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 161</td>
<td>University Physics I Laboratory (Mason Core) (p. 135)</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 260</td>
<td>University Physics II (Mason Core) (p. 135)</td>
<td>3</td>
</tr>
</tbody>
</table>
Additional Coursework
Select two from the following:

- PHYS 303 Classical Mechanics
- PHYS 305 Electromagnetic Theory
- PHYS 306 Wave Motion and Electromagnetic Radiation
- PHYS 307 Thermal Physics
- PHYS 308 Modern Physics with Applications
- PHYS 402 Introduction to Quantum Mechanics and Atomic Physics
- PHYS 428 Relativity
- PHYS 513 Applied Electromagnetic Theory

Total Credits 6

Physics, BS
Banner Code: SC-BS-PHYS

Stephanie Kuhta, Academic Administrative Specialist
203 Planetary Hall
Fairfax Campus
Phone: 703-993-5356
Email: smonk@gmu.edu
Website: physics.gmu.edu/bs-physics/

The Physics, BS prepares students for graduate school and careers in education, business, or industry.

Teacher Licensure
Students who wish to become teachers and plan to seek teacher licensure should consider the following options:

- Secondary Education – Physics (6-12) Undergraduate Certificate (p. 206)
- Physics, BS/Curriculum and Instruction, Accelerated MEd (Secondary Education Physics concentration) (p. 734)

Interested students should attend an information session early in their undergraduate career. For more information, visit the Graduate School of Education's website (http://gse.gmu.edu).

Admissions & Policies

Admissions
University-wide admissions policies can be found in the Undergraduate Admissions Policies (p. 63) 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).

Policies
Students must fulfill all Requirements for Bachelor's Degrees (p. 86) including the Mason Core (p. 135).

The intensive writing requirement is fulfilled by taking PHYS 407 Senior Laboratory in Modern Physics (Mason Core) (p. 135) or ASTR 402 RS: Methods of Observational Astronomy (Mason Core) (p. 135), which are also capstone courses for the major.

For policies governing all undergraduate programs, see AP.5 Undergraduate Policies (p. 84).

Double Majors
Students in the fields of mathematics, science, and engineering who are considering a double major in physics should discuss this option with the respective undergraduate coordinators.

Note that at least 18 credits used to fulfill the Physics, BS cannot be used to fulfill another major or minor. Some course substitutions are allowed for double majors, but these should be discussed in advance.

Alternative Introductory Sequence
Normally, students who intend to major in physics should take the physics introductory sequence:

- PHYS 160 University Physics I (Mason Core) (p. 135) 3
- PHYS 161 University Physics I Laboratory (Mason Core) (p. 135) 1
- PHYS 260 University Physics II (Mason Core) (p. 135) 3
- PHYS 261 University Physics II Laboratory (Mason Core) (p. 135) 1

Students who decide to major in physics after completing PHYS 243 College Physics (Mason Core) (p. 135), PHYS 244 College Physics Lab (Mason Core) (p. 135), PHYS 245 College Physics (Mason Core) (p. 135), and PHYS 246 College Physics Lab (Mason Core) (p. 135) are welcome, but are required to obtain written permission from the Department of Physics and Astronomy (p. 724).

Requirements

Degree Requirements
Total credits: minimum 120

Students should refer to the Admissions & Policies (p. 731) tab for specific policies related to this program.

Students must complete a total of 75 credits in the major (69 credits if completing a second major), including at least 11 credits in mathematics, with a minimum GPA of 2.00.

Students must complete the coursework described below and either select a concentration or select the "BS without Concentration" option:

Physics Core Courses

PHYS 160 University Physics I (Mason Core) (p. 135) 3
**Physics, BS**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 161</td>
<td>University Physics I Laboratory (Mason Core)</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 251</td>
<td>Introduction to Computer Techniques in Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 260</td>
<td>University Physics II (Mason Core)</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 261</td>
<td>University Physics II Laboratory (Mason Core)</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 301</td>
<td>Analytical Methods of Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 303</td>
<td>Classical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 305</td>
<td>Electromagnetic Theory</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 307</td>
<td>Thermal Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 308</td>
<td>Modern Physics with Applications</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 402</td>
<td>Introduction to Quantum Mechanics and Atomic</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 416</td>
<td>Special Topics in Modern Physics</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Credits: 30

1. Students double majoring in engineering and physics may substitute ECE 305 Electromagnetic Theory for PHYS 305 Electromagnetic Theory.

**Mathematics**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 113</td>
<td>Analytic Geometry and Calculus I (Mason Core)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 114</td>
<td>Analytic Geometry and Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 213</td>
<td>Analytic Geometry and Calculus III</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credits: 11

**BS without Concentration**

Mathematics/Computational Physics 6

Select 6 credits from the following:

- PHYS 410 Computational Physics I
- MATH 203 Linear Algebra
- MATH 214 Elementary Differential Equations

Intermediate Laboratory 6

- PHYS 311 Instrumentation
- PHYS 312 Wave and Optics

Research, Internship, or Independent Study 3

Select 3 credits from the following:

- PHYS 326 Problems in Physics II
- PHYS 405 Honors Thesis in Physics
- PHYS 406 Honors Thesis in Physics
- PHYS 408 Senior Research
- PHYS 409 Physics Internship

Capstone 4

- PHYS 407 Senior Laboratory in Modern Physics (Mason Core) (p. 135) 1

Physics Theory 9-15

All students complete the following 9 credits:

- PHYS 306 Wave Motion and Electromagnetic Radiation
- PHYS 403 Quantum Mechanics II
- PHYS 428 Relativity

Only students who are not completing a second major must select 6 additional credits from the following:

- ASTR 210 Introduction to Astrophysics
- ASTR 328 Stars and Interstellar Medium
- ASTR 403 Planetary Sciences
- ASTR 404 Galaxies and Cosmology
- PHYS 370 Molecular Biophysics
- PHYS 412 Solid State Physics and Applications
- PHYS 440 Nuclear and Particle Physics
- PHYS 465 Planetary Atmospheres and Ionspheres
- PHYS 475 Atmospheric Physics

Total Credits 28-34

1. Fulfills the writing intensive requirement.

**Applied and Engineering Physics Concentration (PHAE)**

Mathematics/Computational Physics 3

- PHYS 410 Computational Physics I

Intermediate Laboratory 6

- PHYS 311 Instrumentation
- PHYS 312 Wave and Optics

Physics Theory 9

- PHYS 306 Wave Motion and Electromagnetic Radiation

Select 6 credits from the following:

- PHYS 370 Molecular Biophysics
- PHYS 403 Quantum Mechanics II
- PHYS 412 Solid State Physics and Applications

Capstone 4

- PHYS 407 Senior Laboratory in Modern Physics (Mason Core) (p. 135) 1

Practical Work 6-12

Students who are not completing a second major should select 12 credits from the following. Students who are completing a second major should select 6 credits:

- PHYS 405 Honors Thesis in Physics
- PHYS 406 Honors Thesis in Physics
- PHYS 408 Senior Research
- PHYS 409 Physics Internship
- BENG 320 Bioengineering Signals and Systems
- Or other approved 300 or 400-level Volgenau School of Engineering courses

Total Credits 28-34

1. Fulfills the writing intensive requirement.

**Astrophysics Concentration (PHAP)**

Mathematics/Computational Physics 3

Select 3 credits from the following:

- ASTR 401 Computer Simulation in Astronomy
- PHYS 410 Computational Physics I
- MATH 214 Elementary Differential Equations

Intermediate Laboratory 6

- PHYS 311 Instrumentation
**Phys 312**  Wave and Optics  

**Research, Internship, or Independent Study**  3  
Select 3 credits from the following:  
- ASTR 405  Honors Thesis in Astronomy I  
- ASTR 406  Honors Thesis in Astronomy II  
- ASTR 408  Senior Research  
- ASTR 409  Astronomy Internship  
- PHYS 326  Problems in Physics II  
- PHYS 405  Honors Thesis in Physics  
- PHYS 406  Honors Thesis in Physics  
- PHYS 408  Senior Research  
- PHYS 409  Physics Internship  

**Capstone**  4  
Select 4 credits from the following:  
- ASTR 402  RS: Methods of Observational Astronomy (Mason Core) (p. 135)  
- PHYS 407  Senior Laboratory in Modern Physics (Mason Core) (p. 135)  

**Physics and Astronomy Theory**  12-18  
Students who are not completing a second major must complete the following:  
- ASTR 210  Introduction to Astrophysics  
- ASTR 328  Stars and Interstellar Medium  
- ASTR 403  Planetary Sciences  
- ASTR 404  Galaxies and Cosmology  
- PHYS 306  Wave Motion and Electromagnetic Radiation  
- PHYS 428  Relativity  
Students who are completing a second major must complete the following:  
- ASTR 210  Introduction to Astrophysics  
- ASTR 328  Stars and Interstellar Medium  
Additionally, select 3 credits from the following:  
- PHYS 306  Wave Motion and Electromagnetic Radiation  
- PHYS 428  Relativity  
Lastly, select 3 credits from the following:  
- ASTR 403  Planetary Sciences  
- ASTR 404  Galaxies and Cosmology  

**Total Credits**  28-34  
1  Fulfills the writing intensive requirement.

**Mason Core and Elective Credits**  
In order to meet a minimum of 120 credits, this degree requires 45 (or 51 if completing a second major) additional credits, which may be applied toward any remaining Mason Core (p. 135) requirements (outlined below), Requirements for Bachelor's Degrees (p. 86), and elective courses. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all requirements.

**Mason Core**  
Note: Some Mason Core (p. 135) requirements may already be fulfilled by the major requirements listed above. Students are strongly encouraged to consult their advisors to ensure they fulfill all remaining Mason Core (p. 135) requirements.

**Intermediate Laboratory**  3  
- PHYS 311  Instrumentation  

**Research, Internship, or Independent Study**  3  
Select 3 credits from the following:  
- PHYS 326  Problems in Physics II  
- PHYS 405  Honors Thesis in Physics  
- PHYS 406  Honors Thesis in Physics  
- PHYS 408  Senior Research  
- PHYS 409  Physics Internship  

**Capstone**  4  
Select 4 credits from the following:  
- ASTR 402  RS: Methods of Observational Astronomy (Mason Core) (p. 135)  
- PHYS 407  Senior Laboratory in Modern Physics (Mason Core) (p. 135)  

**Physics and Astronomy Theory**  3-9  
Students who are not completing a second major must select 9 credits of the following. Students who are completing a second major must select 3 credits from the following:  
- ASTR 210  Introduction to Astrophysics  
- ASTR 328  Stars and Interstellar Medium  
- ASTR 403  Planetary Sciences  
- PHYS 306  Wave Motion and Electromagnetic Radiation  
- PHYS 412  Solid State Physics and Applications  

**Total Credits**  28-34  
1  Fulfills the writing intensive requirement.

**Computational Physics Concentration (PHCP)**  
**Mathematics/Computational Physics**  15  
- PHYS 410  Computational Physics I  
- MATH 203  Linear Algebra  
- MATH 214  Elementary Differential Equations  
Additionally, select 6 credits from the following:  
- ASTR 401  Computer Simulation in Astronomy  
- CDS 302  Scientific Data and Databases  
- CDS 303  Scientific Data Mining  
- MATH 446  Numerical Analysis I  
- MATH 447  Numerical Analysis II  

**Founding Requirements**  
Written Communication (p. 135)  6  
Oral Communication (p. 136)  3  
Quantitative Reasoning (p. 136)  3  
Information Technology (p. 136)  3-7  

**Core Requirements**  
Arts (p. 137)  3  
Global Understanding (p. 139)  3  
Literature (p. 140)  3  
Natural Science (p. 141)  7  
Social and Behavioral Sciences (p. 142)  3  
Western Civilization/World History (p. 143)  3
Synthesis/Capstone Requirement

<table>
<thead>
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<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Synthesis/Capstone (p. 143)</td>
<td>3</td>
</tr>
<tr>
<td>Total Credits</td>
<td>40</td>
</tr>
</tbody>
</table>

1 minimum 3 credits

Honors in the Major

Physics majors who have maintained an overall GPA of at least 3.50 in physics courses and a GPA of 3.50 in all courses taken at George Mason University may apply to the physics honors program when they complete the first semester of their junior year.

To graduate with honors in physics, a student is required to maintain a minimum GPA of 3.00 in physics courses and successfully complete PHYS 405 Honors Thesis in Physics and PHYS 406 Honors Thesis in Physics with a GPA of at least 3.50 and a grade of at least 'A-' in PHYS 406 Honors Thesis in Physics.

Accelerated Master's

Physics, BS/Curriculum and Instruction, Accelerated MEd (Secondary Education Physics concentration)

Overview

Highly-qualified undergraduates may be admitted to the bachelor's/accelerated master's program and obtain both a BS in Physics (p. 731) and an MEd in Curriculum and Instruction (p. 161). Secondary Education Physics Concentration in an accelerated timeframe after satisfactory completion of 149 credits. See AP.6.7 Bachelor's/Accelerated Master's Degrees (p. 89) for policies related to this program.

This accelerated option is offered jointly by the department of Physics and Astronomy (p. 724) and the Graduate School of Education (p. 155).

Students in an accelerated degree program must fulfill all university requirements for the master's degree. For policies governing all graduate degrees, see AP.6 Graduate Policies (p. 87).

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 Graduate Admissions Policies (p. 66). For information specific to this accelerated master's program, see Application Requirements and Deadlines (https://cehd.gmu.edu/bachelors-accelerated-masters-program).

Accelerated Option Requirements

Students complete the following courses in their senior year:

<table>
<thead>
<tr>
<th>Senior</th>
<th>Credits</th>
<th>Fall Semester</th>
<th>Credits</th>
<th>Spring Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EDCI 573</td>
<td>3</td>
<td>EDCI 673</td>
<td>3</td>
</tr>
</tbody>
</table>

While undergraduate students, accelerated master’s students are able to apply two of the courses listed above to both the bachelor's and master's degrees. These courses are considered advanced standing for the MEd. A minimum grade of B must be earned to be eligible to count as advanced standing. The other two courses are taken as reserve graduate credit and do not apply to the undergraduate degree. Early in their final undergraduate semester, students must submit the Bachelor's/Accelerated Master's Transition Form to the CEHD Admissions Office and specify which of the four courses are to be designated as advanced standing and reserve graduate credit.

Physics, BS/Applied and Engineering Physics, Accelerated MS

Overview

This program allows academically strong undergraduates with a demonstrable commitment to research to obtain the Physics, BS (p. 731) and Applied and Engineering Physics, MS (p. 726) degrees by successfully completing 144 credits. Upon completion, students are well-prepared for entry into a professional school or a PhD program in physics or a related discipline.

Admitted students take selected graduate courses during their senior year and are able to use up to 6 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 24 credits to receive the master's degree.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (p. 89). For policies governing all graduate degrees, see AP.6 Graduate Policies (p. 87).

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 (p. 66) section of this catalog.

Successful applicants will have completed at least 90 credits toward their undergraduate degree and 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

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.

**Physics, PhD**

*Banner Code: SC-PHD-PHYS*

*Robert Weigel, Associate Professor*
259 Planetary Hall
Fairfax Campus
Phone: 703-993-1361
Email: rweigel@gmu.edu
Website: physics.gmu.edu/phd-in-physics/

The degree program contains a Standard Concentration for traditional physics programs that focus on Astrophysics, Condensed Matter Theory, Dynamical Systems/Biological Physics, High Energy Physics, Materials Physics, Space Sciences, and an Engineering Physics Concentration that combines the disciplines of physics, mathematics, and engineering. The doctoral students accepted into each concentration of the physics PhD program take a required set of core courses for the given concentration (see Requirements tab).

By working with the dissertation committee, a student in the Standard Concentration may choose to specialize in an emphasis area such as Astrophysics, Condensed Matter Theory, Dynamical Systems/Biological Physics, High Energy Physics, Materials Physics, Space Sciences, or others according to his or her particular interests. A student in the Engineering Physics Concentration may choose to specialize in Applied Mechanics, or other applied and engineering physics areas. By the end of their first year, all students should pair with a faculty advisor who will guide them toward doctoral candidacy.

**Admissions & Policies**

**Admissions**

University-wide admissions policies can be found in the Graduate Admissions Policies (p. 66) 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).

Those holding a baccalaureate degree in physics, astronomy, or engineering from a regionally accredited institution, who earned a GPA of 3.00 (out of 4.00) or higher in their last 60 credits, and received acceptable scores on the GRE-GEN are invited to apply for admission. Three letters of recommendation must be submitted, preferably from former professors. The GRE subject test in physics is highly recommended for all interested applicants in the standard concentration who received their baccalaureate degrees within the past five years. A degree-seeking graduate applicant with a baccalaureate degree who has not met all admission requirements may be offered provisional admission if sufficient evidence is presented to suggest that the applicant has the ability to pursue graduate work. For more details concerning admission requirements to George Mason University please refer to Graduate Admission Policies (p. 66).

**Policies**

For policies governing all graduate programs, see AP.6 Graduate Policies (p. 87).

**Reduction of Credits**
For students entering the doctoral program with a master's degree in a related field from a regionally accredited institution, the number of required credits may be reduced up to 30 credits, subject to approval of the program faculty and the college's associate dean. See AP.6.5.2 Reduction of Credits (p. 88) for more information.

**Requirements**

**Degree Requirements**

Total credits: 72

Students should refer to the Admissions & Policies (p. 735) tab for specific policies related to this program.

Students must first choose one concentration, then continue with the additional sections:

**Standard Concentration (STND)**

**Core Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>PHYS 684</td>
<td>Quantum Mechanics I</td>
</tr>
<tr>
<td>PHYS 685</td>
<td>Classical Electrodynamics I</td>
</tr>
<tr>
<td>PHYS 705</td>
<td>Classical Mechanics</td>
</tr>
<tr>
<td>PHYS 711</td>
<td>Statistical Mechanics</td>
</tr>
</tbody>
</table>

**Specialty Science Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 680</td>
<td>Physics of interstellar Media</td>
</tr>
<tr>
<td>ASTR 730</td>
<td>Stellar Astrophysics</td>
</tr>
<tr>
<td>PHYS 784</td>
<td>Quantum Mechanics II</td>
</tr>
<tr>
<td>PHYS 785</td>
<td>Classical Electrodynamics II</td>
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**Seminar Course**

<table>
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<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>PHYS 703</td>
<td>Seminar in Physics (must be taken three times)</td>
</tr>
</tbody>
</table>

Total Credits: 21

**Engineering Physics Concentration (ENGP)**

**Core Courses**

<table>
<thead>
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<th>Course</th>
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</thead>
<tbody>
<tr>
<td>PHYS 510</td>
<td>Computational Physics I</td>
</tr>
<tr>
<td>PHYS 613</td>
<td>Computational Physics II</td>
</tr>
<tr>
<td>PHYS 620</td>
<td>Continuum Mechanics</td>
</tr>
<tr>
<td>PHYS 690</td>
<td>Engineering Thermodynamics</td>
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</tbody>
</table>

**Specialty Science Courses**

<table>
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<th>Title</th>
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</thead>
<tbody>
<tr>
<td>PHYS 640</td>
<td>Finite Element Analysis of Solids and Fluids</td>
</tr>
<tr>
<td>PHYS 694</td>
<td>Applied Mechanics of Solids</td>
</tr>
<tr>
<td>PHYS 695</td>
<td>Applied Fluid Mechanics</td>
</tr>
</tbody>
</table>
At the beginning of each academic year, the program director will appoint members to the qualifying examination committee. This committee is responsible for creating, administering, and grading the qualifying exams offered that year. Additional information and previous qualifying exams can be found on the departmental web page.

**Dissertation Committee and Program of Study**

Upon successful completion of the qualifying examinations, a dissertation committee should be formed by the student as soon as possible. The chair of this committee must be a graduate faculty member from the Department of Physics and Astronomy. The committee must include at least two additional members from the graduate faculty, one of whom must be from outside the Department of Physics and Astronomy. The composition of the committee must be approved by the program director. The dissertation committee is responsible for directing the student in their chosen field of research. The student should work closely with their committee to select specialty courses and electives that form a cohesive program of study. The student's program of study must be approved by the dean before advancement to candidacy.

**Advancement to Candidacy**

Before a student may be advanced to doctoral candidacy, he/she needs to complete all required coursework, pass the qualifying examination, have the program of study and dissertation proposal approved by the dean, and be recommended by the dissertation committee. Advancement to doctoral candidacy implies that the student has demonstrated adequate breadth and depth of knowledge in the field of study and is capable of conducting research on the boundaries of knowledge.

**Dissertation Research**

Note: No more than 24 combined credits from PHYS 998 Doctoral Dissertation Proposal/ASTR 998 Doctoral Dissertation Proposal and PHYS 999 Doctoral Dissertation/ASTR 999 Doctoral Dissertation may be applied toward satisfying the doctoral degree requirements, with no more than 12 credits of PHYS 998 Doctoral Dissertation Proposal/ASTR 998 Doctoral Dissertation Proposal.

Select 24 credits from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 998</td>
<td>Doctoral Dissertation Proposal</td>
</tr>
<tr>
<td>ASTR 999</td>
<td>Doctoral Dissertation</td>
</tr>
<tr>
<td>PHYS 998</td>
<td>Doctoral Dissertation Proposal</td>
</tr>
<tr>
<td>PHYS 999</td>
<td>Doctoral Dissertation</td>
</tr>
</tbody>
</table>

**Total Credits** 24

**Doctoral Dissertations**

After advancing to doctoral candidacy, the student works with their dissertation committee to develop their preliminary research into a doctoral dissertation. The dissertation research should represent a significant contribution to its scientific field and should be deemed publishable in a refereed scientific journal. The dissertation must be defended in a public forum before the dissertation committee and other interested faculty.

**Renewable Energy Interdisciplinary Minor**

Banner Code: RNRG

Harold Geller, Associate Professor and Observatory Director
This college-wide interdisciplinary minor is designed for students considering a career in the field of renewable energy, or as preparation for graduate work in a wide range of academic disciplines.

Renewable energy, as normally understood, includes a variety of methods of energy generation, such as solar, wind, hydro, tidal, and geothermal, as well as energy storage methods and energy conservation. Jobs related to renewable energy lie in a wide range of areas including engineering, business, marketing, finance, installation, software, legal affairs, and research. Projections suggest that employment opportunities in the renewable energy field will increase dramatically in the near future. The Renewable Energy Interdisciplinary Minor is therefore ideally suited for students with majors in engineering, business, and basic science.

Admissions & Policies

Policies

Eight credits of coursework must be unique to the minor. For policies governing all minors, see AP.5.3.4 Minors (p. 86).

Requirements

Minor Requirements

Total credits: 17-20

Students should refer to the Admissions & Policies (p. 737) tab for specific policies related to this program.

Core Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 331</td>
<td>Fundamentals of Renewable Energy</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 385</td>
<td>Materials Science with Applications to Renewable Energy</td>
<td>3</td>
</tr>
<tr>
<td>MATH 113</td>
<td>Analytic Geometry and Calculus I (Mason Core) (p. 135)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>10</td>
</tr>
</tbody>
</table>

Physics

Select one from the following: 1-3

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>PHYS 245</td>
<td>College Physics (Mason Core) (p. 135)</td>
<td>1-3</td>
</tr>
<tr>
<td>PHYS 262</td>
<td>University Physics III (Mason Core) (p. 135)</td>
<td></td>
</tr>
<tr>
<td>PHYS 266</td>
<td>Introduction to Thermodynamics</td>
<td>1-3</td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>1-3</td>
</tr>
</tbody>
</table>

Other Science or Engineering Course

Select 3-4 credits from the following in consultation with minor advisor:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 332</td>
<td>Solar Cells</td>
<td>3-4</td>
</tr>
</tbody>
</table>

Forensic Science Program

Phone: 703-993-5071
Email: fscience@gmu.edu
Website: forensicscience.gmu.edu

Administration

- Mary Ellen O’Toole, Director

The Forensic Science Program is an interdisciplinary academic program with its own dedicated teaching faculty. The program is administered by the forensic science program director, and is governed by the Forensic Science Program committee.

Faculty

Program Faculty

Director

O’Toole

Assistant Professors

Burmeister, DiZinno, Knight, Rancourt, Rule

Adjunct Faculty

Buhrow, Christensen, Clay, Crucitti, Eckenrode, Hutchinson, Mullins, O’Neal, Pruitt, Ramage, Rodway, Stanley

Programs

- Forensic Science Minor
- Forensic Science, BS
- Forensic Science, MS
- Forensics Graduate Certificate