

Date Submitted: 12/11/20 3:15 pm

Viewing: **SC-MS-PHAE : Applied and Engineering
Physics, MS**

Last approved: 03/29/18 9:35 am

Last edit: 12/11/20 3:15 pm

Changes proposed by: jbazaz

**Catalog Pages
Using this Program**

[Applied and Engineering Physics, MS](#)

Are you completing this form on someone else's behalf?

Yes

Requestor:

In Workflow

1. Registrar:CIP Code
2. PHYS GR Committee
3. PHYS Chair
4. SC Curriculum Committee
5. SC Associate Dean
6. SC CAT Editor
7. Assoc Provost-Graduate
8. Registrar:Concentrat Code
9. Registrar-Programs: Duration
10. Registrar-Programs

Approval Path

1. 12/04/19 2:52 pm
Ernest Barreto (ebarreto):
Approved for PHYS GR Committee
2. 12/06/19 2:45 pm
Paul So (paso):
Approved for PHYS Chair
3. 03/03/20 3:27 pm
Jennifer Bazaz Gettys (jbazaz):
Rollback to Initiator
4. 12/11/20 2:26 pm
Johanna Riemen (jriemen): Rollback to Initiator

History

1. Nov 14, 2017 by
clmig-jwehrheim
2. Jan 16, 2018 by
Rebekah Zacharias
(rzachari)
3. Mar 6, 2018 by
Jennifer Bazaz
Gettys (jbazaz)
4. Mar 6, 2018 by
pchampan
5. Mar 14, 2018 by
Rebekah Zacharias
(rzachari)
6. Mar 28, 2018 by
Rebekah Zacharias
(rzachari)
7. Mar 29, 2018 by
Rebekah Zacharias
(rzachari)

Name	Extension	Email
Jessica Rosenberg	9551	jrosenb4

Effective Catalog: 2021-2022

Program Level: Graduate

Program Type: Master's

Degree Type: Master of Science

Title: Applied and Engineering Physics, MS

Banner Title: **Applied & Engineering Phys MS**

Registrar/OAPI Use Only – SCHEV Status Approved

Registrar’s Office Use Only – Program Start Term

Registrar/OAPI Use Only – SCHEV Letter

Registrar/OAPI Use Only – SACSCOC

Status**Concentration(s):**

	Associated Concentrations	Registrar's Office Use Only: Concentration Code
1	Standard Physics Concentration	
2	Engineering Physics Concentration	
3	Applied Physics Concentration	
4	Quantum Information Science and Engineering Concentration	

Registrar/IRR Use Only – Concentration CIP Code

College/School: College of Science

Department / Academic Unit: Physics & Astronomy

Jointly Owned Program? No

Justification

In addition to reorganizing the program's core courses in order to meet SCHEV's minimum 50% shared core requirements, we are changing the name of our areas of study from "Emphases" to "Concentrations" in order to adhere to university norms. Additionally, we are creating a new concentration in Quantum Information Science and Engineering.

The objective of this new concentration is to create a graduate program of study in quantum information science and engineering (QISE) that works alongside industrial partners. The National Quantum Initiative, signed into law in December 2018, mandated the creation of new research and educational programs to support the second quantum technological revolution. By harnessing quantum phenomena, it is possible to radically improve computing, sensing, and communications technology.

Presently, there is a massive shortage of scientists and engineers with the appropriate expertise in quantum experiment and quantum theory. Numerous established companies and young technology startups are actively seeking highly trained Masters-level employees who can help make advances in quantum technologies. Through consultations with companies such as Northrop Grumman, Lockheed Martin, Qrypt, and Montana Instruments, as well as the Quantum Materials Center's participation in a workforce needs surveys with the Quantum Economic Development Consortium, four key focus areas have been identified that constitute key needs in the quantum community. To achieve these goals and readily transition the

transdisciplinary masters' students to employment in the quantum workforce, we have designed a flexible curriculum that has industrial interaction at its core and can adapt as the industry more clearly defines what is needed in this new area.

Total Credits Required: Total credits: 30

Registrar's Office Use Only - Program Code:

SC-MS-PHAE

Registrar/IRR Use Only – Program CIP Code **40.0801 - Physics, General.**

Admission Requirements:

Admissions

University-wide admissions policies can be found in the [Graduate Admissions Policies](#) section of this catalog. To apply for this program, please complete the [George Mason University Admissions Application](#). 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 **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.

Program-Specific Policies:

Policies

For policies governing all graduate programs, see [AP.6 Graduate Policies](#).

Degree Requirements:

Students should refer to the [Admissions & Policies](#) tab for specific policies related to this **program.** ~~program. Select one emphasis and complete all the requirements therein.~~

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

Plan of Study

Before the **beginning end** of their first semester, **students are advised** ~~each student must submit~~ **to meet with their academic advisor and develop** ~~the graduate coordinator's office~~ **a preliminary plan of study for the concentration**

they are interested in pursuing. that has been approved by their academic advisor. The selected courses must be cohesive and lead to comprehensive knowledge in one area; it cannot be a set of disjointed courses. Any deviations from this plan must be approved by the student's academic advisor. A final final, signed version of the plan of study must be approved by the submitted to the graduate coordinator at the start of the semester in which the student graduates. plans to graduate.

Core Courses

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

Choose one course from each grouping:

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

Select one emphasis and complete all the requirements therein. Standard Physics Concentration

This concentration ~~Emphasis~~This emphasis 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** ~~Physics concentration~~ of the **Physics** ~~Physics~~ PhD.

~~Core Courses~~

12

~~PHYS 684~~ Quantum Mechanics I

~~PHYS 685~~ Classical Electrodynamics I

Core Course

3

PHYS 705 Classical Mechanics

PHYS 711 Statistical Mechanics

Emphasis Electives 1

Select 9 credits of graduate-level courses from the following:

9

Concentration Electives

3

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

ASTRPHYS

General Electives

9

Select 9 credits of graduate-level science courses approved by an academic advisor:

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 Emphasis

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

Core Courses

12

Choose one course from each group:

Group One

PHYS 510 Computational Physics I

Group Two

PHYS 502 Introduction to Quantum Mechanics and Atomic Physics

PHYS 684 Quantum Mechanics I

PHYS 690 Engineering Thermodynamics

Group Three

PHYS 513 Applied Electromagnetic Theory

PHYS 620 Continuum Mechanics

PHYS 685 Classical Electrodynamics I

Group Four

PHYS 533 Modern Instrumentation

PHYS 613 Computational Physics II

Emphasis Electives 1

9

Select 9 credits of graduate-level courses from the following:

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**PHYSMATHBENGCEIEECEME

General Electives

9

~~Select 9 credits of graduate-level science and engineering courses approved by an academic advisor.~~**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 ~~Emphasis~~

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

Core Courses**12****Select one course from each group:****Group One****PHYS 510 Computational Physics I****Group Two****Core Course****3**PHYS 533 Modern Instrumentation**Group Three****PHYS 502 Introduction to Quantum Mechanics and Atomic Physics****PHYS 684 Quantum Mechanics I****Group Four****PHYS 513 Applied Electromagnetic Theory****PHYS 685 Classical Electrodynamics I****Concentration Electives****3****In consultation with an advisor, select 3 credits of graduate-level courses from the following course prefixes: 1**PHYS**General Electives 2****9**

Select 9 credits of graduate-level science and engineering courses approved by an academic advisor.

[BINF](#)

[CHEM](#)

[CLIM](#)

[MATH](#)

[CSI](#)

[STAT](#)

General Electives

9

Select 9 credits of graduate-level courses from the following:

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

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.

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 646](#) Applied Cryptography

[ECE 699](#) Advanced Topics in Electrical and Computer Engineering

[ECE 746](#) Advanced Applied Cryptography

[ECE 747](#) Cryptographic Engineering

Focus Area: Hardware

<u>PHYS 512</u>	Solid State Physics and Applications
<u>PHYS 533</u>	Modern Instrumentation
<u>PHYS 611</u>	Electro-optics
<u>PHYS 784</u>	Quantum Mechanics II
<u>CHEM 579</u>	Special Topics
<u>CHEM 736</u>	Computational Quantum Mechanics
<u>ECE 685</u>	Nanoelectronics
<u>ME 754</u>	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.

<u>PHYS 798</u>	Research Project
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General Electives**9**

Select 9 credits of graduate-level science and engineering courses approved by an academic advisor. 1

Total Credits

15

- 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 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](#). 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.

**Retroactive
Requirements
Updates:**

Plan of Study:

Program Outcomes

Additional Program Information

This information is required by the Office of Accreditation and Program Integrity.

Courses offered via distance (if applicable):

What is the primary delivery format for the program?
Face-to-Face Only

Does any portion of this program occur off-campus?

No

Are you working with a vendor / other collaborators to offer your program?

No

Related Departments

Could this program prepare students for any type of professional licensure, in Virginia or elsewhere?

No

Are you adding or removing a licensure component?

No

Additional SCHEV & SACSCOC Information

Are you changing the total number of credits required for this program?

No

Are you changing the delivery format in any way (e.g adding an online option)?

No

Are you adding/removing a licensure option which was approved by SCHEV?

No

Will any portion of this program be offered at an off-campus location?

No

Will this program change affect any specialized accreditation?

No

Is the content of the new program closely related to that of an existing approved program?

No

Is this new program considered to be "advancing the degree level of a currently approved program" (i.e. existing content is at lower degree level, new content is at the higher degree level)?

No

Is this new program considered to be "lowering the degree level of a currently approved program" (i.e. existing content is at higher degree level, new content is at the lower degree level)?

No

Does this change represent a repackaging of content in an existing approved degree/certificate program?

No

Percentage of total credits containing new course content, excluding gen ed courses for undergraduate programs. ("New content" means content that is not currently included in an existing approved degree/certificate program.) Please choose a percentage (i.e. 0%-100%)

Greater than 33%

Are the total credits for the program increasing or decreasing by more than 3 credits?

No

Will any additional equipment/facilities be needed?

No

Will any additional faculty be required?

No

Will any additional financial resources be needed?

No

Will any additional library/learning resources needed?

No

OAPI Use Only – Determination of SACSCOC Impact

Comments or Notes

Green Leaf Program Designation

Is this a Green Leaf program? No

Does this program cover material which crosses into another department?

No

Additional Attachments [msphae_001.pdf](#)

SCHEV Proposal

Executive Summary

Reviewer

Comments

Jennifer Bazaz Gettys (jbazaz) (03/03/20 3:27 pm): Rollback: Modifications may need to be shredded after confirmation from department.

Johanna Riemen (jriemen) (12/11/20 2:26 pm): Rollback: Per 12/11/20 email request

Additional Comments

Is this course required of all students in this degree program?

%wi_required.eshtml%

Key: 347