Program Approval Form

For approval of new programs and deletions or modifications to an existing program.

Action Requested:

- [ ] Create New (SCHEV approval required except for minors)
- [ ] Inactivate Existing
- [x] Modify Existing (check all that apply)
  - [ ] Title (SCHEV approval required except for minors)
  - [ ] **Concentration** (Choose one): [ ] *Add* [ ] *Delete* [ ] *Modify*
  - [x] Degree Requirements
  - [ ] Admission Standards/ Application Requirements
  - [x] Other Changes: Total Credits

Type (Check one)**:**

- [ ] B.A. [x] B.S. [ ] Minor
- [ ] M.A. [ ] M.S. [ ] M.Ed.
- [ ] Ph.D.
- [ ] Undergraduate Certificate*
- [ ] Graduate Certificate*
- [ ] Other:

College/School:	COS	**Department:**	Physics & Astronomy		
Submitted by:	Philip Rubin	**Ext:**	3815	**Email:**	prubin@gmu.edu

Effective Term: Fall 2016

Please note: For students to be admitted to a new degree, minor, certificate or concentration, the program must be fully approved, entered into Banner, and published in the University Catalog.

Justification: (attach separate document if necessary)

Adjust requirements to incorporate new computational requirement, PHYS 150.

Degree Requirements:
Consult University Catalog for models, attach separate document if necessary using track changes for modifications

Existing	New/Modified
Physics Core Courses (27 credits) **And** choose at least 7 credits from the following courses: • CS 112 - Introduction to Computer Programming Credits: 4 • Additional approved upper-level physics, astronomy, computational and data sciences, chemistry, electrical engineering, or mathematics courses (for examples, see the areas of emphasis below)	Physics Core Courses (30 credits) • PHYS 150 - Computing for Physics and Engineering I (Mason Core: IT All course) **And** choose at least 7 credits from approved upper-level physics, astronomy, computational and data sciences, chemistry, engineering, or mathematics courses
TOTAL CREDITS REQUIRED: 65	68

***For Certificates Only:** Indicate whether students are able to pursue on a [ ] **Full-time basis** [ ] **Part-time basis**

Approval Signatures

Department Date | College/School Date | Provost's Office Date
Required for Minors and Interdisciplinary Programs

If this program may impact another unit or is in collaboration with another unit at Mason, the originating department must circulate this proposal for review by those units and obtain the necessary signatures prior to submission. Failure to do so will delay action on this proposal.

Unit Name	Unit Approval Name	Unit Approver's Signature	Date

For Graduate Programs Only

Graduate Council Member	Provost Office	Graduate Council Approval Date

For Registrar Office's Use Only: Received_____Banner_____Catalog_____
revised 6/7/12

Program Proposal Submitted to the College of Science Curriculum Committee (COSCC)

The form above is processed by the Office of the University Registrar. This second page is for the COSCC's reference. Please complete the applicable portions of this page to clearly communicate what the form above is requesting.

FOR ALL PROGRAMS (required)

Program Title: Physics B.S.

Date of Departmental Approval:

FOR MODIFIED PROGRAMS (required if modifying a program)

- Summary of the Modification: Add required computation course that satisfies IT All requirement; remove CS 112 as elective; add 3 credits to major total credit requirements (3 Mason Core credits reduced)

- Text before Modification (title, degree requirements, etc.):

Physics, BS

Banner Code: SC-BS-PHYS

This program of study is offered by the Department of Physics and Astronomy in the College of Science.

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

Students must fulfill all requirements for bachelor's degrees including the Mason Core. In addition, students must complete a total of 45 credits in the major and 17 in mathematics, with a minimum GPA of 2.00, distributed as follows. Through the coursework below, physics majors satisfy the Mason Core requirements in 'Natural Science' and 'Quantitative Reasoning'. The intensive writing requirement is fulfilled by taking PHYS 407.

This undergraduate program offers students the option of applying to the Physics, BS/Applied and Engineering Physics, Accelerated MS or the Physics, BS/Curriculum and Instruction, Accelerated MEd (Secondary Education Physics Concentration). See each listing for specific requirements.
Alternative Introductory Sequence

Normally, students who intend to major in physics should take the physics introductory sequence (PHYS 160, PHYS 161, PHYS 260, PHYS 261, PHYS 262, and PHYS 263). Students who decide to

major in physics after completing PHYS 243, PHYS 244, PHYS 245, and PHYS 246 may do so but only with written permission of the Department of Physics and Astronomy. Those students are required to take 4 additional credits in approved physics courses.

Degree Requirements

Physics Core Courses (27 credits)

Note: Students double majoring in engineering and physics may substitute ECE 305 for PHYS 305, and ECE 333/ECE 334 for PHYS 407.

PHYS 160 - University Physics I Credits: 3 (Mason Core: Natural Science course)
PHYS 161 - University Physics I Laboratory Credits: 1 (Mason Core: Natural Science course)
PHYS 260 - University Physics II Credits: 3 (Mason Core: Natural Science course)
PHYS 261 - University Physics II Laboratory Credits: 1 (Mason Core: Natural Science course)
PHYS 262 - University Physics III Credits: 3 (Mason Core: Natural Science course)
PHYS 263 - University Physics III Laboratory Credits: 1 (Mason Core: Natural Science course)
PHYS 303 - Classical Mechanics Credits: 3
PHYS 305 - Electromagnetic Theory Credits: 3
PHYS 308 - Modern Physics with Applications Credits: 3
PHYS 402 - Introduction to Quantum Mechanics and Atomic Physics Credits: 3
PHYS 407 - Senior Laboratory in Modern Physics Credits: 3

Physics Electives (6 credits)

Students take 6 credits selected from the following:

PHYS 251 - Introduction to Computer Techniques in Physics Credits: 3
PHYS 306 - Wave Motion and Electromagnetic Radiation Credits: 3
PHYS 307 - Thermal Physics Credits: 3
PHYS 405 - Honors Thesis in Physics Credits: 3 or PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 2-3
or PHYS 409 - Physics Internship Credits: 3
PHYS 416 - Special Topics in Modern Physics Credits: 1
ASTR 328 - Stars and Interstellar Medium Credits: 3
or PHYS 428 - Relativity Credits: 3

Mathematics (17 credits)

MATH 113 - Analytic Geometry and Calculus I Credits: 4 (Mason Core: Quantitative Reasoning course)
MATH 114 - Analytic Geometry and Calculus II Credits: 4
MATH 203 - Linear Algebra Credits: 3
MATH 213 - Analytic Geometry and Calculus III Credits: 3
MATH 214 - Elementary Differential Equations Credits: 3

Analytical Methods (3 credits)

Choose one of the following:

PHYS 301 - Analytical Methods of Physics Credits: 3

MATH 313 - Introduction to Applied Analysis Credits: 3
MATH 314 - Introduction to Applied Mathematics Credits: 3

Additional Science Courses (12 credits)

Choose no more than 5 credits from the following courses:

PHYS 121 - Uses of Physics Credits: 1
PHYS 122 - Inside Relativity Credits: 1
PHYS 123 - Inside the Quantum World Credits: 1
PHYS 124 - Experimental Explorations in Physics Credits: 2
ASTR 210 - Introduction to Astrophysics Credits: 3
ASTR 301 - Astrobiology Credits: 3

And choose at least 7 credits from the following courses:
CS 112 - Introduction to Computer Programming Credits: 4
Additional approved upper-level physics, astronomy, computational and data sciences, chemistry, electrical engineering, or mathematics courses (for examples, see the areas of emphasis below)

Emphasis Options

In meeting all or part of the requirement for 12 credits of Additional Science Courses (above), students may be guided by the following model emphases. Students should plan a program of study in consultation with their advisor.

Emphases and suggested courses for each are listed below.
Emphasis in Applied Solid State Physics

This emphasis is for students who wish to pursue a career in the semiconductor industry. To complete this emphasis, students should take 12 credits selected from the following courses:

PHYS 512 - Solid State Physics and Applications Credits: 3
ECE 430 - Principles of Semiconductor Devices Credits: 3
ECE 431 - Digital Circuit Design Credits: 3

And one from the following:
PHYS 405 - Honors Thesis in Physics Credits: 3
PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 2-3
PHYS 409 - Physics Internship Credits: 3

Emphasis in Astrophysics

This emphasis is for students who are planning to attend graduate school in astrophysics or pursue a career in industry. To complete this emphasis, students should take 12 credits selected from the following courses:

PHYS 428 - Relativity Credits: 3
ASTR 328 - Stars and Interstellar Medium Credits: 3
ASTR 404 - Galaxies and Cosmology Credits: 3
MATH 446 - Numerical Analysis I Credits: 3

Students may choose only one from the following:
PHYS 405 - Honors Thesis in Physics Credits: 3
PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 2-3
PHYS 409 - Physics Internship Credits: 3

Emphasis in Computational Physics

This emphasis is for students who wish to pursue a career that applies computers to the solution of physical problems and data analysis. To complete this emphasis, students should take 12 credits selected from the following courses:

PHYS 510 - Computational Physics I Credits: 3
MATH 446 - Numerical Analysis I Credits: 3
MATH 447 - Numerical Analysis II Credits: 3

And one from the following:
PHYS 405 - Honors Thesis in Physics Credits: 3
PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 2-3
PHYS 409 - Physics Internship Credits: 3

Emphasis in Electronics

This emphasis is for students who wish to pursue a career in industry, applying a strong background in electronics to physical problems. To complete this emphasis, students should take 12 credits selected from the following courses:

ECE 301 - Digital Electronics Credits: 3
ECE 333 - Linear Electronics I Credits: 3
ECE 430 - Principles of Semiconductor Devices Credits: 3
ECE 431 - Digital Circuit Design Credits: 3
ECE 433 - Linear Electronics II Credits: 3

Students may choose only one from the following:
PHYS 405 - Honors Thesis in Physics Credits: 3
PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 2-3
PHYS 409 - Physics Internship Credits: 3

Emphasis on Graduate School Preparation

Although any of the options listed here provide the successful student with a fully adequate background to enter graduate school, this emphasis is for students whose career goals definitely include graduate

work in physics. To complete this emphasis, students should take 12 credits selected from the following courses:

PHYS 410 - Computational Physics I Credits: 3
PHYS 412 - Solid State Physics and Applications Credits: 3
PHYS 440 - Nuclear and Particle Physics Credits: 3
PHYS 405 - Honors Thesis in Physics Credits: 3
PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 2-3
PHYS 409 - Physics Internship Credits: 3

Emphasis in Medical Physics

Physics majors generally have an excellent acceptance record in applying to medical, dental, or veterinary schools. Although there is no formal set of courses within physics that is uniquely suitable, students should meet with a physics advisor and a health sciences advisor for information about the university's Medical Sciences Advisory Committee. For more information, call 703-993-1050.

Because schools in the health sciences vary both in their philosophies and specific requirements, it is wise for students to become aware of such information well in advance of applying for admission. Although specific requirements vary, most programs do require applicants to complete at least one year of biology. Other requirements generally include organic chemistry.

PHYS 408 - Senior Research Credits: 2-3
CHEM 313 - Organic Chemistry Credits: 3
CHEM 314 - Organic Chemistry II Credits: 3
CHEM 315 - Organic Chemistry Lab I Credits: 2
CHEM 318 - Organic Chemistry Lab II Credits: 2

Emphasis in Physics Education

This emphasis is intended for students wishing to pursue a career teaching secondary school physics. The goal of the program is to allow students to receive a license to teach physics in Virginia secondary schools within 120 credits.

It is recommended that students seeking a career in physics education take PHYS 306 and PHYS 307 to fulfill the additional physics requirement (see above) for the major. In addition to the standard requirements for the physics major, students should enroll in 3 credits of directed study in physics laboratory instruction under PHYS 390.

The following courses are required to qualify for the teaching license. A grade of 'C' or better is required for all licensure coursework. Students who complete EDRD 419 and either EDCI 473 or EDCI 483 fulfill 6 of the 12 credits of the Additional Science Courses requirement (see above) and should consult the physics advisor on which courses fulfill the remainder of the requirement.

PHYS 390 - Topics in Physics Credits: 1-4 (physics laboratory instruction) for 3 credits
EDCI 473 - Teaching Science in the Secondary School Credits: 3
EDCI 483 - Advanced Methods of Teaching Science in Secondary School Credits: 3
EDRD 419 - Literacy in the Content Areas Credits: 3

EDCI 490 - Student Teaching in Education Credits: 6 (Mason Core: Synthesis course)
EDUC 372 - Human Development, Learning, and Teaching Credits: 3 (Mason Core: Social and Behavioral Science course)
EDUC 422 - Foundations of Secondary Education Credits: 3
Pass the Praxis Core and Praxis II exams

Mason Core and Elective Credits (55 credits)

In order to meet a minimum of 120 credits, this degree requires an additional 55 credits, which may be applied towards any remaining Mason Core requirements (outlined below), requirements for bachelor's degrees, and elective courses. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all requirements.
Mason Core

Please note that some Mason Core requirements may already be fulfilled by the major requirements listed above.

Expand each item below for a link to specific course lists for each category:
Foundation Requirements (15-19 credits)

Mason Core UWCU - Written Communication Credits: 6
Mason Core UOC - Oral Communication Credits: 3
Mason Core UQR - Quantitative Reasoning Credits: 3
Mason Core UITC - Information Technology Credits: 3-7

Core Requirements (22 credits)

Mason Core UFA - Arts Credits: 3
Mason Core UGU - Global Understanding Credits: 3
Mason Core ULIT - Literature Credits: 3
Mason Core UNSL - Natural Science Credits: 7
Mason Core USBS - Social and Behavioral Sciences Credits: 3
Mason Core UWC - Western Civilization/Western History Credits: 3

Synthesis/Capstone Requirement (minimum 3 credits)

Mason Core USYN - Synthesis/Capstone Credits: minimum 3

Degree Total: Minimum 120 credits

- Text after Modification (title, degree requirements, etc.):

Physics, BS

Banner Code: SC-BS-PHYS

This program of study is offered by the Department of Physics and Astronomy in the College of Science.

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

Students must fulfill all requirements for bachelor's degrees including the Mason Core. In addition, students must complete a total of 51 credits in the major and 17 in mathematics, with a minimum GPA of 2.00, distributed as follows. Through the coursework below, physics majors satisfy the Mason Core requirements in 'Natural Science' and 'Quantitative Reasoning'. The intensive writing requirement is fulfilled by taking PHYS 407.

This undergraduate program offers students the option of applying to the Physics, BS/Applied and Engineering Physics, Accelerated MS or the Physics, BS/Curriculum and Instruction, Accelerated MEd (Secondary Education Physics Concentration). See each listing for specific requirements.
Alternative Introductory Sequence

Normally, students who intend to major in physics should take the physics introductory sequence (PHYS 160, PHYS 161, PHYS 260, PHYS 261, PHYS 262, and PHYS 263). Students who decide to major in physics after completing PHYS 243, PHYS 244, PHYS 245, and PHYS 246 may do so but only with written permission of the Department of Physics and Astronomy. Those students are required to take 4 additional credits in approved physics courses.
Degree Requirements
Physics Core Courses (30 credits)

Note: Students double majoring in engineering and physics may substitute ECE 305 for PHYS 305, and ECE 333/ECE 334 for PHYS 407.

PHYS 150 - Computing for Physics and Engineering I Credits: 3 (Mason Core: IT All course)
PHYS 160 - University Physics I Credits: 3 (Mason Core: Natural Science course)
PHYS 161 - University Physics I Laboratory Credits: 1 (Mason Core: Natural Science course)
PHYS 260 - University Physics II Credits: 3 (Mason Core: Natural Science course)
PHYS 261 - University Physics II Laboratory Credits: 1 (Mason Core: Natural Science course)
PHYS 262 - University Physics III Credits: 3 (Mason Core: Natural Science course)
PHYS 263 - University Physics III Laboratory Credits: 1 (Mason Core: Natural Science course)
PHYS 303 - Classical Mechanics Credits: 3
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Physics Electives (6 credits)

Students take 6 credits selected from the following:

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Choose one of the following:

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ASTR 301 - Astrobiology Credits: 3

And choose at least 7 credits from approved upper-level physics, astronomy, computational and data sciences, chemistry, electrical engineering, or mathematics courses (for examples, see the areas of emphasis below)

Emphasis Options

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Emphasis in Astrophysics

This emphasis is for students who are planning to attend graduate school in astrophysics or pursue a career in industry. To complete this emphasis, students should take 12 credits selected from the following courses:

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ASTR 404 - Galaxies and Cosmology Credits: 3
MATH 446 - Numerical Analysis I Credits: 3

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EDUC 372 - Human Development, Learning, and Teaching Credits: 3 (Mason Core: Social and Behavioral Science course)
EDUC 422 - Foundations of Secondary Education Credits: 3
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Mason Core and Elective Credits (55 credits)

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Mason Core ULIT - Literature Credits: 3
Mason Core UNSL - Natural Science Credits: 7
Mason Core USBS - Social and Behavioral Sciences Credits: 3
Mason Core UWC - Western Civilization/Western History Credits: 3

Synthesis/Capstone Requirement (minimum 3 credits)

Mason Core USYN - Synthesis/Capstone Credits: minimum 3

Degree Total: Minimum 120 credits

- Reason for the Modification: As a result of program review, a need for a focused introduction to computing in physics has been identified. In brief, it has been recognized that Physics B.S. students are not graduating with the computational and data analysis skills expected of Physics B.S. graduates. This need has not been met by any existing course. This course, designed by experts in computational physics, is designed to meed this need. As a required course added to the major, it supplants a Mason Core requirement (IT All) and so no total degree credits are added.