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)
  - [x] **Concentration** (Choose one): [x] *Add* [ ] *Delete* [ ] *Modify*
  - [x] Degree Requirements
  - [ ] Admission Standards/ Application Requirements
  - [ ] Other Changes:

Type (Check one)**:**

- [ ] B.A. [x] B.S. [ ] Minor
- [ ] Master's
- [ ] Ph.D.
- [ ] Undergraduate Certificate*
- [ ] Graduate Certificate*
- [ ] Bachelor's/Accelerated Master's [ ] Other:

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

Effective Term: Fall 2017

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)

See attached

	Existing	New/Modified
Program Title: (Required) Title must identify subject matter. Do not include name of college/school/dept.	Physics B.S.	
Concentration(s):		Applied and Engineering Physics; Astrophysics; Computational Physics, Teacher Education
Admissions Standards / Application Requirements: (Required only if different from those listed in the University Catalog)		
Degree Requirements: Consult University Catalog for models, attach separate document if necessary using track changes for modifications		See Attached.
Courses offered via distance: (if applicable)		
TOTAL CREDITS REQUIRED:	120	120

***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 Undergraduate Programs only

Undergraduate Council Member	Provost Office	Undergraduate Council Approval Date

For Graduate Programs Only

Graduate Council Member	Provost Office	Graduate Council Approval Date

For Registrar Office's Use Only: Received_____ Banner_____ Catalog_____

revised 9/2/2016

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: Modify degree requirements and credits required; add concentrations

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

Physics, BS

Banner Code: SC-BS-PHYS

College: College of Science
Department: Physics and Astronomy

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. 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 Health Professions Advising.

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)

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

Physics, BS

Banner Code: SC-BS-PHYS

College: College of Science
Department: Physics and Astronomy

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. Students must complete a total of 75 credits in the major (or 69 credits if completing a second major, with the exception of the Physics Education Concentration, which can lead to a certificate from the Graduate School of Education and requires 74 credits in the major), including at least 11 credits in mathematics, with a minimum GPA of 2.00, distributed as follows. The intensive writing requirement is fulfilled by taking PHYS 407 or ASTR 402, which are also capstone courses for the major.

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). Students who decide to major in physics after completing PHYS 243, PHYS 244, PHYS 245, and PHYS 246 are welcome, but are required to obtain written permission from 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)
Mathematics Courses (11 credits)
Concentrations
BS without Concentration (34 Credits, or 28 Credits if completing a second major)
Applied and Engineering Physics Concentration (34 Credits, or 28 Credits if completing a second major)
Astrophysics Concentration (34 Credits, or 28 Credits if completing a second major)
Computational Physics Concentration (34 Credits, or 28 Credits if completing a second major)
Physics Education Concentration (33 Credits)

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 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 251 – Introduction to Computer Techniques in Physics: 3 credits (Mason Core: IT [IT only])
PHYS 301 - Analytical Methods of Physics Credits: 3
PHYS 303 - Classical Mechanics Credits: 3
PHYS 305 - Electromagnetic Theory Credits: 3
PHYS 307 - Thermal Physics 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~~
PHYS 416 - Special Topics in Modern Physics Credits: 1

Mathematics (11 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~~

BS without Concentration (34 Credits, or 28 Credits if completing a second major)

Mathematics/Computational Physics (6 Credits)

Two (2) of

- MATH 203 - Linear Algebra Credits: 3
- MATH 214 - Elementary Differential Equations Credits: 3
- PHYS 410 - Computational Physics I Credits: 3

Intermediate Laboratory (6 Credits)

- PHYS 311 – Instrumentation Credits: 3
- PHYS 312 – Waves and Optics Credits: 3

Physics Theory (15 Credits or 9 Credits if completing a second major)

- PHYS 306 - Wave Motion and Electromagnetic Radiation Credits: 3
- PHYS 403 - Quantum Mechanics II Credits: 3
- PHYS 428 - Relativity Credits: 3

and, if not completing a second major, two (2) of

- PHYS 370 - Molecular Biophysics Credits: 3
- PHYS 412 - Solid State Physics and Applications Credits: 3
- PHYS 440 - Nuclear and Particle Physics Credits: 3
- PHYS 465 - Planetary Atmospheres and Ionospheres Credits: 3
- PHYS 475 - Atmospheric Physics Credits: 3
- ASTR 210 - Introduction to Astrophysics Credits: 3
- ASTR 328 - Stars and Interstellar Medium Credits: 3
- ASTR 403 - Planetary Sciences Credits: 3
- ASTR 404 - Galaxies and Cosmology Credits: 3

Research, Internship, or Independent Study (3 Credits)

One (1) of

- PHYS 326 - Problems in Physics II Credits: 3
- PHYS 405 - Honors Thesis in Physics Credits: 3
- PHYS 406 - Honors Thesis in Physics Credits: 3
- PHYS 408 - Senior Research Credits: 3
- PHYS 409 - Physics Internship Credits: 3

Capstone (4 Credits)

- PHYS 407 - Senior Laboratory in Modern Physics Credits: 4 [Course modification required]

BS with Concentration (34 credits or 28 Credits if completing a second major)

Applied and Engineering Physics Concentration (34 Credits, or 28 Credits if completing a second major)

Mathematics/Computational Physics (3 Credits)

PHYS 410 - Computational Physics I Credits: 3

Intermediate Laboratory (6 Credits)

PHYS 311 – Instrumentation Credits: 3
PHYS 312 – Waves and Optics Credits: 3

Physics Theory (9 Credits)

PHYS 306 - Wave Motion and Electromagnetic Radiation Credits: 3

and two (2) of

PHYS 370 - Molecular Biophysics Credits: 3
PHYS 403 - Quantum Mechanics II Credits: 3
PHYS 412 - Solid State Physics and Applications Credits: 3

Practical Work (12 Credits, or 6 Credits if completing a second major)

Four (4), or, if completing a second major, two (2) of

PHYS 405 - Honors Thesis in Physics Credits: 3
PHYS 406 - Honors Thesis in Physics Credits: 3
PHYS 408 - Senior Research Credits: 3
PHYS 409 - Physics Internship Credits: 3
BENG 320 - Bioengineering Signals and Systems Credits: 3
approved 300- or 400-level VSE courses

Capstone (4 Credits)

PHYS 407 - Senior Laboratory in Modern Physics Credits: 4 [Course modification required]

Astrophysics Concentration (34 Credits, or 28 Credits if completing a second major)

Mathematics/Computational Physics (3 Credits)

One (1) of

- MATH 214 - Elementary Differential Equations Credits: 3
- PHYS 410 - Computational Physics I Credits: 3
- ASTR 401 - Computer Simulation in Astronomy Credits: 3

Intermediate Laboratory (6 Credits)

- PHYS 311 – Instrumentation Credits: 3
- PHYS 312 – Waves and Optics Credits: 3

Physics and Astronomy Theory (18 Credits or 12 Credits if completing a second major)

- PHYS 306 - Wave Motion and Electromagnetic Radiation Credits: 3
- PHYS 428 - Relativity Credits: 3
- ASTR 210 - Introduction to Astrophysics Credits: 3
- ASTR 328 - Stars and Interstellar Medium Credits: 3
- ASTR 403 - Planetary Sciences Credits: 3
- ASTR 404 - Galaxies and Cosmology Credits: 3

or, if completing a second major,

- ASTR 210 - Introduction to Astrophysics Credits: 3
- ASTR 328 - Stars and Interstellar Medium Credits: 3

and one (1) of

- PHYS 306 - Wave Motion and Electromagnetic Radiation Credits: 3
- PHYS 428 - Relativity Credits: 3

and one (1) of

- ASTR 403 - Planetary Sciences Credits: 3
- ASTR 404 - Galaxies and Cosmology Credits: 3

Research, Internship, or Independent Study (3 Credits)

One (1) of

- PHYS 326 - Problems in Physics II Credits: 3
- PHYS 405 - Honors Thesis in Physics Credits: 3
- PHYS 406 - Honors Thesis in Physics Credits: 3
- PHYS 408 - Senior Research Credits: 3
- PHYS 409 - Physics Internship Credits: 3
- ASTR 405 - Honors Thesis in Astronomy I Credits: 3
- ASTR 406 - Honors Thesis in Astronomy II Credits: 3
- ASTR 408 - Senior Research Credits: 3
- ASTR 409 - Astronomy Internship Credits: 3

Capstone (4 Credits)

One (1) of

PHYS 407 - Senior Laboratory in Modern Physics Credits: 4 [Course modification required]
ASTR 402 - RS: Methods of Observational Astronomy Credits: 4

Computational Physics Concentration (34 Credits, or 28 Credits if completing a second major)

Mathematics/Computational Physics (15 Credits)

- MATH 203 - Linear Algebra Credits: 3
- MATH 214 - Elementary Differential Equations Credits: 3
- PHYS 410 - Computational Physics I Credits: 3

and two (2) of

- ASTR 401 - Computer Simulation in Astronomy Credits: 3
- CDS 302 - Scientific Data and Databases Credits: 3
- CDS 303 - Scientific Data Mining Credits: 3
- MATH 446 - Numerical Analysis I Credits: 3
- MATH 447 - Numerical Analysis II Credits: 3

Intermediate Laboratory (3 Credits)

- PHYS 311 – Instrumentation Credits: 3

Physics and Astronomy Theory (9 Credits or 3 Credits if completing a second major)

Three (3), or, if completing a second major, one (1) of

- PHYS 306 - Wave Motion and Electromagnetic Radiation Credits: 3
- PHYS 412 - Solid State Physics and Applications Credits: 3
- ASTR 210 - Introduction to Astrophysics Credits: 3
- ASTR 328 - Stars and Interstellar Medium Credits: 3
- ASTR 403 - Planetary Sciences Credits: 3

Research, Internship, or Independent Study (3 Credits)

One (1) of

- PHYS 326 - Problems in Physics II Credits: 3
- PHYS 405 - Honors Thesis in Physics Credits: 3
- PHYS 406 - Honors Thesis in Physics Credits: 3
- PHYS 408 - Senior Research Credits: 3
- PHYS 409 - Physics Internship Credits: 3

Capstone (4 Credits)

One (1) of

- PHYS 407 - Senior Laboratory in Modern Physics Credits: 4 [Course modification required]
- ASTR 402 - RS: Methods of Observational Astronomy Credits: 4

Physics Education Concentration (33 Credits)

Note: Students completing this concentration can earn a Secondary Education – Physics (6-12) Undergraduate Certificate and be eligible for recommendation for an initial VA teaching license. See the Graduate School of Education in the College of Education and Human Development for more information.

Mathematics/Computational Physics (3 Credits)

One (1) of

MATH 203 - Linear Algebra Credits: 3
MATH 214 - Elementary Differential Equations Credits: 3
PHYS 410 - Computational Physics I Credits: 3

Intermediate Laboratory (3 Credits)

One (1) of

PHYS 311 – Instrumentation Credits: 3
PHYS 312 – Waves and Optics Credits: 3

Physics Practice (3 Credits)

PHYS 390 - Topics in Physics Credits: 1-4 (physics laboratory instruction) for 3 credits [This should be changed to an independent study section, but requires negotiation with the School of Education]

Teacher Education (24 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)
EDCI 491 - Internship Seminar in Secondary Training Credits: 3
EDUC 372 - Human Development, Learning, and Teaching Credits: 3 (Mason Core: Social and Behavioral Science course)
EDUC 422 - Foundations of Secondary Education Credits: 3

Mason Core, Second Major, and Elective Credits

In order to meet a minimum of 120 credits, this degree requires additional credits (specific credit counts by concentration are shown below), which may be applied towards any remaining Mason Core requirements (outlined below), second majors, minors, other requirements for Bachelor's Degrees, and elective courses. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all requirements.

- Without concentration: 45 credits (51 credits if completing second major)
- Applied & Engineering Physics concentration: 45 credits (51 credits if completing second major)
- Astrophysics concentration: 45 credits (51 credits if completing second major)
- Computational Physics concentration: 45 credits (51 credits if completing second major)
- Physics Education concentration: 46 credits

- Reason for the Modification: See attached.

Justification

Summary

In Fall 2015, the Department of Physics & Astronomy created a task force to evaluate and modify, as deemed necessary, the Physics B.S. program. The committee worked and met throughout the 2015 – 2016 academic year. A selection of working papers and other resources can be found at http://physics.gmu.edu/ugcurrcomm/taskforce.

The primary conclusions of the task force were that 1) our students are beginning intermediate-level studies too late; 2) our students are under-prepared for both graduate school and work; 3) the program lacks flexibility; 4) the program insufficiently encourages and prepares students for independent research; and 5) the program lacks a mechanism for assessing its learning outcomes. To address these issues, the task force proposed modifying the program to 1) reduce the number of introductory-level courses; 2) require more intermediate-level core subject courses; 3) introduce and require computer methods and intermediate laboratory courses; 4) transform its emphases into concentrations; 5) require independent work; and 6) incorporate capstone courses and a final review course.

Explication

A large body of literature (see, for example the references below) exists which enumerates the knowledge and skills expected of physics graduates by both graduate schools and employers, and an equally large body exists recommending ways to revise major curricula to improve the development and retention of these by majors.

Comparing our required content courses to the expectations of the physics GRE, for example, made clear that our students were not getting enough electromagnetism, quantum mechanics, thermal physics, computer applications, and laboratory training. These last two gaps comprise a rather large deficit in our present students' education: technical know-how. Overall, the literature tells us the following, much of which is obvious but maybe not as fully addressed by the current program as it should be:

Typical skills that should be developed by a physics major

Analytical and quantitative thinking: apply math to a variety of real-world problems, manage information (determining what is and is not relevant), think logically, and interpret data.

Problem solving: examine a situation, identify problems, and—along with searching the literature, collaborating, experimenting, and reasoning--think critically and creatively about a solution.

Laboratory instrumentation: use a variety of different instruments (such as standard physics equipment like optical components, electronics, machine shop tools, vacuum systems, telescopes, spectrographs) and exercise skills related to their operation, maintenance, repair, quality control, and troubleshooting.

Computer hardware and software: write new code or modify existing programs, use statistical analysis software and modeling, image processing, and simulation techniques, and employ programs like LabVIEW to run equipment and take data or build specialized interfaces.

Research and independent work: participate in open-ended research, including design, data analysis, error analysis, and complex problem solving, as well as finding, reading, analyzing, and interpreting relevant background information.

Communication: write technical reports, proposals, and research papers, write about science for a nontechnical audience, and present orally.

Work with others: collaborate, lead, and make decisions.

Curricular features common to departments recognized as effectively preparing students for STEM careers

- Curricular flexibility
- Varied and high-quality laboratory and computational courses
- Research and internship opportunities
- Communication skill development

Proposal

The task force's recommendations resulted in this program modification proposal. Its major components include:

1. Reducing the introductory sequence for majors to two semesters from three (half the third semester is redundant with PHYS 308) and requiring all standard core courses.
2. Converting so-called emphases into concentrations, increasing the number of credits in each from 12 to 34 (or 28 if the student completes a second major) mainly by integrating elective credits and additional math, computing, and laboratory courses into the concentrations.
3. Introducing new laboratory courses and rearranging schedules to allow students to take more advanced courses.
4. Requiring independent work.
5. Replacing the synthesis requirement with capstone courses.

The net result is to increase credits in the major to 75 (69 for those completing a second major) from 65, but since 6 General Education credits are now absorbed into the major, the increase in required credits is only 4 (-2 for those completing a second major).

References

http://www.aip.org/statistics
http://www.aps.org/careers/guidance/advisors/bestpractices/index.cfm
http://www.compadre.org/JTUPP/report.cfm
http://www.spsnational.org/careerstoolbox/
http://www.spsnational.org/cup/careerpathways/equipping-physics-majors.pdf