PHYSICS, BACHELOR OF SCIENCE (B.S.)

The Bachelor of Science in Physics requires a minimum of 120 credits, including 54 credits in physics and physics-related courses, as detailed in the course lists.

The curriculum in physics prepares students for technical careers in physics or an allied area, for careers in engineering and for the teaching of physics in secondary schools. The curriculum also prepares students for graduate studies in physics or a related area.

Student learning outcomes

Upon completing this program, students will know how to do the following:

- Perform scientific reasoning and complex problem-solving
  Physics majors will receive a fundamental understanding of the main areas of physics so that they are prepared for jobs that use physics-based technologies. They are expected to have mastered the analytical approach to solving technical problems by identifying simple subsystems that obey known physical laws and using these laws to approximate the behavior of the whole system.
- Demonstrate a fundamental understanding of the main areas of physics
- Demonstrate communication skills, both written and oral, needed to explain the analysis of technical problems
- Demonstrate scientific literacy skills including searching, reading and critically reviewing scientific publications
- Demonstrate proficiency in information processing by generating and interpreting data presented in tables, graphs, drawings and models

Double major in engineering and physics

A detailed description of this program (http://bulletin.vcu.edu/undergraduate/engineering/double-major-physics/) can be found in the “College of Engineering” section of this bulletin.

Degree requirements for Physics, Bachelor of Science (B.S.)

Course	Title	Hours
General education (http://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/)		
Select 30 credits of general education courses in consultation with an adviser.		30
Major requirements		
• Major core requirements		
PHYS 208	University Physics II	5
PHYS 301	Classical Mechanics I	3
PHYS 320 & PHYZ 320	Modern Physics and Modern Physics Laboratory	4
PHYS 340	Statistical Mechanics and Thermodynamics	3
PHYS 376	Electromagnetism I	3
PHYS 380	Quantum Physics I	3
PHYS 450	Senior Physics Laboratory	3
PHYS 490	Seminar in Conceptual Physics	1
• Major electives		
Select a total of nine credits from the list of elective physics and physics-related courses provided below. Those students who have their primary major in physics are required to fulfill at least three of these credits using upper-level physics courses		9
Ancillary requirements		
HUMS 202	Choices in a Consumer Society	1
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
MATH 201	Calculus with Analytic Geometry II	4
MATH 301	Differential Equations	3
MATH 307	Multivariate Calculus	4
PHYS 207	University Physics I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
Experiential fine arts [1]		1-3
Foreign language through the 102 level (by course or placement)		0-6
Open electives		
Select any course.		35-43
Total Hours		**120**

[1] Course offered by the School of the Arts

The minimum number of credit hours required for this degree is 120.

Physics and physics-related electives

Course	Title	Hours
Any of the following physics courses:		
PHYS 211	Physical Analysis	
PHYS 302	Classical Mechanics II	
PHYS 325	Visualization of Physics Using Mathematica	
PHYS 335	Experimental Skills for Physicists	
PHYS 351	Guided Inquiry for University Physics I	
PHYS 352	Guided Inquiry for University Physics II	
PHYS 377	Electromagnetism II	
PHYS 397	Directed Study (maximum of 3 credits)	
PHYS 417	Topics in Biophysics	
PHYS 420	Quantum Physics II	
PHYS 422	Optics	
PHYS 425	Computational Physics and Data Analysis	
PHYS 440	Introduction to Condensed Matter Physics	
PHYS 470	Introduction to Nanoscience	
PHYS 480	Particle Physics	
PHYS 483	Introduction to Astrophysics	
PHYS 491	Topics in Physics (maximum of 3 credits)	
PHYS 492	Independent Study (maximum of 3 credits)	

PHYS 514	Modeling Biocomplexity
PHYS 522	Optics and Laser Physics
PHYS 571	Theoretical Mechanics
PHYS 573	Analytical Methods in Physics
PHYS 576	Electromagnetic Theory
PHYS 580	Quantum Mechanics
PHYS 583	Geometrical Methods of Physics and Gravitation
Any of the following math or statistics courses:	
MATH 310	Linear Algebra
MATH 415	Numerical Methods
MATH 433	Partial Differential Equations
MATH 511	Applied Linear Algebra
STAT 441	Applied Statistics for Engineers and Scientists
Any of the following chemistry courses:	
CHEM 409	Instrumental Analysis
CHEM 510	Atomic and Molecular Structure
Any of the following engineering courses:	
CLSE 301	Transport Phenomena I
CLSE 302	Transport Phenomena II
EGMN 301	Fluid Mechanics
EGMN 309	Material Science for Engineers
EGMN 351	Nuclear Engineering Fundamentals
EGMN 352	Nuclear Reactor Theory
EGRB 427	Biomaterials
EGRE 303	Electronic Devices
EGRE 306	Introduction to Microelectronics
EGRE 307	Integrated Circuits
EGRE 310	Electromagnetic Fields and Waves
EGRE 334	Introduction to Microfabrication
EGRE 521	Advanced Semiconductor Devices

Those students intending to pursue graduate studies in physics should choose electives from the following:

Course	Title	Hours
PHYS 302	Classical Mechanics II	
PHYS 325	Visualization of Physics Using Mathematica	
PHYS 420	Quantum Physics II	
PHYS 440	Introduction to Condensed Matter Physics	
PHYS 480	Particle Physics	
PHYS 483	Introduction to Astrophysics	
PHYS 514	Modeling Biocomplexity	
PHYS 522	Optics and Laser Physics	
PHYS 571	Theoretical Mechanics	
PHYS 573	Analytical Methods in Physics	
PHYS 576	Electromagnetic Theory	
PHYS 580	Quantum Mechanics	
PHYS 583	Geometrical Methods of Physics and Gravitation	

Those interested in experimental physics should also take one or more credits in PHYS 397 or PHYS 492.

Courses not applicable toward the major

Course	Title	Hours
The following courses are not applicable toward the physics major requirements but may be used as general electives toward the bachelor's degree:		
PHYS 101	Foundations of Physics	
PHYS 103	Elementary Astronomy	
PHYS 107	Wonders of Technology	
PHYS 201	General Physics I	
PHYS 202	General Physics II	
PHYS 215	Science, Technology and Society	
PHYS 291	Topics in Physical Science	
PHYS/MHIS 307	The Physics of Sound and Music	
PHYS/ENVS 315	Energy and the Environment	
PHYS 391	Topics in Physics	
PHYZ 101	Foundations of Physics Laboratory	
PHYZ 103	Elementary Astronomy Laboratory	

What follows is a sample plan that meets the prescribed requirements within a four-year course of study at VCU. Please contact your adviser before beginning course work toward a degree.

Freshman year		
Fall semester		**Hours**
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
UNIV 111 Play course video for Focused Inquiry I	Focused Inquiry I (satisfies general education UNIV foundations)	3
Experiential fine arts		1-3
General education course (select AOI for global perspectives)		3
General education course		3
	Term Hours:	**14-16**
Spring semester		
HUMS 202	Choices in a Consumer Society	1
MATH 201	Calculus with Analytic Geometry II	4
PHYS 207	University Physics I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
UNIV 112 Play course video for Focused Inquiry II	Focused Inquiry II (satisfies general education UNIV foundations)	3
General education course (select BOK to complete breadth of knowledge requirement and AOI for creativity, innovation and aesthetic inquiry)		3
	Term Hours:	**16**
Sophomore year		

Fall semester		
MATH 307	Multivariate Calculus	4
PHYS 208	University Physics II	5
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication (satisfies general education UNIV foundations)	3
Foreign language 101		3
	Term Hours:	**15**
Spring semester		
MATH 301	Differential Equations	3
PHYS 301	Classical Mechanics I	3
PHYS 320 & PHYZ 320	Modern Physics and Modern Physics Laboratory	4
Foreign language 102		3
Open elective		1-3
	Term Hours:	**14-16**
Junior year		
Fall semester		
General education course (select BOK to complete breadth of knowledge requirement)		3
Major electives		6
Open electives		6
	Term Hours:	**15**
Spring semester		
PHYS 376	Electromagnetism I	3
PHYS 380	Quantum Physics I	3
Open electives		9
	Term Hours:	**15**
Senior year		
Fall semester		
PHYS 340	Statistical Mechanics and Thermodynamics	3
Major elective		3
Open electives		9
	Term Hours:	**15**
Spring semester		
PHYS 450	Senior Physics Laboratory	3
PHYS 490	Seminar in Conceptual Physics	1
Open electives (complete upper level if needed)		12
	Term Hours:	**16**
	Total Hours:	**120-124**

The minimum number of credit hours required for this degree is 120.

Accelerated B.S. and M.S.

The accelerated B.S. and M.S. program allows academically talented students to earn both the B.S. in Physics and M.S. in Physics and Applied Physics in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. Students in the program may count up to 12 hours of graduate courses toward both the B.S. and M.S. degrees. Thus, the two degrees may be earned with a minimum of 138 credits rather than the 150 credits necessary if the two degrees are pursued separately.

Students holding these degrees will be more competitive when seeking research and development positions in industry and admission to physics Ph.D. programs. In addition, an M.S. degree is required for most undergraduate teaching positions. The master's program enables students to deepen their understanding of physics while gaining actual experience in research at the frontiers of physics.

Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to this accelerated program include completion of 85 undergraduate credit hours, including PHYS 376 and PHYS 380; an overall GPA of 3.25; and a GPA of 3.25 in physics course work.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "**Satisfactory academic progress**" section of Bulletin, including maintaining a 3.0 GPA. Guidance to students in an accelerated program is provided by both the undergraduate physics adviser and the graduate adviser specified in the student's agreed-upon plan of study.

Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin.

Degree requirements

The Bachelor of Science in Physics degree will be awarded upon completion of a minimum of 120 credits and the satisfactory completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

A maximum of 12 graduate credits may be taken prior to completion of the baccalaureate degree. These graduate credits substitute for required major electives or open elective credits for the undergraduate degree. These courses are shared credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements.

The graduate physics courses that may be taken as an undergraduate, once a student is admitted to the program, are:

Course	Title	Hours
NANO 570	Nanoscale Physics	3
PHYS 560	Fundamentals of Semiconductor Nanostructures	3

PHYS 571	Theoretical Mechanics	3
PHYS 580	Quantum Mechanics	3

Recommended course sequence/plan of study

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the junior year prior to admission to the accelerated program in the senior year. The thesis option for the M.S. is shown.

Course	Title	Hours
Junior year		
Fall semester		
General education course (select BOK to complete breadth of knowledge requirement		
Major electives		6
Open electives		6
Term Hours:		15
Spring semester		
PHYS 340	Statistical Mechanics and Thermodynamics	3
PHYS 376	Electromagnetism I	3
PHYS 380	Quantum Physics I	3
Open electives		6
Term Hours:		15
Senior year		
Fall semester		
NANO 570	Nanoscale Physics	3
PHYS 450	Senior Physics Laboratory	3
PHYS 571	Theoretical Mechanics	3
Electives		6
Term Hours:		15
Spring semester		
PHYS 490	Seminar in Conceptual Physics	1
PHYS 492	Independent Study (begin research)	3
PHYS 560	Fundamentals of Semiconductor Nanostructures	3
PHYS 580	Quantum Mechanics	3
Open electives		6
Term Hours:		16
Fifth year		
Fall semester		
NANO 571	Nanoscale Chemistry	3
PHYS 697	Directed Research	3
600-level PHYS elective [1]		3
Term Hours:		9
Spring semester		
PHYS 697	Directed Research	6
600-level PHYS elective [1]		3
Term Hours:		9

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It is recommended, but not required, that one hour of PHYS 690 be taken as part of the elective credits.