

Department of Physics and Astronomy

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Mission Statement

The mission of the Department of Physics and Astronomy is the preparation of scientifically enlightened citizens. Science literacy is promoted by the production of teachers, researchers, technical professionals and knowledgeable individuals through the integration of classroom and experiential learning.

Vision

We strive to be a leading undergraduate physics and astronomy department by building a research-active, student-centered community.

Values

Excellence, integrity and mutual respect are the core values that define our department. The vigorous pursuit of research with undergraduates is central to extending our understanding of nature and the engagement of students directly in the practice of physics and astronomy.

Service to the university, the public and the profession is essential for continued vitality of science education and research.

Goals

To help students:

- Develop competence in using computers for computation, data acquisition, numerical control, device development, and information acquisition and processing.
- Appreciate the role of science in society and the historical development of physics in the ongoing quest to discover the structure of the universe.
- Gain an understanding of the basic principles and the experimental basis of the various fields of physics and the logical relationships of the various fields.
- Become capable problem solvers using techniques that require mathematical skills, conceptual and mathematical models, order-of-magnitude estimates and an understanding of limiting cases.
- Develop competence in designing, constructing and using laboratory instruments and to draw valid conclusions from experimental data.

- Improve written and oral technical communication skills.

Co-Curricular and Organizations

- Society of Physics Students

Degree and Major Requirements Bachelor of Arts in Physics

Degree Requirements

Required Courses	Credit Hours
General Education ¹	41
Foreign Language classes (intermediate level required) ²	0-14
Philosophy course (in addition to General Education courses)	3
University electives	23-37
Major core requirements ³	39
Major concentration requirements ³	26-39
	120

¹ The General Education program contains a set of requirements each student must fulfill. The number of credit hours necessary to fulfill these requirements may vary.

² The foreign language requirement may be satisfied by successful completion of the second semester of the intermediate level (typically Z32) of the student's chosen language or by placing out of that language through the Department of Foreign Languages, Literatures and Cultures' placement test.

³ Some of the courses required for the major complete Cluster Three of General Education. PHIL 101 is part of Cluster Two.

Program Concentrations

Each student, in consultation with his/her faculty adviser, will choose one of the following program concentrations:

- Individual Option
- Professional
- Physics Specialist

Major Core Requirements

Courses	Credit Hours
PHYS 105. Foundations of Physics	1
Choose one of the following:	6
PHYS 140-150. College Physics I-II	
PHYS 240-250. University Physics I-II	
Choose one of the following:	2
PHYS 140L-150L. College Physics I-II Laboratory	
PHYS 246-247. Data Acquisition and Analysis Techniques in Physics I, II	
PHYS 260. University Physics III	4

PHYS 270. Modern Physics	4
MATH 235, MATH 236 and MATH 237. Calculus I-III	12
CHEM 131 + 131L. General Chemistry with Lab	4
Choose one of the following:	4
BIO 114. Organisms	
GEOL 110. Physical Geology	
PHYS 391-392. Seminar	1
PHYS 491-492. Physics Assessment and Seminar	1

39

In addition, the student must complete one of the following concentrations.

Individual Option

The individual option is a course of study chosen specifically to match the interest and career plans of the student. This option will allow custom designed cross disciplinary majors such as the history of physics and physics and the fine arts.

A student electing the individual option must complete the major core requirements of the B.A. in physics and will select a program consisting of a coherent collection of a minimum of 26 additional credits of physics courses numbered above 270, astronomy courses numbered above 301, and courses in related fields. This individualized program must be selected in consultation with a faculty adviser in the department and must be approved by that adviser, the department head and one other faculty member in the department.

The individualized program, as approved by the department and accepted by the student, becomes the major requirements for the student.

Students are expected to review progress toward completion of the selected program of study with their faculty adviser.

Professional

Students in this concentration must complete the following courses in addition to core requirements:

Required Courses	Credit Hours
MATH 238. Linear Algebra with Differential Equations	4
PHYS 340. Mechanics	3
PHYS 350. Electricity and Magnetism	3
Three credits chosen from PHYS courses at the 300-level or higher	3

Students are expected to review progress toward completion of the selected program of study with their faculty adviser.

Pre-Medical Preparation

Students pursuing the B.A. in physics and astronomy with a professional concentration may complete a track in pre-medical preparation.

In addition to core and concentration requirements, students complete the following courses.

First Year Fall Courses

PHYS 105. Foundations of Physics
PHY 240. University Physics I
MATH 235. Calculus

First Year Spring Courses

PHYS 246. Data Acquisition and Analysis Techniques in Physics I
PHYS 250. University Physics II
MATH 236. Calculus II
BIO 114. Organisms

Second Year Fall Courses

CHEM 131 and CHEM 131L. General Chemistry I and Lab

PHYS 247. Acquisition and Analysis Techniques in Physics II
PHYS 260. University Physics III
MATH 237. Calculus III

Second Year Spring Courses

BIO 214. Cell and Molecular Biology
CHEM 132 and CHEM 132L. General Chemistry II and Lab
MATH 238. Linear Algebra with Differential Equations
PHYS 270. Modern Physics

Third Year Fall Courses

CHEM 241. Organic Chemistry I
PHYS 340. Mechanics
PHYS 391. Seminar

Third Year Spring Courses

CHEM 242 and CHEM 242L. Organic Chemistry II and Lab
PHYS 326 or other PHYS elective 300 level or higher
PHYS 392. Seminar

Fourth Year Fall Courses

CHEM 361. Biochemistry
PHYS 491. Physics Assessment and Seminar

Fourth Year Spring Courses

PHYS 326 or other PHYS elective 300 level or higher
PHYS 492. Physics Assessment and Seminar

Physics Specialist

Students in this concentration must complete the following courses in addition to core requirements:

Required Courses	Credit Hours
MATH 238. Linear Algebra with Differential Equations	4
Choose one of the following:	3
PHYS 340. Mechanics	
PHYS 350. Electricity and Magnetism	
Choose two of the following:	6
ASTR 220. General Astronomy I	
PHYS/CHEM/MATS 275. An Introduction to Materials Science	
PHYS 326. Biophysics	
Option TBD	

Students are expected to review progress toward completion of the selected program of study with their faculty adviser.

Bachelor of Science in Physics Degree Requirements

Required Courses	Credit Hours
General Education ¹	41
Quantitative requirement (in addition to General Education)	3
Scientific Literacy requirement (in addition to General Education)	3-4
University electives	2-8
Major core requirements (listed below)	40
Major program concentration requirements	25-31

120

¹ The General Education program contains a set of requirements each student must fulfill. The number of credit hours necessary to fulfill these requirements may vary.

Major Core Requirements

Courses	Credit Hours
PHYS 105. Foundations of Physics	3
Choose one of the following:	6
PHYS 140-150. College Physics I-II	
PHYS 240-250. University Physics I-II	
PHYS 246, PHYS 247. Data Acquisition and Analysis Techniques in Physics I, II	2
PHYS 260. University Physics III	4

PHYS 270. Modern Physics	4	Computational Physics Courses ¹	Credit Hours
Cognate Disciplines		PHYS 340. Mechanics	3
CHEM 131-132. General Chemistry I-II	6	PHYS 380. Thermodynamics and Statistical Mechanics	3
CHEM 131L-132L. General Chemistry Lab I-II	2	Choose one of the following pairs of courses:	3
MATH 235-237. Calculus I-III	12	PHYS/MATH 265. Introduction to Fluid Mechanics	
MATH 248. Computer Methods in Engineering and Science	4	or PHYS/MATH 266. Introduction to Solid Mechanics	
	40	Choose one of the following pairs of courses:	3
		MATH/PHYS 365. Computational Fluid Mechanics	
		or MATH/PHYS 366E. Computational Solid Mechanics	

Program Concentrations

Each student, in consultation with his/her faculty adviser, will choose one of the following program concentrations:

- Applied Physics
- Physics/Engineering Combined Program
- Fundamental Studies
- Individual Option
- Multidisciplinary

Applied Physics Concentration

The applied physics concentration is designed to prepare students for careers in a wide variety of scientific areas including laboratory and industrial settings. It is separated into three tracks: computational physics, materials physics, and electronics and instrumentation.

All students in the applied physics concentration must complete the following courses:

Required Courses (in addition to core requirements)	Credit Hours
PHYS 344, PHYS 345, PHYS 346. Advanced Physics Laboratory I, II, III	3
PHYS 360. Analog Electronics	4
PHYS 391-392. Seminar	1
PHYS 491-492. Assessment and Seminar	1
PHYS/ASTR 498R. Applied Physics Research	2
MATH 238. Linear Algebra with Differential Equations	4
Additional physics courses approved by the physics adviser	3
	18

In addition to the required courses, students must complete one of the following tracks: Applied Nuclear Physics, Electronics and Instrumentation, Materials Physics, or Computational Physics.

Applied Nuclear Physics Courses	Credit Hours
PHYS 340. Mechanics	3
PHYS 460. Quantum Mechanics	3
PHYS 339. Introduction Nuclear Science	4
or CHEM 450. Nuclear and Radiation Chemistry + CHEM 450L.	
PHYS 338. Nuclear Physics	3
or PHYS 333. Introduction to Particle Physics	
	13

Electronics and Instrumentation Courses	Credit Hours
PHYS 350. Electricity and Magnetism	3
PHYS 371. Digital Electronics	2
PHYS 372. Microcontrollers and Applications	2
PHYS 380. Thermodynamics and Statistical Mechanics	3
Additional physics courses approved by the physics adviser	2-3
	12-13

Materials Physics Courses	Credit Hours
PHYS 340. Mechanics	3
PHYS 350. Electricity and Magnetism	3
PHYS/MATS 275. An Introduction to Materials Science	3
PHYS/MATS 381. Material Characterization with Lab	3

¹ Students in this track must minor in mathematics.

Physics and Engineering Combined Program Concentration

This dual degree program makes it possible for the student to earn a B.S. degree in physics from JMU and a Master of Engineering degree from the University of Virginia. The engineering areas available under this program include biomedical, environmental, transportation, materials science, systems engineering and engineering physics.

During the first three years at JMU, the student must complete 96 credit hours including all JMU general education requirements, the physics core requirements, differential equations and at least 12 additional credit hours in physics courses designated by the JMU Department of Physics and Astronomy with at least a "B+" average. In general, these 12 additional hours will be chosen from those recommended for the applied physics track, but substitutions may be approved by the program adviser, Dr. Sean Scully. During the fourth year of study (while in residence at the University of Virginia), the student will take further courses approved by the JMU Department of Physics and Astronomy for credit toward the B.S. degree in physics. A total of 37 credit hours of physics or other physics-related courses taken at either school will be required for the JMU Bachelor of Science degree in physics.

Fundamental Studies Concentration

The fundamental studies concentration is designed to prepare students for immediate post-baccalaureate employment or for entrance to advanced study in physics or related areas.

Required Courses (in addition to core requirements)	Credit Hours
MATH 238. Linear Algebra with Differential Equations	4
PHYS 340. Mechanics	3
PHYS 344, PHYS 345, PHYS 346. Advanced Physics Laboratory I, II, III	3
PHYS 350. Electricity and Magnetism	3
PHYS 360. Analog Electronics	4
PHYS 380. Thermodynamics and Statistical Mechanics	3
PHYS 391-392. Seminar	1
PHYS 460. Quantum Mechanics	3
PHYS 491-492. Assessment and Seminar	1
Choose one of the following:	2-6
PHYS/ASTR 398. Problems in Physics or Astronomy (2 credits)	
PHYS/ASTR 498R. Undergraduate Research in Physics or Astronomy (2 credits)	
ISCI 450. Interscience Research (2 credits)	
PHYS 494. Internship in Physics (2 credits)	
PHYS 499. Honors (6 credits)	

Multidisciplinary Concentration

The multidisciplinary concentration is designed to provide a solid foundation in physics for students whose interests extend beyond traditional physics fields. The four tracks of business, technical and scientific communication, biophysics, and secondary education open doors to the pursuit of graduate degrees in law, the medical sciences, business and education, and other career paths requiring a technical background. Also, the concentrations in business and technical and scientific communication concentrations are excellent preparation for jobs in industry.

The following are also required for all tracks in the multidisciplinary concentration.

Courses	Credit Hours
BIO 114. Organisms	4
MATH 238. Linear Algebra with Differential Equations	4
PHYS/CHEM/MATS 275. An Introduction to Materials Science	3
PHYS 340. Mechanics	3
PHYS 350. Electricity and Magnetism	3
PHYS 380. Thermodynamics and Statistical Mechanics	3
PHYS 391-392. Seminar	1
PHYS 491-492. Physics Assessment and Seminar	1
Two credits from the following:	2
PHYS/ASTR 398. Independent Study in Physics and Astronomy (2 credits)	
PHYS/ASTR 498R. Undergraduate Research in Physics or Astronomy (2 credits)	
ISCI 450. Interscience Research (2 credits)	
PHYS 494. Internship in Physics (2 credits)	
PHYS 499. Honors (6 credits)	

24

The student must choose one of the following tracks:

- Business
- Technical and Scientific Communication (TSC)
- Biophysics
- Geophysics
- Secondary Education

Business Track Courses	Credit Hours
COB 204. Computer Information Systems	3
ACTG 244. Accounting for Non-Business Majors	3
ECON 201. Principles of Economics (Micro)	3
FIN 345. Finance for the Non-Financial Manager	3
MGT 305. Management and Organizational Behavior	3
MKTG 380. Principles of Marketing	3

18

No more than 27 hours may be taken in the College of Business.

TSC Track Courses	Credit Hours
Choose six credits:	6
Physics course numbered above 300	
ASTR 480. Astrophysics	
WRTC 103. Critical Reading and Writing	3
WRTC 300. Professional Editing	3
WRTC 316. Research Methodologies	3
WRTC 350. Foundations of Technical Communication	3
Choose six credits:	6
WRTC 301. Language, Law and Ethics	
WRTC 318. Intercultural Professional Communication	
WRTC 458. Writing about Science and Technology	
Other upper-level courses with permission	

24

Biophysics Track Courses	Credit Hours
PHYS 326. Biophysics	3
CHEM 241-242. Organic Chemistry I & II	6
CHEM 242L. Organic Chemistry Laboratory	2
CHEM/BIO 361. Biochemistry I	3
BIO 214. Cell and Molecular Biology	4
BIO 370. Animal Physiology	4
BIO 490. Biomechanics	4

26

Geophysics Track Courses	Credit Hours
Choose one of the following:	3-4
GEOL 110. Physical Geology	
GEOL 210. Applied Physical Geology	
Choose one of the following:	3
ASTR 220. Astronomy	
GEOL 272. Planetary Geology	
GEOL 365. Structural Geology	
GEOL 440. Geophysics	
At least three credits from a field- or geographic-based course:	3-6
GEOG 215. Cartography and GIS	
GEOG 216. Remote Sensing and GPS	
GEOL 399. Field Geology (Ireland)	
GEOL 444. Field Geophysics	
At least nine credits from the following:	9
GEOL 280. Mineralogy	
GEOL 300. Petrology	
GEOL/MATS 395. Geologic Perspectives in Materials Science	
GEOL 396. X-Ray Characterization	
GEOL 415. Evolution of North America	
GEOL 460. Geohydrology	
PHYS/MATH 265. Fluid Mechanics	
PHYS/MATS 337. Solid State Physics	
PHYS 360. Analog Electronics	
PHYS/MATS 381. Materials Characterization	
Any other 300- or 400-level geology or physics course (Upon approval from adviser).	3

24

Secondary Education Track Required Courses	Credit Hours
PSYC 160. Life Span Human Development	3
EDUC 370. Instructional Technology	3
Students must be fully admitted into pre-professional teacher education prior to enrolling in these courses:	
EDUC 310. Teaching in a Diverse Society	3
MSSE 370. General Instruction Methods for Grades 6-12	3
MSSE 371. Clinical Experience in Adolescent Education	1
MSSE 470S. Natural Sciences Teaching Methods, Grades 6-8	3
MSSE 471S. Field Experience in Middle School Natural Science	3
READ 440. Literacy-Based Learning in Secondary Education	3

22

Students interested in becoming teachers must meet specific curriculum requirements in their major as part of the undergraduate academic degree.

In addition to the general education and academic major requirements, physics majors desiring secondary teacher licensure must be admitted to teacher education, complete the pre-professional program in secondary education at the undergraduate level and complete the graduate level Master of Arts in Teaching degree.

It is critical that students seeking licensure consult regularly with both their education adviser and their major adviser to

support their progression through the programs. For a full description of the program in secondary teaching, refer to the Department of Middle, Secondary and Mathematics Education, in addition to the College of Education section of the catalog.

Individual Option Concentration

The individual option is a course of studies chosen specifically to match the interest and career plans of the student. This option will allow custom designed cross disciplinary majors such as chemical physics, as well as majors designed for students whose educational and career goals are not met by the existing concentrations in the major.

A student electing the individual option must complete the core requirements for the B.S. in physics and will select a program consisting of a coherent collection of a minimum of 25 additional credits of physics courses numbered above 260, astronomy courses numbered above 301 and courses in related fields.

This individualized program must be selected in consultation with a faculty adviser in the department, and must be approved by that adviser, the department head and one other faculty member in the department.

The individualized program, as approved by the department and accepted by the student, becomes the major requirements for that student.

Students are expected to review progress toward completion of the selected program of study with their faculty adviser.

Recommended Schedule for Majors

First Year	Credit Hours
CHEM 131-132. General Chemistry I-II	6
CHEM 131L-132L. General Chemistry Laboratory	2
General Education, Cluster One: Skills for the 21st Century	9-12
MATH 235-236. Calculus I-II	8
PHYS 246. Data Acquisition and Analysis Techniques in Physics I	1
Choose one of the following:	6
PHYS 140-150. College Physics I-II	
PHYS 240-250. University Physics I-II	
	32-35
Second Year	Credit Hours
MATH 237. Calculus III	4
MATH 238. Linear Algebra with Differential Equations	4
MATH 248. Computer Methods in Engineering and Science	4
PHYS 260. University Physics III	4
PHYS 270. Modern Physics	4
PHYS 247. Data Acquisition and Analysis Techniques in Physics II	1
General Education courses	11
	32

Third and Fourth Years

During their junior and senior years, students will select courses to complete the specific program track which they are following. These course selections will be made with the assistance of a faculty adviser.

Minor Requirements

Astronomy Minor

The minimum requirement for a minor in astronomy is 21 credit hours selected as follows:

Astronomy Minor Electives	Credit Hours
Choose one of the following:	6
PHYS 140-150. College Physics I-II	
PHYS 240-250. University Physics I-II	
Choose one of the following:	2
PHYS 140L-150L. General Physics Laboratory I-II	
PHYS 246-247. Data Acquisition and Analysis Techniques in Physics I, II	
ASTR 220-221. General Astronomy I-II	7
ASTR 320. Astronomical Techniques	3
One course selected from the following:	3
GEOL 272. Planetary Geology	
ASTR 480. Astrophysics	
HON 300Z. Life Beyond Earth	
PHYS 297, PHYS 397 or PHYS 497. Topics in Physics	
Appropriate topics could include the relativity, cosmology, cosmic rays or other astronomy-related topics with approval of minor adviser.	
ASTR 297, ASTR 397, ASTR 497. Topics in Astronomy	
	21

Physics Minor

The minimum requirement for a minor in physics is 22 credit hours selected as follows:

Physics Minor Electives	Credit Hours
Choose one of the following:	6
PHYS 140-150. College Physics I-II	
PHYS 240-250. University Physics I-II	
Choose one of the following:	2
PHYS 140L-150L. General Physics Laboratory I-II	
PHYS 246-247. Data Acquisition and Analysis Techniques in Physics I, II	
PHYS 260. University Physics III	4
Ten credits selected from the following:	10
Physics courses numbered above 260	
ASTR 320. Astronomical Techniques	
ASTR 480. Astrophysics	