UNIVERSITY OF PITTSBURGH
DIETRICH SCHOOL OF ARTS AND SCIENCES
DEPARTMENT OF PHYSICS AND ASTRONOMY

Undergraduate Degree Programs in the Department of Physics and Astronomy

Updated
10/10/2019

This document describes all of the degree programs and areas of concentration for the Department of Physics and Astronomy. It also provides departmental course descriptions and basic information about the department.

Introduction

Many students who major in physics and/or astronomy plan to become physicists or astronomers. The course of study in our degree programs will certainly help to prepare you for graduate school and the life of a scientist, but there are other career options open to you as well. High school science teachers are in high demand, so you could have a career as a teacher. You may also consider a career in journalism or scientific writing. Your analytical skills and knowledge of physics will also open up many related technical fields to you such as engineering, computer science, etc. Many companies that are looking for engineers or managers for technical positions will hire physics majors for these positions. You could also pursue a career in medicine by applying to medical school or to a graduate program in medical physics.

Our department has three basic degree programs plus several optional areas of concentration, all of which will be discussed below. These degree options have been designed to give you considerable flexibility in deciding your career path after graduation.

1.1 Advising

If you are interested in majoring in physics and/or astronomy, or even if you are simply considering it, then we encourage you to contact either our Undergraduate Advisor Russell Clark or our Program Director Michael Wood-Vasey as early as possible. We also welcome and encourage visits from prospective students prior to admission to the University or registration for classes. You may also stop by our main office in 100 Allen Hall or call 412-624-9000.

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1.2 Teaching

Almost all of our faculty members participate actively in the undergraduate program. Even in the large introductory courses, lecturers, with rare exceptions, are members of the faculty. Graduate teaching assistants lead introductory course recitation and lab sections. Upper level courses are generally small, allowing for greater interaction between you and the faculty instructor.

1.3 Learning and Experiential Goals

The training of undergraduates (both our majors and students in service courses) is a vital component of our department's mission. To that end we have identified several characteristics that we strive to instill in all students who pass through our department.

1. At graduation, our majors should have a thorough knowledge and comprehension of the core concepts of classical and modern physics.
2. At graduation, our majors should have a set of fundamental skills that can be applied to a variety of situations. These skills should include the following:
    a. Presentation skills. Physics majors should be able to express (orally and in writing) their understanding of core physical principles, the results of experiments, and their analysis of physical problems.
    b. Laboratory skills. Physics majors should be competent experimentalists. They should be able to design and set up an experiment, collect and analyze data, identify sources of error, and interpret their result and connect it to related areas of physics.
    c. Computer skills. Physics majors should be competent users of basic software, such as word processing, spreadsheet, and graphing programs. They should also have an understanding of the fundamental aspects of a programming and/or computer algebra language (Fortran, C++, Mathematica, etc.).

d. Problem-solving skills. Physics majors should be competent problem- solvers. They should be able to identify the essential aspects of a problem and formulate a strategy for solving the problem. They should be able to estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of their solution, interpret their result and connect it to related areas of physics.

3. Physics majors should be adequately trained to apply their physics experience and knowledge to analyze new situations.
4. All physics students (majors, minors, students in introductory courses, and Gen Ed students) should understand the nature of science.
5. General Education students should understand several core concepts of physics/astronomy.

2 Degree Tracks and Other Options

2.1 BACHELOR OF SCIENCE IN PHYSICS

This program is designed for those who intend to pursue a professional career in physics or some other related area. The required courses will help you to achieve a mastery of the fundamentals of physics and you may choose the electives based on your individual needs or interests. The graduation requirements for this program are listed on page 9.

2.1.1 Area of Concentration: Graduate School Preparation

You may choose this area of concentration if you intend to apply to graduate school in physics, astrophysics or another related field. Several upper level physics courses are added to the standard B.S. in Physics program to better prepare you for graduate school. The graduation requirements for this area of concentration are listed on page 11.

2.1.2 Area of Concentration: Education

You may choose this area of concentration if you intend to pursue a career as a high school physics teacher. This area of concentration requires less upper level physics courses than the standard B.S. in Physics program but has additional courses in the area of Education. These additional Education courses either fulfill the prerequisites for admission to the University Of Pittsburgh School Of Education or cover the required content knowledge for physics teachers in the State of Pennsylvania. The graduation requirements for this area of concentration are listed on page 13.

2.2 BACHELOR OF SCIENCE IN PHYSICS AND ASTRONOMY

This program is designed for those who intend to pursue a professional career in astronomy, space science or another related field. The required courses will help you to achieve a mastery of the fundamentals of physics and give you a solid background in astronomy. You may also choose the electives based on your individual needs or interests. The graduation requirements for this program are listed on page 14.

2.2.1 Area of Concentration: Graduate School Preparation

You may choose this area of concentration if you intend to apply to graduate school in physics, astrophysics or another related field. Several upper level physics courses are added to the standard B.S. in Physics degree to better prepare you for graduate school. The graduation requirements for this area of concentration are listed on page 16.

2.2.2 Area of Concentration: Education

You may choose this area of concentration if you intend to pursue a career as a high school physics teacher. This area of concentration requires less upper level physics courses than the standard B.S. in Physics and Astronomy program but has additional courses in the area of Education. These additional Education courses either fulfill the prerequisites for admission to the University Of Pittsburgh School Of Education or cover the required content knowledge for physics teachers in the State of Pennsylvania. The graduation requirements for this area of concentration are listed on page 18.

2.3 BACHELOR OF ARTS IN ASTRONOMY

This program is designed to give you a thorough background in basic physics and astronomy, as well as the historical development of modern physical concepts and the relationship of these basic sciences to other fields. You may choose this degree program if you intend to pursue a career in which science and technology have a large impact, such as certain kinds of law, business administration, governmental administration, technical writing and science education. The graduation requirements for this program are listed on page 19.

2.3.1 Area of Concentration: Science Communication

This area of concentration requires more writing and communication courses than the standard B.A. in Astronomy but fewer science electives. You should choose this area of concentration if you intend to pursue a career in which you communicate scientific results to a broad audience. The graduation requirements for this area of concentration are listed on page 21.

2.3.2 Area of Concentration: Science Breadth

This area of concentration provides broader exposure to other sciences in comparison to the standard B.A. in Astronomy, while at the same time going into much greater depth in physics and astronomy then the Natural Sciences major (in the College of General Studies). With the proper choice of electives, it will satisfy all of the necessary requirements to apply for admission to medical school. The graduation requirements for this area of concentration are listed on page 22.

2.4 HONORS REQUIREMENTS

You will graduate with honors for any of the standard degrees listed above if you meet the following requirements.

- You maintain a GPA greater than 3.2 in the major.
- You maintain a cumulative GPA greater than 3.0.
- You complete PHYS 1903 or ASTRON 1903 (Directed Research).
- You submit a paper detailing your research within the department.
- You present your research in a public forum such as the Honors College Undergraduate Poster Fair.

2.5 MINOR IN PHYSICS

The graduation requirements for the Physics Minor are: PHYS 0174, 0175, 0219, 0477 and one of the following: 0481, 1374, 1375, 1376, or 1378. Note that students in the B.A. in Astronomy program automatically complete the requirements for the Physics Minor, but you must declare the minor in order to receive it.

2.6 JOINT UNDERGRADUATE NANOSCIENCE AND ENGINEERING CERTIFICATE

The Undergraduate Joint NanoScience and Engineering Certificate (NSEC) program will consist of a five-course requirement that must be combined with a B.S. degree in Chemistry, Engineering, or Physics. Progress towards the certificate will be assessed by the program director for the primary major of the student. Physics, or Physics and Astronomy majors who are interested in the certificate should contact the departmental advisor, Russell Clark.

2.7 Combined Accelerated Studies in Education (CASE) Program

Students interested in the CASE program may apply for admission during the spring of their sophomore year, for admission in the following fall. Students admitted to the program will follow the course of study prescribed in the Education sub-plan for either the B.S. in Physics, or the B.S. in Physics and Astronomy major. During their final semester of undergraduate study, students who have successfully completed the curricular requirements, and maintained a 3.0 grade point average may apply for admission to the graduate portion of the CASE Program.

2.8 Grading Policy

A grade of C or better in a major course indicates satisfactory competence at the baccalaureate level. A grade of B or better indicates potential for graduate study.

2.9 Related Areas of Study

Our majors complete a number of mathematics courses as pre-requisites for the physics and astronomy courses. So it is not uncommon for our majors to take the additional courses needed to complete either a minor or even second major in math. Likewise, because of the overlap in course subjects, some of our majors will pursue a second major in chemistry, computer science or the School of Engineering. If you are interested in a second major related to physics and astronomy then you are encouraged to contact an advisor from that department before you start taking classes in their program.

3 Graduation Requirements for the B.S. in Physics

	Course	Title	Credits
	Required Introductory Courses (8 credit hours):		
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	Required Intermediate and Advanced Courses (20 credit hours):		
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1321	Computational Methods in Physics	3
	PHYS 1331	Mechanics	3
	PHYS 1341	Thermodynamics and Statistical Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	PHYS 1370	Introduction to Quantum Mechanics 1	3
	Laboratory Courses (Choose at least 10 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	PHYS 0525	Analog and Digital Electronics	3
	PHYS 1361	Wave Motion and Optics	3
	PHYS 1426	Modern Physics Laboratory	2
	Prerequisite Math Courses (18 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 0290, 1270	Applied Differential Equations	3
	Science Electives (Choose at least 9 credit hours from groups A and B with at least 3 credit hours from group B):		
	GROUP A		
	BIOSC 0150	Foundations of Biology 1	3
	BIOSC 0160	Foundations of Biology 2	3
	BIOENG 1070	Introduction to Cell Biology 1	3
	BIOENG 1071	Introduction to Cell Biology 2	3
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	CHEM 0310, 0730	Organic Chemistry 1	3
	CHEM 0320, 0740	Organic Chemistry 2	3
	CS 0401	Intermediate Programming Using Java	4
	CS 0445	Data Structures	3
	ENGR 0240	Nanotechnology and Nano-Engineering	3
	GEOL 0040	Physical Geology	3
	STAT 1151	Introduction to Probability	3
	STAT 1152	Introduction to Mathematical Statistics	3

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

	Course	Title	Credits
	GROUP B		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	CHEM 1410	Physical Chemistry 1	3
	CHEM 1420	Physical Chemistry 2	3
	CHEM 1620	Atoms, Molecules and Materials	3
	ECE 1232	Introduction to Lasers & Optical Electronics	3
	ECE 1247	Semiconductor Device Theory	3
	GEOL 1410	Exploration Geophysics	3
	MATH 1470	Partial Differential Equations 1	3
	MATH 1550	Vector Analysis and Applications	3
	MATH 1560	Complex Variables and Applications	3
	MEMS 1054	Materials Science	3
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1374	Introduction to Solid State Physics	3
	PHYS 1375	Foundations of Nanoscience	3
	PHYS 1376	Introduction to Biological Physics	3
	PHYS 1378	Introduction to Nuclear/Particle Physics	3

Suggested sequence of courses for the B.S. in Physics

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477	0525	1321, 1351	1310, 1331, 1341	1370	1426
Math	0220 or 0230	0230 or 0240	0240	0280	0290			
Electives						Science	Science, Lab	Science

Suggested sequence of courses for more advanced students

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Physics	0475	0476	0520, 0477	0525, 1331	1351, 1370	1310, 1341	1321	1426
Math	0230	0240, 0280	0290					
Electives						Science	Science, Lab	Science

4 Graduation Requirements for the B.S. in Physics – Graduate School Preparation

	Course	Title	Credits
	Required Introductory Courses (8 credit hours):		
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	Required Intermediate and Advanced Courses (29 credit hours):		
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1321	Computational Methods in Physics	3
	PHYS 1331	Mechanics	3
	PHYS 1341	Thermodynamics and Statistical Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	PHYS 1370	Introduction to Quantum Mechanics 1	3
	PHYS 1371	Introduction to Quantum Mechanics 2	3
	PHYS 1372	Electromagnetic Theory	3
	PHYS 1373	Mathematical Methods of Physics	3
	Laboratory Courses (Choose at least 7 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	PHYS 0525	Analog and Digital Electronics	3
	PHYS 1361	Wave Motion and Optics	3
	PHYS 1426	Modern Physics Laboratory	2
	Prerequisite Math Courses (18 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 0290, 1270	Applied Differential Equations	3
	Science Electives (Choose at least 9 credit hours from groups A and B with at least 3 credit hours from group B):		
	GROUP A		
	BIOSC 0150	Foundations of Biology 1	3
	BIOSC 0160	Foundations of Biology 2	3
	BIOENG 1070	Introduction to Cell Biology 1	3
	BIOENG 1071	Introduction to Cell Biology 2	3
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	CHEM 0310, 0730	Organic Chemistry 1	3
	CHEM 0320, 0740	Organic Chemistry 2	3
	CS 0401	Intermediate Programming Using Java	4
	CS 0445	Data Structures	3
	ENGR 0240	Nanotechnology and Nano-Engineering	3
	GEOL 0040	Physical Geology	3
	STAT 1151	Introduction to Probability	3
	STAT 1152	Introduction to Mathematical Statistics	3

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

	Course	Title	Credits
	GROUP B		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	CHEM 1410	Physical Chemistry 1	3
	CHEM 1420	Physical Chemistry 2	3
	CHEM 1620	Atoms, Molecules and Materials	3
	ECE 1232	Introduction to Lasers & Optical Electronics	3
	ECE 1247	Semiconductor Device Theory	3
	GEOL 1410	Exploration Geophysics	3
	MATH 1470	Partial Differential Equations 1	3
	MATH 1550	Vector Analysis and Applications	3
	MATH 1560	Complex Variables and Applications	3
	MEMS 1054	Materials Science	3
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1374	Introduction to Solid State Physics	3
	PHYS 1375	Foundations of Nanoscience	3
	PHYS 1376	Introduction to Biological Physics	3
	PHYS 1378	Introduction to Nuclear/Particle Physics	3

Suggested sequence of courses for the B.S. in Physics – Graduate School Preparation

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477	0525	1321, 1351	1310, 1331, 1341	1370, 1373	1371, 1372
Math	0220 or 0230	0230 or 0240	0240	0280	0290			
Electives					Lab	Science	Science	Science

Suggested sequence of courses for more advanced students

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Physics	0475	0476	0520, 0477	0525, 1331	1321, 1351, 1370	1310, 1341, 1371	1373	1372
Math	0230	0240, 0280	0290					
Electives					Lab	Science	Science	Science

5 Graduation Requirements for the B.S. in Physics – Education

	Course	Title	Credits
	Required Introductory Courses (8 credit hours):		
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	Required Intermediate and Advanced Courses (11 credit hours):		
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1331	Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	Laboratory Courses (Choose at least 7 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	PHYS 0525	Analog and Digital Electronics	3
	PHYS 1361	Wave Motion and Optics	3
	PHYS 1426	Modern Physics Laboratory	2
	Prerequisite Math Courses (18 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 0290, 1270	Applied Differential Equations	3
	Required Science Electives (11 credit hours):		
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	PHYS 0481	Applications of Modern Physics	3
	Education Related Courses (6 credit hours):		
	PSYED 1001	Introduction to Educational Psychology	3
	IL 1580	Foundations of Special Education	3
	Courses Emphasizing the Broader Impact of Science (Choose at least 3 credit hours):		
	HPS	Any History and Philosophy of Science (HPS) course.	3
	PHYS0086	Physics and Public Policy	3
	PHYS0087	Nuclear Science and Society	3

Suggested sequence of courses for the B.S. in Physics - Education

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477	0481	1351	0525, 1331		1310
Math	0220 or 0230	0230 or 0240	0240	0280	0290			
Electives	CHEM 0110	CHEM 0120		Science			Education, Lab	Education

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

6 Graduation Requirements for the B.S. in Physics and Astronomy

	Course	Title	Credits
	Required Introductory Courses (11 credit hours):		
	ASTRON 0113	Introduction to Astronomy	3
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	Required Intermediate and Advanced Courses (29 credit hours):		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	ASTRON 1122, GEOL 1701	Exoplanets and the Solar System	3
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1321	Computational Methods in Physics	3
	PHYS 1331	Mechanics	3
	PHYS 1341	Thermodynamics and Statistical Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	PHYS 1370	Introduction to Quantum Mechanics 1	3
	Laboratory Courses (Choose at least 7 credit hours including PHYS 0219 or 0520 and ASTRON 1263):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	PHYS 0525	Analog and Digital Electronics	3
	PHYS 1361	Wave Motion and Optics	3
	PHYS 1426	Modern Physics Laboratory	2
	Prerequisite Math Courses (18 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 0290, 1270	Applied Differential Equations	3
	Science Electives (Choose at least 3 credit hours):		
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	CHEM 1410	Physical Chemistry 1	3
	CS 0401	Intermediate Programming Using Java	4
	CS 0445	Data Structures	3
	GEOL 0040	Physical Geology	3
	GEOL 1410	Exploration Geophysics	3
	GEOL 1701[2]	Geology of the Planets	3
	MATH 1470	Partial Differential Equations 1	3
	MATH 1550	Vector Analysis and Applications	3
	MATH 1560	Complex Variables and Applications	3
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1371	Introduction to Quantum Mechanics 2	3
	PHYS 1372	Electromagnetic Theory	3
	PHYS 1373	Mathematical Methods of Physics	3
	PHYS 1378	Introduction to Nuclear/Particle Physics	3
	STAT 1151	Introduction to Probability	3
	STAT 1152	Introduction to Mathematical Statistics	3

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

[2] GEOL 1701 may be used to satisfy either one of the required astronomy courses or the science elective, but not both.

Suggested sequence of courses for the B.S. in Physics and Astronomy

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy				0113 or 0413	1120[1] or 1263[2]	1121[3] or 1122[4]	1120 or 1263	1121 or 1122
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477		1321, 1351	1310, 1331, 1341	1361, 1370	
Math	0220 or 0230	0230 or 0240	0240, 0290	0280				
Electives								Science

Suggested sequence of courses for more advanced students

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy				0113 or 0413	1120 or 1263	1121 or 1122	1120 or 1263	1121 or 1122
Physics	0475	0476	0520, 0477	1331	1321, 1351, 1370	1310, 1341	1361	
Math	0230	0240, 0280	0290					
Electives								Science

[1] ASTRON 1120 is only offered in odd years (2017, 2019, etc.).

[2] ASTRON 1263 is only offered in even years (2018, 2020, etc.).

[3] ASTRON 1121 is only offered in even years (2018, 2020, etc.).

[4] ASTRON 1122 is only offered in odd years (2017, 2019, etc.).

7 Graduation Requirements for the B.S. in Physics and Astronomy – Graduate School Preparation

	Course	Title	Credits
	Required Introductory Courses (11 credit hours):		
	ASTRON 0113	Introduction to Astronomy	3
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	Required Intermediate and Advanced Courses (38 credit hours):		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	ASTRON 1122, GEOL 1701	Exoplanets and the Solar System	3
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1321	Computational Methods in Physics	3
	PHYS 1331	Mechanics	3
	PHYS 1341	Thermodynamics and Statistical Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	PHYS 1370	Introduction to Quantum Mechanics 1	3
	PHYS 1371	Introduction to Quantum Mechanics 2	3
	PHYS 1372[1]	Electromagnetic Theory	3
	PHYS 1373	Mathematical Methods of Physics	3
	Laboratory Courses (Choose at least 7 credit hours including PHYS 0219 or 0520 and ASTRON 1263):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[2]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	PHYS 0525	Analog and Digital Electronics	3
	PHYS 1361	Wave Motion and Optics	3
	PHYS 1426	Modern Physics Laboratory	2
	Prerequisite Math Courses (18 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 0290, 1270	Applied Differential Equations	3
	Science Electives (Choose at least 3 credit hours):		
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	CHEM 1410	Physical Chemistry 1	3
	CS 0401	Intermediate Programming Using Java	4
	CS 0445	Data Structures	3
	GEOL 0040	Physical Geology	3
	GEOL 1410	Exploration Geophysics	3
	GEOL 1701[3]	Geology of the Planets	3
	MATH 1470	Partial Differential Equations 1	3
	MATH 1550	Vector Analysis and Applications	3
	MATH 1560	Complex Variables and Applications	3
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1378	Introduction to Nuclear/Particle Physics	3
	STAT 1151	Introduction to Probability	3
	STAT 1152	Introduction to Mathematical Statistics	3

[1] PHYS 1372 and 1373 will also count as a science elective.

[2] PHYS 0219 or 0520 may be used as a lab elective, but not both.

[3] GEOL 1701 may be used to satisfy either one of the required astronomy courses or the science elective, but not both.

Suggested sequence of courses for the B.S. in Physics and Astronomy – Graduate School Preparation

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy				0113 or 0413	1120[1] or 1263[2]	1121[3] or 1122[4]	1120 or 1263	1121 or 1122
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477		1321, 1351, 1361	1310, 1331, 1341	1370, 1373	1371, 1372
Math	0220 or 0230	0230 or 0240	0240, 0290	0280				
Electives								

Suggested sequence of courses for more advanced students

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy				0113 or 0413	1120 or 1263	1121 or 1122	1120 or 1263	1121 or 1122
Physics	0475	0476	0520, 0477	1331	1321, 1351, 1370	1310, 1341, 1371	1361, 1373	1372
Math	0230	0240, 0280	0290					
Electives								

[1] ASTRON 1120 is only offered in odd years (2017, 2019, etc.).

[2] ASTRON 1263 is only offered in even years (2018, 2020, etc.).

[3] ASTRON 1121 is only offered in even years (2018, 2020, etc.).

[4] ASTRON 1122 is only offered in odd years (2017, 2019, etc.).

8 Graduation Requirements for the B.S. in Physics and Astronomy –Education

	Course	Title	Credits
	Required Introductory Courses (11 credit hours):		
	ASTRON 0113	Introduction to Astronomy	3
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	Required Intermediate Courses (20 credit hours):		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	ASTRON 1122, GEOL 1701	Exoplanets and the Solar System	3
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1331	Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	Required Laboratory Courses (8 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	PHYS 1361	Wave Motion and Optics	3
	Prerequisite Math Courses (18 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 0290, 1270	Applied Differential Equations	3
	Science Electives (Choose 11 credit hours including CHEM 0110 and CHEM 0120):		
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1341	Thermodynamics and Statistical Mechanics	3
	PHYS 1370	Introduction to Quantum Mechanics 1	3
	Education Related Courses (12 credit hours):		
	PSYED 1001	Introduction to Educational Psychology	3
	IL 1580	Foundations of Special Education	3

Suggested sequence of courses for the B.S. in Physics and Astronomy - Education

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy			0113 or 0413		1120[2] or 1263[3]	1121[4] or 1122[5]	1120 or 1263	1121 or 1122
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477		1351	1310, 1331	1361	
Math	0220 or 0230	0230 or 0240	0240, 0290	0280				
Electives	CHEM 0110	CHEM 0120		Science			Education	Education

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.
[2] ASTRON 1120 is only offered in odd years (2017, 2019, etc.).
[3] ASTRON 1263 is only offered in even years (2018, 2020, etc.).
[4] ASTRON 1121 is only offered in even years (2018, 2020, etc.).
[5] ASTRON 1122 is only offered in odd years (2017, 2019, etc.).

9 Graduation Requirements for the B.A. in Astronomy

	Course	Title	Credits
	Required Courses (22 credit hours):		
	ASTRON 0113	Introduction to Astronomy	3
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1331	Mechanics	3
	Intermediate/Advanced Astronomy Courses (Choose at least 6 credit hours):		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	ASTRON 1122, GEOL 1701	Exoplanets and the Solar System	3
	Laboratory Courses (Choose at least 5 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	Prerequisite Math Courses (15 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0290, 1270	Applied Differential Equations	3
	Course in History and Philosophy of Science or Science Policy/Management (Choose at least 3 credit hours):		
	HPS	Any History and Philosophy of Science (HPS) course.	3
	BUSERV 1915	Introduction to Management	3
	PHYS0086	Physics and Public Policy	3
	PHYS0087	Nuclear Science and Society	3
	PUBSRV 1315	Managing Projects and Contracts	3
	Writing or Communication Course (Choose at least 3 credit hours):		
	COMMRC 0320	Mass Communication Process	3
	COMMRC 0520	Public Speaking	3
	COMMRC 1105	Television and Society	3
	ENGCMP 0400	Written Professional Communication	3
	ENGCMP 1101	Language of Science and Technology	3
	ENGCMP 1400	Grant and Proposal Writing	3
	ENGWRT 1330	Intermediate Nonfiction: Scene and Point-of-View	3
	ENGWRT 1340	Advanced Nonfiction: Long Form Narrative	3
	ENGWRT 1394	Science Writing	3
	LING 1000	Introduction to Linguistics	3

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

	Course	Title	Credits
	Science Electives (Choose at least 6 credit hours):		
	BIOSC 0150	Foundations of Biology 1	3
	BIOSC 0160	Foundations of Biology 2	3
	BIOENG 1070	Introduction to Cell Biology 1	3
	BIOENG 1071	Introduction to Cell Biology 2	3
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	CHEM 0310, 0730	Organic Chemistry 1	3
	CHEM 0320, 0740	Organic Chemistry 2	3
	CHEM 1410	Physical Chemistry 1	3
	CHEM 1420	Physical Chemistry 2	3
	CS 0401	Intermediate Programming Using Java	4
	CS 0445	Data Structures	3
	GEOL 0040	Physical Geology	3
	GEOL 1410	Exploration Geophysics	3
	GEOL 1701[1]	Geology of the Planets	3
	MATH 0280, 1180, 1185	Introduction to Matrices and Linear Algebra	3
	MATH 1470	Partial Differential Equations 1	3
	MATH 1550	Vector Analysis and Applications	3
	MATH 1560	Complex Variables and Applications	3
	PHYS 1321	Computational Methods in Physics	3
	PHYS 1341	Thermodynamics and Statistical Mechanics	3
	PHYS 1351	Electricity and Magnetism	3
	PHYS 1370	Introduction to Quantum Mechanics 1	3
	PHYS 1378	Introduction to Nuclear/Particle Physics	3
	STAT 1151	Introduction to Probability	3
	STAT 1152	Introduction to Mathematical Statistics	3

Suggested sequence of courses for the B.A. in Astronomy

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy			0113 or 0413		1120[2] or 1263[3]	1121[4] or 1122[5]	1120 or 1263	1121 or 1122
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477	0481		1310, 1331		
Math	0220 or 0230	0230 or 0240	0240	0290	0280			
Electives						HPS or SPM	Science	Science, Writing

[1] GEOL 1701 may be used to satisfy either one of the required astronomy courses or the science elective, but not both.

[2] ASTRON 1120 is only offered in odd years (2017, 2019, etc.).

[3] ASTRON 1263 is only offered in even years (2018, 2020, etc.).

[4] ASTRON 1121 is only offered in even years (2018, 2020, etc.).

[5] ASTRON 1122 is only offered in odd years (2017, 2019, etc.).

10 Graduation Requirements for the B.A. in Astronomy – Science Communication

	Course	Title	Credits
	Required Courses (22 credit hours):		
	ASTRON 0113	Introduction to Astronomy	3
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 0481	Applications of Modern Physics	3
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1331	Mechanics	3
	Intermediate/Advanced Astronomy Courses (Choose at least 6 credit hours):		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	ASTRON 1122, GEOL 1701	Exoplanets and the Solar System	3
	Laboratory Courses (Choose at least 5 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	Prerequisite Math Courses (15 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0290, 1270	Applied Differential Equations	3
	Course in History and Philosophy of Science or Science Policy/Management (Choose at least 3 credit hours):		
	HPS	Any History and Philosophy of Science (HPS) course.	3
	BUSERV 1915	Introduction to Management	3
	PHYS0086	Physics and Public Policy	3
	PHYS0087	Nuclear Science and Society	3
	PUBSRV 1315	Managing Projects and Contracts	3
	Writing or Communication Course (3 credit hours):		
	ENGCMP 0400	Written Professional Communication	3
	Communication Electives (Choose at least 12 credit hours):		
	COMMRC 0320	Mass Communication Process	3
	COMMRC 0520	Public Speaking	3
	COMMRC 1105	Television and Society	3
	ENGCMP 1101	Language of Science and Technology	3
	ENGCMP 1400	Grant and Proposal Writing	3
	ENGWRT 0610	Introduction to Journalism and Non-fiction	3
	ENGWRT 1330	Intermediate Nonfiction: Scene and Point-of-View	3
	ENGWRT 1340	Advanced Nonfiction: Long Form Narrative	3
	ENGWRT 1394	Science Writing	3
	LING 1000	Introduction to Linguistics	3

Suggested sequence of courses for the B.A. in Astronomy – Science Communication

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy			0113 or 0413		1120[2] or 1263[2]	1121[2] or 1122[2]	1120[2] or 1263[2]	1121[2] or 1122[2]
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477	0481		1310, 1331		
Math	0220 or 0230	0230 or 240	0240	0290	0280			
Electives		HPS or SPM	ENGCMP 0400		Communication	Communication	Communication	Communication

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

[2] ASTRON 1120 and 1122 are only offered in odd years (2017, 2019, etc.), and ASTRON 1121 and 1263 are only offered in even years (2018, 2020, etc.).

11 Graduation Requirements for the B.A. in Astronomy – Science Breadth

	Course	Title	Credits
	Required Courses (19 credit hours):		
	ASTRON 0113	Introduction to Astronomy	3
	PHYS 0174, 0475	Basic Physics for Science and Engineering 1	4
	PHYS 0175, 0476	Basic Physics for Science and Engineering 2	4
	PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
	PHYS 1310	Undergraduate Seminar	1
	PHYS 1331	Mechanics	3
	Intermediate/Advanced Astronomy Courses (Choose at least 6 credit hours):		
	ASTRON 1120	Stars, Stellar Structure and Evolution	3
	ASTRON 1121	Galaxies and Cosmology	3
	ASTRON 1122, GEOL 1701	Exoplanets and the Solar System	3
	Laboratory Courses (Choose at least 5 credit hours):		
	ASTRON 1263	Techniques of Astronomy	3
	PHYS 0219[1]	Basic Lab. Physics for Science and Engineering	2
	PHYS 0520	Modern Physical Measurements	3
	Prerequisite Math Courses (15 credit hours):		
	MATH 0220	Analytic Geometry and Calculus 1	4
	MATH 0230, 0235	Analytic Geometry and Calculus 2	4
	MATH 0240, 0245	Analytic Geometry and Calculus 3	4
	MATH 0290, 1270	Applied Differential Equations	3
	Course in History and Philosophy of Science or Science Policy/Management (Choose at least 3 credit hours):		
	HPS	Any History and Philosophy of Science (HPS) course.	3
	BUSERV 1915	Introduction to Management	3
	PHYS0086	Physics and Public Policy	3
	PHYS0087	Nuclear Science and Society	3
	PUBSRV 1315	Managing Projects and Contracts	3
	Science Electives (Choose one of the three tracks below totaling at least 6 credit hours):		
	Science Elective Track 1		
	CHEM 0310, 0730	Organic Chemistry 1	3
	CHEM 0330	Organic Chemistry Laboratory 1	1
	CHEM 0320, 0740	Organic Chemistry 2	3
	CHEM 0340	Organic Chemistry Laboratory 2	1
	Science Elective Track 2		
	CS 0401	Intermediate Programming Using Java	4
	CS 0445	Data Structures	3
	Science Elective Track 3		
		Any advanced course in BIOSC, BIOENG, CHEM, CS or GEOL	3
		Any advanced course in BIOSC, BIOENG, CHEM, CS or GEOL	3

[1] PHYS 0219 or 0520 may be used as a lab elective, but not both.

	Course	Title	Credits
	Science Requirements (Choose two of the three tracks below totaling at least 16 credit hours):		
	Science Requirement Track 1		
	CHEM 0110, 0710	General Chemistry 1	4
	CHEM 0120, 0720	General Chemistry 2	4
	Science Requirement Track 2A		
	BIOSC 0150	Foundations of Biology 1	3
	BIOSC 0050	Foundations of Biology Laboratory 1	1
	BIOSC 0160	Foundations of Biology 2	3
	BIOSC 0060	Foundations of Biology Laboratory 2	1
	Science Requirement Track 2B		
	BIOENG 1070	Introduction to Cell Biology 1	3
	BIOSC 0050	Foundations of Biology Laboratory 1	1
	BIOENG 1071	Introduction to Cell Biology 2	3
	BIOSC 0060	Foundations of Biology Laboratory 2	1
	Science Requirement Track 3		
	GEOL 0040	Physical Geology	3
	GEOL 0055	Geology Laboratory	2
	GEOL 0890	Physical Oceanography	3

Suggested sequence of courses for the B.A. in Astronomy – Science Breadth

Semester Term	1 Fall	2 Spring	3 Fall	4 Spring	5 Fall	6 Spring	7 Fall	8 Spring
Astronomy			0113 or 0413		1120[1] or 1263[2]	1121[3] or 1122[4]	1120 or 1263	1121 or 1122
Physics	0174 or 0475	0175 or 0476	0219 or 0520, 0477			1310, 1331		
Math	0220 or 0230	0230 or 240	0240	0290	0280			
Electives		HPS	Science	Science	Science	Science	Science	Science

[1] ASTRON 1120 is only offered in odd years (2017, 2019, etc.).

[2] ASTRON 1263 is only offered in even years (2018, 2020, etc.).

[3] ASTRON 1121 is only offered in even years (2018, 2020, etc.).

[4] ASTRON 1122 is only offered in odd years (2017, 2019, etc.).

12 Requirements for the Joint Nanoscience and Engineering Certificate

	Course	Title	Credits
	Required Courses (9 credit hours):		
	ENGR 0240	Nanotechnology and Nano-Engineering	3
	PHYS 1375 or CHEM 1630	Foundations of Nanoscience	3
	PHYS 1903	Directed Research in Nanoscience and Nanotechnology	3
	Elective Courses (Choose at least 6 credit hours):		
	CHEM 1410/1420 or 1480	Physical Chemistry 1, 2 or Intermediate	3
	CHEM 1450	Molecular Modeling and Graphics	3
	CHEM 1600	Synthesis and Characterization of Polymers	3
	CHEM 1620	Atoms, Molecules and Materials	3
	ECE 0257	Analysis & Design of Electronic Circuits	3
	ECE 1247	Semiconductor Device Theory	3
	ECE 2295	Nanosensors	3
	ENGR 0241	Fabrication and Design in Nanotechnology	3
	IE 1012, 2012	Manufacture of Structural Nano-Materials	3
	MEMS 1057	Micro/Nano Manufacturing	3
	MEMS 1447	Nanocharacterization	3
	MEMS 1469	Materials Science of Nanostructures	3
	MEMS 1477	Thin Film Processes and Characterization	3
	MEMS 1478	Nanoparticles: Science and Technology	3
	MEMS 1480	Introduction to Microelectromechanical Systems	3
	PHYS 0520	Modern Physical Measurements	3
	PHYS 1361	Wave Motion and Optics	3
	PHYS 1370/1371	Introduction to Quantum Mechanics 1 or 2	3
	PHYS 1374	Introduction to Solid State Physics	3

13 Schedule of Course Offerings

The upper level courses in both Physics and Astronomy are not offered every semester. Instead, they are offered once per year on a fixed schedule which is given in the table below. This table is only for courses offered by the Department of Physics and Astronomy.

Course	Title	Credits
Fall, Spring and Summer		
PHYS 0174	Basic Physics for Science and Engineering 1	4
PHYS 0175	Basic Physics for Science and Engineering 2	4
PHYS 0219	Basic Lab. Physics for Science and Engineering	2
Fall and Spring		
ASTRON 0113	Introduction to Astronomy	3
ASTRON 0413	Honors Introduction to Astronomy	4
PHYS 1310	Undergraduate Seminar	1
Fall		
ASTRON 1120[1]	Stars, Stellar Structure and Evolution	3
ASTRON 1263[2]	Techniques of Astronomy	3
PHYS 0475	UHC Introduction to Physics for Science and Engineering 1	4
PHYS 0477	Intro to Thermodynamics, Relativity and Quantum Theory	4
PHYS 0520	Modern Physical Measurements	3
PHYS 1321	Computational Methods in Physics	3
PHYS 1351	Electricity and Magnetism	3
PHYS 1361	Wave Motion and Optics	3
PHYS 1370	Introduction to Quantum Mechanics 1	3
PHYS 1373	Mathematical Methods of Physics	3
PHYS 1376	Introduction to Biological Physics	3
Spring		
ASTRON 1121[3]	Galaxies and Cosmology	3
ASTRON 1122[4]	Exoplanets and the Solar System	3
PHYS 0476	UHC Introduction to Physics for Science and Engineering 2	4
PHYS 0481	Applications of Modern Physics	3
PHYS 0525	Analog and Digital Electronics	3
PHYS 1331	Mechanics	3
PHYS 1341	Thermodynamics and Statistical Mechanics	3
PHYS 1371	Introduction to Quantum Mechanics 2	3
PHYS 1372	Electromagnetic Theory	3
PHYS 1426	Modern Physics Laboratory	2
No Fixed Schedule		
PHYS 0086	Physics and Public Policy	3
PHYS 0087	Physics and Society	3
PHYS 1374	Solid State Physics	3
PHYS 1375	Foundations of Nanoscience	3
PHYS 1378	Introduction to Nuclear/Particle Physics	3

[1] ASTRON 1120 is only offered in odd years (2017, 2019, etc.).

[2] ASTRON 1263 is only offered in even years (2018, 2020, etc.).

[3] ASTRON 1121 is only offered in even years (2018, 2020, etc.).

[4] ASTRON 1122 is only offered in odd years (2017, 2019, etc.).

14 Undergraduate Course Descriptions

14.1 Astronomy Lecture Courses

ASTRON 0113 ***Introduction to Astronomy*** (3 credit hours) – This course is an introduction to the study of the solar system, stars, galaxies, extragalactic objects and the universe at large. [Pre-requisites: C or better in any one of the following MATH courses: 0032, 0100, 0120, 0125, 0200, 0220 or 0235.]

ASTRON 0413 ***Honors Introduction to Astronomy*** (4 credit hours) – This course will be an introduction to astronomy and astrophysics. The 4-credit honors course will consists of all aspects of the 3-credit course, including lectures and homework with additional problems tailored for this course. ASTRON 0413 includes an additional 50-minute class session each week. In these extra sessions, basic topics will be covered in more detail than in ASTRON 0113. These extra sessions will also involve significant problem solving and discussions of the derivations of fundamental results in astronomy and astrophysics. Students considering a major in physics, astronomy, or physics and astronomy are strongly encouraged to take ASTRON 0413 instead of ASTRON 0113. [Pre-requisites: MATH 0230 or MATH 0235, PHYS 0110 or PHYS 0174 or PHYS 0475.]

ASTRON 1120 ***Stars; Stellar Structure and Evolution*** (3 credit hours) – This course offers a study of the properties, formation, structure, and evolution of stars. It is only offered in the fall semester of odd years (2015, 2017, etc.) [Pre-requisites: ASTRON 0113 or 0413, MATH 0240 or 0245 and MATH 0290. Co-requisite: PHYS 0477.]

ASTRON 1121 ***Galaxies and Cosmology*** (3 credit hours) – A study of the nature of our Milky Way Galaxy, objects outside of our Galaxy and the structure of evolution of the universe. It is only offered in the spring semester of even years (2016, 2018, etc.) [Pre-requisites: ASTRON 0113 or 0413, MATH 0240 or 0245 and MATH 0290. Co-requisite: PHYS 0477.]

ASTRON 1122 ***Exoplanets and the Solar System*** (3 credit hours) – This course offers a study of exoplanets and the objects of the solar system. It is only offered in the fall semester of even years (2016, 2018, etc.) [Pre-requisites: ASTRON 0113 or 0413, and PHYS 0111, 0175 or 0476.]

14.2 Astronomy Non-Lecture Courses:

ASTRON 1900 ***Internship*** (1-9 credit hours) – This course places the student in an "on-the-job" setting in which they receive practical experience in a supervised training environment. [Pre-requisite: Departmental consent.]

ASTRON 1901 ***Independent Study*** (1-9 credit hours) – This course gives the student the opportunity to work with a faculty member to design and carry out an individual project not covered by any course offerings. [Pre-requisite: Departmental consent.]

ASTRON 1902 ***Directed Reading*** (1-9 credit hours) – This course is designed to give the student the opportunity to design a plan of reading to be agreed upon by the student and a supervising faculty member. [Pre-requisite: Departmental consent.]

ASTRON 1903 ***Directed Research*** (1-9 credit hours) – This course is designed to give the student the opportunity to design and carry out a research project to be agreed upon by the student and a supervising faculty member. [Pre-requisite: Departmental consent.]

14.3 Physics Lecture Courses

PHYS 0086 ***Physics and Public Policy*** (3 credit hours) – This course introduces students to the physical ideas involved in understanding and evaluating some of the important issues facing society at large.

PHYS 0087 ***Physics and Society*** (3 credit hours) – This course introduces students to the physical ideas underlying the role of nuclear science in modern life. [Pre-requisite: Any MATH course or one of the following MATH co-requisites: 0032, 0100, 0120, 0125, 0200, or 0220.]

PHYS 0174 ***Basic Physics for Science and Engineering 1*** (4 credit hours) – This is the first part of a two-term sequence that introduces students to the basic principles of physics. An effort has been made to achieve a better integration of physics with the first term of calculus, engineering, and chemistry. The course covers mechanics and waves. [Co-requisite: MATH 0220.]

PHYS 0175 ***Basic Physics for Science and Engineering 2*** (4 credit hours) – This is the second part of a two-term sequence that introduces students to the basic principles of physics. An effort has been made to achieve a better integration of physics with the first term of calculus, engineering, and chemistry. This course covers electricity, magnetism, circuits, electromagnetic theory and optics. [Pre-requisite: A minimum grade of 'C' in PHYS 0174 and MATH 0235. Co-requisite: MATH 0230 (if MATH 0235 is not completed).]

PHYS 0475 ***UHC Introduction to Physics for Science and Engineering 1*** (4 credit hours) – This is the first term of a two-term honors version of the introductory physics sequence which deals with mechanics, waves and thermodynamics. This course may be used as a substitute for any PHYS 0174 pre-requisite. [Pre-requisite: A minimum cumulative QPA of 3.25. Co-requisite: MATH 0230 or 0235.]

PHYS 0476 ***UHC Introduction to Physics for Science and Engineering 2*** (4 credit hours) – This is the second term of a two-term honors version of the introductory physics sequence which deals with electricity and magnetism, relativity, and an introduction to modern physics and quantum phenomena. This course may be used as a substitute for any PHYS 0175 pre-requisite. [Pre-requisites: A minimum cumulative QPA of 3.25, a minimum grade of 'C' in PHYS 0475, or a minimum grade of 'B' in PHYS 0174. Co-requisite: MATH 0240.]

PHYS 0477 ***Introduction to Thermodynamics, Relativity and Quantum Theory*** (4 credit hours) – A survey of basic principles of thermodynamics, relativity and quantum physics, with applications to the physics of atoms. [Pre-requisites: A minimum grade of 'B-' in PHYS 0175 or a minimum grade of 'C' in PHYS 0476. Co-requisite: MATH 0240.]

PHYS 0481 ***Principles of Modern Physics 2*** (3 credit hours) – A continuation of Physics 0477, including treatments of multi-electron atoms, molecules, solids, nuclei, and particles. [Pre-requisite: A minimum grade of 'C' or better in PHYS 0477.]

PHYS 1310 ***Undergraduate Seminar*** (1 credit hour) – The undergraduate seminar provides a venue for students to discuss topics of interest in physics and astronomy. It gives students experience presenting research in the form of a poster presentation. The seminar will give the students a taste of what conducting scientific research and presenting scientific results is all about. [Pre-requisites: A minimum grade of C in all courses. PHYS 0477 and (PHYS 0520, PHYS 0525, PHYS 1361, PHYS 1426, or ASTRON 1263) or (PHYS 0219 and any ASTRON course at or above 1120 or any PHYS course at or above 1321).]

PHYS 1321 ***Computational Methods in Physics*** (3 credit hours) – In this course the students will learn how to program a computer rather than to use existing programs. Lectures will explain the strategies in approximation and good programming technique. Then, homework problems will provide the student with their own experiences. [Pre-requisites: A minimum grade of 'C-' in PHYS 0477, PHYS 0219 and a minimum grade of 'C-' in MATH 0240 or 0245. Co-requisite: PHYS 0477, PHYS 0219 or PHYS 0520 or CS 0008 or ENGR 0012, MATH 0240, MATH 0290.]

PHYS 1331 ***Mechanics*** (3 credit hours) – This is a course in intermediate classical mechanics, with vector calculus and differential equations as tools. [Pre-requisites: a minimum grade of 'C' in all courses. PHYS 0175 or 0476, and MATH 0240, and MATH 0290 (or MATH 1270). Co-requisite: MATH 0280.]

PHYS 1341 ***Thermodynamics and Statistical Mechanics*** (3 credit hours) – The properties of matter as described by thermodynamics, in which atomic structure is irrelevant, and by statistical mechanics, which is based on the atomic point of view. [Pre-requisites: A minimum grade of 'C' in all courses: PHYS 0477, MATH 0240 and MATH 0290 (or MATH 1270).]

PHYS 1351 ***Intermediate Electricity and Magnetism*** (3 credit hours) – Electromagnetic theory is formulated with the use of vector calculus. [Pre-requisites: A minimum grade of 'C' in both PHYS 0175 and MATH 0240. Co-requisite: MATH 0290 or MATH 1270.]

PHYS 1370 ***Introduction to Quantum Mechanics 1*** (3 credit hours) – This is the first-term of a two-term introduction to quantum mechanics. This term introduces the necessary formalism and treats some of its basic applications. [Co-requisite: PHYS 1331 and 1351, Pre-requisites: A minimum grade of 'C' in both PHYS 0477 and MATH 0280 (or MATH 1180 or MATH 1185).]

PHYS 1371 ***Introduction to Quantum Mechanics 2*** (3 credit hours) – This is the second-term of a two-term introduction to quantum mechanics. The quantum formalism developed in the first term will be applied in a variety of physical situations. [Pre-requisite: A minimum grade of 'C' in PHYS 1370.]

PHYS 1372 ***Electromagnetic Theory*** (3 credit hours) – This is an advanced course in which Maxwell's equations are applied to a variety of electromagnetic phenomena. [Co-requisite: PHYS 1331, Pre-requisites: PHYS 0477, a minimum grade of 'C-' in both PHYS 1351 and MATH 0280.]

PHYS 1373 ***Mathematical Methods in Physics*** (3 credit hours) – The course is primarily concerned with the mathematical techniques used most frequently in physics. [Co-requisite: PHYS 1370.]

PHYS 1374 ***Solid State Physics*** (3 credit hours) – This course is an introduction to solid state physics for undergraduates. No previous knowledge of solid state physics is assumed, but familiarity with basic quantum mechanics (Schrodinger equation) will be assumed. Topics include: electron bands in solids, quantum confinement and two-dimensional structures and nanostructures, phonons (sound quanta), drift and diffusion of electrons, solid state quantum optics, coherence and dephasing, magnetic systems, and superconductors. [Pre-requisites: PHYS 0477 or CHEM 0710 or 1410.]

PHYS 1375 ***Foundations of Nanoscience*** (3 credit hours) – This course provides an introductory overview of the scientific issues that arise when we attempt to extend our current knowledge of physical systems into the nano length scale. Simple one-dimensional quantum problems will be examined, and difficulties of extending these to small but significant arrays of particles will be discussed. Simple statistical mechanical systems will be discussed, and difficulties of bringing them down to much smaller numbers of particles will be discussed. The course will conclude with consideration of all these issues as applied to one nano system of interest, which may be selected differently each time the course is offered.

PHYS 1376 ***Introduction to Biological Physics*** (3 credit hours) – This course is designed for students with different backgrounds, such as physics, biology, chemistry, bioengineering, and mathematics. The idea is to introduce to the students a quantitative approach to the study of biological systems. The course will focus mainly on the application of physical methodology and techniques, such as thermal and statistical physics to describe and model the behavior of various biological systems. [Pre-requisites: PHYS 0111 or 0175 and either MATH 0230, 0235 or (MATH 0220 and STAT 1000).]

PHYS 1378 ***Introduction to Nuclear/Particle Physics*** (3 credit hours) – This course gives an introduction into the theory concepts and the experimental methods used for nuclear and particle physics research. While some of the basic principles will be discussed from a historical perspective, the emphasis of this course is on modern developments, such as the standard model and the Higgs boson, super-symmetry, extra dimensions, dark matter, CP-violation and baryogensis, and neutrino oscillations. The main aspects of physics processes will be understood and calculated from symmetry principles and kinematics. [Pre-requisite: PHYS 1370.]

14.4 Physics and Astronomy Laboratory Courses

ASTRON 1263 ***Techniques of Astronomy*** (3 credit hours) – This course offers an introduction to the use of astronomical instruments and techniques to process and analyze data. It is only offered in the spring semester of odd years (2015, 2017, etc.) [Pre-requisites: ASTRON 0113, PHYS 0175 and PHYS 0219.]

PHYS 0219 ***Basic Laboratory Physics for Science and Engineering*** (2 credit hours) – An introductory laboratory associated with Physics 0174 and 0175. Experiments from many areas of physics are performed. [Co-requisite: PHYS 0175.]

PHYS 0520 ***UHC Modern Physics Measurements*** (3 credit hours) – An introduction to the scientific basis of modern physical measurements. This course may be used as a substitute for any PHYS 0219 pre-requisite. [Pre-requisites: A minimum grade of 'C' in PHYS 0476, or a minimum grade of 'B' in PHYS 0175, a minimum cumulative QPA of 3.25, or permission of the instructor.]

PHYS 0525 ***Analog and Digital Electronics*** (3 credit hours) – This laboratory course is designed to introduce the student to contemporary analog and digital electronics techniques that are used in basic science and engineering research. Topics include the study of measurement instruments, passive circuits, diode and transistor circuits, operational amplifiers and feedback, digital gates, analog to digital and digital to analog circuits. [Pre-requisite: A minimum grade of 'C' in PHYS 0219 or PHYS 0520.]

PHYS 1361 ***Wave Motion and Optics*** (3 credit hours) – This is an intermediate-level course dealing with wave motion and optics. Laboratory work is included as part of this course. [Pre-requisites: A minimum grade of 'C' in both PHYS 0219 and MATH 0240. Co-requisite: MATH 0280 or MATH 1180 or MATH 1185.]

PHYS 1426 ***Modern Physics Laboratory*** (2 credit hours) – This is an advanced laboratory course that introduces students to the experimental techniques and equipment used in research laboratories. [Pre-requisites: PHYS 0477 and PHYS 0525.]

14.5 Physics Writing Practicum Courses

PHYS 1626 ***Modern Physics Laboratory Writing Practicum*** (1 credit hour) – This is a writing practicum to accompany PHYS 1426 or ASTRON 1263. [Pre-requisite: Declared major in Physics, Physics and Astronomy, or Astronomy. Co-requisite: PHYS 1426 or ASTRON 1263.]

PHYS 1661***Fall Term Laboratory Writing Practicum*** (1 credit hour) – This is a writing practicum to accompany PHYS 0520 or 1361. [Pre-requisite: Declared major in Physics, Physics and Astronomy, or Astronomy. Co-requisite: PHYS 0520 or 1361.]

14.6 Physics Non-Lecture Courses:

PHYS 1900 ***Internship*** (1-9 credit hours) – This course places the student in an "on-the-job" setting in which they receive practical experience in a supervised training environment. [Pre-requisite: Departmental consent.]

PHYS 1901 ***Independent Study*** (1-9 credit hours) – This course gives the student the opportunity to work with a faculty member to design and carry out an individual project not covered by any course offerings. [Pre-requisite: Departmental consent.]

PHYS 1902 ***Directed Reading*** (1-9 credit hours) – This course is designed to give the student the opportunity to design a plan of reading to be agreed upon by the student and a supervising faculty member. [Pre-requisite: Departmental consent.]

PHYS 1903 ***Directed Research*** (1-9 credit hours) – This course is designed to give the student the opportunity to design and carry out a research project to be agreed upon by the student and a supervising faculty member. [Pre-requisite: Departmental consent.]

15 Facilities for Undergraduates

15.1 Buildings

The Department of Physics and Astronomy is located primarily in a set of interconnected buildings on the Oakland campus a couple of blocks from the Cathedral of Learning (http://www.tour.pitt.edu/tour-080.html). There are also additional facilities located in the Pittsburgh area.

Allen Hall (http://www.tour.pitt.edu/tour-116.html) is the main building for the offices, labs and classrooms for the department. The main office is located in 100 Allen Hall. Allen Hall is also the home of the Pittsburgh Particle Physics, Astrophysics and Cosmology Center (Pitt PACC, http://www.physicsandastronomy.pitt.edu/pittpacc).

Engineering Hall (http://www.tour.pitt.edu/tour-240.html), which is also called Old Engineering Hall (OEH), is connected to Allen Hall. This building contains offices, research labs and our undergraduate teaching labs.

The Van de Graaff building (http://www.tour.pitt.edu/tour-285.html) houses many of our research labs and our machine shop.

Thaw Hall (http://www.tour.pitt.edu/tour-490.html) has two of our large lecture halls and a demonstration area, the Physics Resource Room (http://www.physicsandastronomy.pitt.edu/resource_room) for help with homework and the Physics Exploration Center (http://www.phyast.pitt.edu/~pec/).

Alumni Hall (http://www.tour.pitt.edu/tour-102.html) which is across the street from the Cathedral of Learning is the location of our largest lecture hall and demonstration area.

Allegheny Observatory (http://www.physicsandastronomy.pitt.edu/AO) is a functioning research observatory that is also used for undergraduate teaching and public outreach.

15.2 Undergraduate Laboratories

The third and fourth floors of Engineering Hall (OEH) are almost exclusively used for our undergraduate laboratories. The introductory labs are on the fourth floor and the honors, modern physics, electronics and optics labs are located on the third floor. We have a wide range of equipment and potential experiments for you to work with. In our introductory labs you will work with equipment specifically designed for teaching labs, but by the time you take one of our junior or senior level labs you will be working with research quality instruments.

15.3 Computers

The University provides numerous computing labs across campus, but in addition our department also has computer resources that go along with our instructional labs. Because of the large role that computers play in many areas, physics majors are expected to have acquired some knowledge of simple computer programming by the end of their sophomore year. If you become involved in research work as an undergraduate then you may also have access to various computing resources such as the Center for Simulation and Modeling (http://www.sam.pitt.edu/), the PittGrid (http://www.pittgrid.pitt.edu/) and the internationally recognized Pittsburgh Supercomputing Center (http://www.psc.edu/).

15.4 Library Facilities

The Physics collection is housed in the Bevier Engineering Library (see the link below) located in Benedum Hall (http://www.tour.pitt.edu/tour-118.html). The collection of books and bound periodicals is supplemented continually by new acquisitions as well as subscriptions to hundreds of technical journals from many countries. The library also provides access to national information-retrieval networks. Undergraduates have regular access to this library as well as to several others within easy walking distance. An additional astronomy library is located at the Allegheny Observatory.

Bevier Engineering Library: http://www.library.pitt.edu/libraries/engineering/engineer.html

15.5 Undergraduate Lounge

The Undergraduate Lounge is a room set aside for the exclusive use of our undergraduate majors. This room is furnished with computers, a comfortable seating area, and work tables. Once you become a major in our department, you can obtain a key to the lounge from the main office. There is a small, refundable deposit required for the key.

16 Undergraduate Activities

16.1 Undergraduate Research

One of the most important advantages to being at a large university is the opportunity to become involved in research, even at the undergraduate level. Research work is not required for our undergraduate majors except for those pursuing an Honors degree (see page 7). Even so, we strongly encourage all of our majors to become involved in research work. Research experience will enhance your education and it will make you significantly more marketable to a future employer or graduate admissions board. Your advisor will discuss with you how to find and take advantage of research opportunities within our department. Generally, most of our faculty will be able to pay you a small salary from their research grants, but you may alternately receive college credit through one of our directed research courses, PHYS 1903 or ASTRON 1903. There are also undergraduate awards that can be used to support research work (see below). Your advisor can also help you to find research opportunities outside of the department such as the NSF REU summer programs.

16.2 Undergraduate Awards

There are several awards that are given out by our department on a yearly or semester by semester basis. These awards reward strong academic performance, good writing skills or promising research proposals. The funding for these awards comes from either outside agencies, such as NASA, or from the charitable contributions of groups and individuals.

- **Peter F. M. Koehler Junior/Senior Level Academic Achievement Award** – This award is given on a yearly basis to the junior or senior level student in our department with the highest academic performance.

- **Peter F.M. Koehler Sophomore/Junior Level Academic Achievement Award** – This award is given on a yearly basis to the sophomore or junior level student in our department with the highest academic performance.

- **Thomas-Lain Fund Scholarship** - This award is issued to undergraduate or graduate students in the Department of Physics and Astronomy. The awardees are chosen by a committee evaluating essays that the applicants supply. These essays are written based on a topic chosen for the contest each year.

- **Julia Thompson Excellence in Undergraduate Scientific Writing** - The award is given for a paper written during the academic year by an undergraduate student that is scientifically accurate, written in excellent English, and interesting to read.

- **Halliday Award for Excellence in Undergraduate Research** - This award is given in recognition of outstanding research done by an undergraduate student. Usually, the student will be nominated by her or his research adviser. Any University of Pittsburgh undergraduate student who has conducted research with a faculty member in the Department of Physics and Astronomy is eligible for this award, regardless of whether she or he is a major in our department.

- **Emil Sanielevici Undergraduate Research Scholarship** - This award is given annually in the Department of Physics and Astronomy in memory of our student, Emil Sanielevici (1979-2000), whose enthusiasm and love of scientific research continue to inspire us all.

- **The NASA Pennsylvania Space Grant Consortium (PASGC) Research Scholarship** – This award is given out semester by semester to several students. Each student applicant, along with a faculty mentor, submits a research proposal. Successful applicants receive a stipend (research scholarship) to support them as they carry out the proposed project. Five awards are given for part time research work in the fall and spring semesters and three awards are given for full time research work over the summer.

16.3 Undergraduate Seminar and Departmental Colloquia

Even though you will only be required to take the Undergraduate Seminar (PHYS 1310) once, you are welcome to attend these weekly meetings at any time. Topics in the seminar usually range through various areas of current research, presented by faculty members and students, as well as such subjects as employment opportunities and mentoring.

Every week there are a number of colloquia talks both here and at Carnegie Mellon University. These talks are open to everyone and you are encouraged to attend any that interest you. The level of the talks varies, but no matter how advanced a given talk may be, you will understand enough to learn something new and interesting. A schedule of talks at Pitt and CMU is sent out every week.

16.4 Departmental Administration

As an undergraduate major you are encouraged to attend general department meetings. One representative undergraduate from the department does have voting membership on the undergraduate curriculum committee.

16.5 Society of Physics Students

Our Society of Physics Students (SPS, http://www.spsnational.org/) chapter has won recognition as an Outstanding Chapter, and has received awards for projects designed to enhance interest in physics among students and the general public. There is also a local chapter of Sigma Pi Sigma (http://www.sigmapisigma.org/), a physics honorary society within the Society of Physics Students.

You are encouraged to join the national SPS through our chapter. The dues are small and members receive the AIP monthly magazine *Physics Today.*