Physics

Raymond E. Frey, Department Head
541-346-5873
541-346-5861 fax
120 Willamette Hall
1274 University of Oregon
Eugene, Oregon 97403-1274

Physics, the most basic of the natural sciences, is concerned with the discovery and development of the laws that describe our physical universe. This endeavor serves, also, to directly benefit humankind: integrated circuits found in computers, mobile phones, and solar cells, lasers in DVD players and computer mice, and the Internet itself were developed from fundamental physics discoveries.

Faculty

Benjamín Alemán, assistant professor (experimental condensed matter, optical physics). BS, 2004, Oregon; MA, 2010, PhD, 2011, California, Berkeley. (2013)

Dietrich Belitz, professor (condensed matter theory). Dipl Phys, 1980, Dr.rer.nat., 1982, Technical University Munich. (1987)

Bryan S. Boggs, lecturer (optical physics). BS, 1995, MS, 1996, PhD, 2012, Oregon. (2013)

Gregory D. Bothun, professor (astronomy). BS, 1976, PhD, 1981, Washington (Seattle). (1990)

James E. Brau, Philip H. Knight Professor (experimental elementary particle physics). BS, 1969, United States Air Force Academy; MS, 1970, PhD, 1978, Massachusetts Institute of Technology. (1988)

Spencer Chang, associate professor (theoretical high-energy physics). BS, 1999, Stanford; PhD, 2004, Harvard. (2010)

Timothy Cohen, assistant professor (elementary particle theory). BS, 2006, MS, 2009, PhD, 2011, Michigan, Ann Arbor. (2015)

Eric Corwin, associate professor (biophysics, soft condensed matter). BA, 2001, Harvard; PhD, 2007, Chicago. (2010)

Paul L. Csonka, professor (elementary particle theory). PhD, 1963, Johns Hopkins. (1968)

Nilendra G. Deshpande, professor (elementary particle theory). BSc, 1959, MSc, 1960, Madras; PhD, 1965, Pennsylvania. (1975)

Miriam Deutsch, professor (optical physics). BSc, 1988, PhD, 1996, Hebrew. (2000)

R. Scott Fisher, lecturer (astronomy). BS, 1993, PhD, 2001, Florida. (2012)

Raymond E. Frey, professor (experimental elementary particle physics). BA, 1978, California, Irvine; MS, 1981, PhD, 1984, California, Riverside. (1989)

Stephen Gregory, associate professor (solid state physics). BSc, 1969, Manchester; MSc, 1970, Essex; PhD, 1975, Waterloo. (1992)

Roger Haydock, professor (solid state theory). BA, 1968, Princeton; MA, PhD, 1972, ScD, 1989, Cambridge. (1982)

James N. Imamura, professor (astrophysics); director, Institute of Theoretical Science. BA, 1974, California, Irvine; MA, 1978, PhD, 1981, Indiana. (1985)

Timothy Jenkins, senior instructor (physics education). BA, 1975, Linfield College; PhD, 1992, Clarkson. (1992)

Stephen D. Kevan, professor (solid state physics). BA, 1976, Wesleyan; PhD, 1980, California, Berkeley. (1985)

Graham Kribs, professor (elementary particle theory). BASc, 1993, Toronto; PhD, 1998, Michigan, Ann Arbor. (2004)

Dean W. Livelybrooks, senior instructor (geophysics). BS, 1977, Massachusetts Institute of Technology; MS, 1984, PhD, 1990, Oregon. (1996)

Stephanie Majewski, associate professor (experimental elementary particle physics). BS, 2002, Illinois, Urbana-Champaign; PhD, 2007, Stanford. (2012)

Brian W. Matthews, professor (protein crystallography). BSc, 1959, BSc, 1960, PhD, 1964, Adelaide. (1969)

Benjamin McMorran, associate professor (experimental condensed matter, optical physics). BS, 2000, Oregon State; MS, PhD, 2009, Arizona. (2011)

Stanley J. Micklavzina, senior instructor (physics education). BS, 1982, MS, 1985, Oregon. (1985)

Jens Nöckel, associate professor (optical physics). Dipl. Phys., 1992, Hamburg; PhD, 1997, Yale. (2001)

Raghuveer Parthasarathy, Alec and Kay Keith Professor (condensed matter physics, biophysics). BA, 1997, California, Berkeley; PhD, 2002, Chicago. (2006)

Michael G. Raymer, Philip H. Knight Professor (quantum optics and optical physics). BA, 1974, California, Santa Cruz; PhD, 1979, Colorado. (1988)

Stephen J. Remington, professor (protein crystallography). BS, 1971, Oregon State; PhD, 1977, Oregon. (1985)

William C. Scannell, lab instructor (physics education). BS, 2002, MS, 2004, PhD, 2010, Oregon. (2016)

James M. Schombert, Noble F. and Frances L. Miller Professor in Astrophysics (astronomy). BS, 1979, Maryland; MPhil, 1982, PhD, 1984, Yale. (1996)

Brian J. Smith, associate professor (quantum optics, optical physics). BA, 2000, Gustavus Adolphus College; PhD, 2007, Oregon. (2015)

Davison E. Soper, professor (elementary particle theory). BA, 1965, Amherst; PhD, 1971, Stanford. (1977)

Daniel Steck, associate professor (atom optics and nonlinear dynamics). BS, 1995, Dayton; PhD, 2001, Texas, Austin. (2004)

David M. Strom, professor (experimental elementary particle physics). BA, 1980, St. Olaf; PhD, 1986, Wisconsin, Madison. (1991)

Richard P. Taylor, professor (solid state physics). BS, 1985, PhD, 1988, Nottingham. CAD, 1995, Manchester School of Art; MA, 2000, New South Wales. (1999)

John J. Toner, professor (condensed matter theory). BS, 1977, Massachusetts Institute of Technology; MA, 1979, PhD, 1981, Harvard. (1995)

Eric Torrence, professor (experimental elementary particle physics). BS, 1990, Washington (Seattle); PhD, 1997, Massachusetts Institute of Technology. (2000)

Tristan S. Ursell, assistant professor (condensed matter physics, biophysics). BS, 2003, Rensselaer Polytechnic Institute; MS, 2003, PhD, 2009, California Institute of Technology. (2014)

Steven J. van Enk, professor (theoretical optical physics). MSc, 1988, Utrecht; PhD, 1992, Leiden. (2006)

Hailin Wang, professor (quantum optics); Alec and Kay Keith Chair in Physics. BS, 1982, Science and Technology (China); MS, 1986, PhD, 1990, Michigan. (1995)

Special Staff

Robert Schofield, senior research associate (nuclear biophysics). BS, 1982, Brigham Young; PhD, 1990, Oregon. (1993)

Nikolai Sinev, senior research associate (experimental high energy physics). BS, 1968, PhD, 1974, Moscow State. (1993)

Frank Vignola, senior research associate (solar energy). BA, 1967, California, Berkeley; MS, 1969, PhD, 1975, Oregon. (1977)

Emeriti

Bernd Crasemann, professor emeritus. AB, 1948, California, Los Angeles; PhD, 1953, California, Berkeley. (1953)

Rudolph C. Hwa, professor emeritus. BS, 1952, MS, 1953, PhD, 1957, Illinois; PhD, 1962, Brown. (1971)

Harlan Lefevre, professor emeritus. BA, 1951, Reed; PhD, 1961, Wisconsin. (1961)

Joel W. McClure Jr., professor emeritus. BS, 1949, MS, 1951, Northwestern; PhD, 1954, Chicago. (1954)

David K. McDaniels, professor emeritus. BS, 1951, Washington State; MS, 1958, PhD, 1960, Washington (Seattle). (1963)

John T. Moseley, professor emeritus. BS, 1964, MS, 1966, PhD, 1969, Georgia Institute of Technology. (1979)

George W. Rayfield, professor emeritus. BS, 1958, Stanford; PhD, 1964, California, Berkeley. (1967)

David R. Sokoloff, professor emeritus. BA, 1966, City University of New York, Queens; PhD, 1972, Massachusetts Institute of Technology. (1978)

Robert L. Zimmerman, professor emeritus. BA, 1958, Oregon; PhD, 1963, Washington (Seattle). (1966)

The date in parentheses at the end of each entry is the first year on the University of Oregon faculty.

- **Bachelor of Arts: Applied Physics**
- **Bachelor of Arts: Teaching Physics** (p. 4)
- **Bachelor of Arts: Physics**
- **Bachelor of Science: Applied Physics**
- **Bachelor of Science: Teaching Physics**
- **Bachelor of Science: Physics**
- **Minor**

Undergraduate Studies

As it involves the development of analytical, technical, problem-solving, and science communication skills, a major in physics provides a good start for many career paths. In addition to major and minor programs, the Department of Physics offers a variety of courses for nonmajors and health science premajor students.

Preparation

Entering freshmen should have taken as much high school mathematics as possible in preparation for starting calculus in their freshman year. High school study of physics and chemistry is desirable.

Transfer Students

Because of the sequential nature of the physics curriculum, it is useful for students from two-year colleges to complete as much as possible of calculus, differential equations, several-variable calculus, chemistry, and calculus-based physics (part of an associate's degree) before transferring.

Years Completed Before Transfer	Suggested Completed Courses	UO Equivalent Courses
Two, more than two	One year of differential and integral calculus	MATH 251–253-253
Two, more than two	One year of calculus general physics with laboratory	PHYS 251–253-253, PHYS 290
Two, more than two	General chemistry	CH 221–222-222 or CH 224H–225H-225H
Two, more than two	One term of differential equations and two terms of multivariable calculus	MATH 256, MATH 281–282-282
More than two	Second year of physics	

Transfer students should also have completed as many as possible of the university requirements for the bachelor’s degree (see Bachelor’s Degree Requirements (http://catalog.uoregon.edu/archive/2017-2018/bachelorrequirements)).

Careers

Fifty percent of graduates with bachelor’s degrees in physics find employment in the private sector working as applied physicists, software developers, managers, or technicians, typically alongside engineers and computer scientists. About 30 percent of students who earn an undergraduate degree continue their studies in a graduate degree program, leading to a career in teaching or research or both at a university, at a government laboratory, or in industry. In addition, a degree in physics is good preparation for a career in business. Students who have demonstrated their ability with a good record in an undergraduate physics program are generally considered very favorably for admission to medical and other professional schools.

Major Requirements

The major in physics leads to a bachelor of arts (BA) or a bachelor of science degree (BS). Complete requirements are listed under **Bachelor's Degree Requirements**. The bachelor of arts degree has a second-language requirement. Knowledge of a language other than English is recommended for students planning graduate study in physics.

Required courses must be taken for letter grades and a grade point average of 2.00 (mid-C) or better must be earned in these courses. Courses beyond the minimum requirement may be taken pass/no pass (P/N). At least 20 of the upper-division credits must be completed in residence at the University of Oregon. Exceptions to these requirements must be approved by the physics director of undergraduate studies.

Undergraduate research is strongly encouraged. Laboratory courses such as Foundations of Physics Laboratory (PHYS 290) and Physics Experimentation Data Analysis Laboratory (PHYS 391) provide the correct foundation. Approximately 50 percent of physics undergraduates engage in substantive research during their course of study—typically beginning with Research Project I-III (PHYS 491–493). Contact the physics advisor for more information.

The sequential nature of physics courses makes it imperative to start planning a major program in physics early. Interested students should consult the advisor in the Department of Physics near the beginning of their studies. Sample programs are designed for students who are preparing for employment in industry and choose the applied physics emphasis or who are preparing for graduate studies and choose the physics emphasis. The programs assume that students are prepared to take calculus in their freshman year. Consult the physics advisor for assistance in planning a specific program adapted to a student's individual needs.

The department offers three areas of emphasis for the physics major.

- **physics—**designed for majors with a strong interest in studying physics in graduate school
- **applied physics—**designed for majors who seek a less theoretical study of physics and a more applied focus in optics, electronics, and other project areas
- **teaching physics—**designed for majors preparing to teach physical sciences in middle or high school

All physics majors have the same curriculum for the first two years.

Bachelor of Arts: Applied Physics

Code	Title	Credits
Core Courses		
MATH 251–253	Calculus I-III	12
or MATH 261–263	Calculus with Theory I-III	
PHYS 251–253	Foundations of Physics I	12
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 290	Foundations of Physics Laboratory [1]	2
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Interdisciplinary Science Core Courses		
Two from the following: [2]		8
CH 221	General Chemistry I	
CH 222	General Chemistry II	
CH 224H	Honors General Chemistry	
CH 225H	Honors General Chemistry	
BI 211	General Biology I: Cells	
BI 212	General Biology II: Organisms	
BI 213	General Biology III: Populations	
CIS 210	Computer Science I	
CIS 211	Computer Science II	
CIS 212	Computer Science III	
GEOL 201	Earth's Interior Heat and Dynamics	
HPHY 212	Evidence, Inference, and Biostatistics	
Applied Physics Upper-Division Courses		
PHYS 412–413	Mechanics, Electricity, and Magnetism	8
Applied Physics Core Courses		
Select one of the following:		8
PHYS 424 & PHYS 425	Classical Optics and Modern Optics	
PHYS 431 & PHYS 432	Analog Electronics and Digital Electronics	
PHYS 481	Design of Experiments	4
Three laboratory courses [3]		12
Total Credits		**94**

1. To be repeated, totaling 2 credits.
2. Students are strongly urged to complete this requirement in the first two years.
3. Any combination of the four core courses listed for the Applied emphasis that have not been used to satisfy the core, and Research Project I-III (PHYS 491–493) topic modules satisfy this requirement. Different topic modules (e.g., optics, instrumentation, fundamental) of Research Project I-III (PHYS 491–493) may be taken. PHYS 401: Research also counts for this requirement if taken graded.

Applied Physics Sample Program

First Year		Credits
CH 221–222	General Chemistry (or any two courses from the Interdisciplinary Science Core)	8
PHYS 251–253	Foundations of Physics I	12
PHYS 290	Foundations of Physics Laboratory (two or more terms)	2
MATH 251–253	Calculus I-III	12
Second Year		
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Third Year		
PHYS 412–413	Mechanics, Electricity, and Magnetism	8
PHYS 431	Analog Electronics [1]	4
PHYS 432	Digital Electronics [1]	4
PHYS 424	Classical Optics [1]	4
PHYS 425	Modern Optics [1]	4

Fourth Year		
PHYS 491–493	Research Project I-III	6
PHYS 481	Design of Experiments	4
	Total Credits:	**96**

[1] Students must take either PHYS 431–432 or PHYS 424–425.

Bachelor of Science: Applied Physics

Code	Title	Credits
Core Courses		
MATH 251–253	Calculus I-III	12
or MATH 261–263	Calculus with Theory I-III	
PHYS 251–253	Foundations of Physics I	12
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 290	Foundations of Physics Laboratory [1]	2
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Interdisciplinary Science Core Courses		
Two from the following: [2]		8
CH 221	General Chemistry I	
CH 222	General Chemistry II	
CH 224H	Honors General Chemistry	
CH 225H	Honors General Chemistry	
BI 211	General Biology I: Cells	
BI 212	General Biology II: Organisms	
BI 213	General Biology III: Populations	
CIS 210	Computer Science I	
CIS 211	Computer Science II	
CIS 212	Computer Science III	
GEOL 201	Earth's Interior Heat and Dynamics	
HPHY 212	Evidence, Inference, and Biostatistics	
Applied Physics Upper-Division Courses		
PHYS 412–413	Mechanics, Electricity, and Magnetism	8
Applied Physics Core Courses		
Select one of the following:		8
PHYS 424 & PHYS 425	Classical Optics and Modern Optics	
PHYS 431 & PHYS 432	Analog Electronics and Digital Electronics	
PHYS 481	Design of Experiments	4
Three laboratory courses [3]		12
Total Credits		**94**

[1] To be repeated, totaling 2 credits.

[2] Students are strongly urged to complete this requirement in the first two years.

[3] Any combination of the four core courses listed for the Applied emphasis that have not been used to satisfy the core, and Research Project I-III (PHYS 491–493) topic modules satisfy this requirement. Different topic modules (e.g., optics, instrumentation, fundamental) of Research Project I-III (PHYS 491–493) may be taken. PHYS 401: Research also counts for this requirement if taken graded.

Applied Physics Sample Program

First Year		Credits
CH 221–222	General Chemistry (or any two courses from the Interdisciplinary Science Core)	8
PHYS 251–253	Foundations of Physics I	12
PHYS 290	Foundations of Physics Laboratory (two or more terms)	2
MATH 251–253	Calculus I-III	12
Second Year		
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Third Year		
PHYS 412–413	Mechanics, Electricity, and Magnetism	8
PHYS 431	Analog Electronics [1]	4
PHYS 432	Digital Electronics [1]	4
PHYS 424	Classical Optics [1]	4
PHYS 425	Modern Optics [1]	4
Fourth Year		
PHYS 491–493	Research Project I-III	6
PHYS 481	Design of Experiments	4
	Total Credits:	**96**

[1] Students must take either PHYS 431–432 or PHYS 424–425.

Bachelor of Arts: Teaching Physics

Code	Title	Credits
Physics Core Courses		
MATH 251–253	Calculus I-III	12
or MATH 261–263	Calculus with Theory I-III	
PHYS 251–253	Foundations of Physics I	12
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 290	Foundations of Physics Laboratory [1]	2
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Interdisciplinary Science Core		
Two from the following: [2]		8
CH 221	General Chemistry I	
CH 222	General Chemistry II	
CH 224H	Honors General Chemistry	
CH 225H	Honors General Chemistry	
BI 211	General Biology I: Cells	

BI 212	General Biology II: Organisms	
BI 213	General Biology III: Populations	
CIS 211	Computer Science II	
CIS 210	Computer Science I	
CIS 212	Computer Science III	
GEOL 201	Earth's Interior Heat and Dynamics	
HPHY 212	Evidence, Inference, and Biostatistics	
Teaching Physics Core Courses		
ASTR 321	Topics in Astrophysics	4
PHYS 362	Biological Physics	4
PHYS 420	Physics Demonstrations	4
PHYS 431 & PHYS 432	Analog Electronics and Digital Electronics	8
PHYS 491–493	Research Project I-III	8
PHYS 409	Supervised Tutoring [3]	6
Total Credits		**96**

1. To be repeated, totaling 2 credits.
2. Students are strongly urged to complete this requirement in the first two years.
3. Does not need to be taken for a letter grade.

Teaching Physics Sample Program

First Year		Credits
CH 221–222	General Chemistry (or any two courses from the Interdisciplinary Science Core)	8
PHYS 251–253	Foundations of Physics I	12
PHYS 290	Foundations of Physics Laboratory (two or more terms)	2
MATH 251–253	Calculus I-III	12
Second Year		
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Third Year		
ASTR 321	Topics in Astrophysics	4
PHYS 409	Supervised Tutoring	6
PHYS 420	Physics Demonstrations	4
PHYS 431	Analog Electronics	4
PHYS 432	Digital Electronics	4
Fourth Year		
PHYS 491–493	Research Project I-III	8
	Total Credits:	**92**

Bachelor of Science: Teaching Physics

Code	Title	Credits
Physics Core Courses		
MATH 251–253 or MATH 261–263	Calculus I-III Calculus with Theory I-III	12
PHYS 251–253	Foundations of Physics I	12
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 290	Foundations of Physics Laboratory [1]	2
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Interdisciplinary Science Core		
Two from the following: [2]		8
CH 221	General Chemistry I	
CH 222	General Chemistry II	
CH 224H	Honors General Chemistry	
CH 225H	Honors General Chemistry	
BI 211	General Biology I: Cells	
BI 212	General Biology II: Organisms	
BI 213	General Biology III: Populations	
CIS 211	Computer Science II	
CIS 210	Computer Science I	
CIS 212	Computer Science III	
GEOL 201	Earth's Interior Heat and Dynamics	
HPHY 212	Evidence, Inference, and Biostatistics	
Teaching Physics Core Courses		
ASTR 321	Topics in Astrophysics	4
PHYS 362	Biological Physics	4
PHYS 420	Physics Demonstrations	4
PHYS 431 & PHYS 432	Analog Electronics and Digital Electronics	8
PHYS 491–493	Research Project I-III	8
PHYS 409	Supervised Tutoring [3]	6
Total Credits		**96**

1. To be repeated, totaling 2 credits.
2. Students are strongly urged to complete this requirement in the first two years.
3. Does not need to be taken for a letter grade.

Teaching Physics Sample Program

First Year		Credits
CH 221–222	General Chemistry (or any two courses from the Interdisciplinary Science Core)	8
PHYS 251–253	Foundations of Physics I	12
PHYS 290	Foundations of Physics Laboratory (two or more terms)	2
MATH 251–253	Calculus I-III	12
Second Year		
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Third Year		
ASTR 321	Topics in Astrophysics	4
PHYS 409	Supervised Tutoring	6
PHYS 420	Physics Demonstrations	4

PHYS 431	Analog Electronics	4
PHYS 432	Digital Electronics	4
Fourth Year		
PHYS 491–493	Research Project I-III	8
	Total Credits:	**92**

Bachelor of Arts: Physics

Code	Title	Credits
Physics Core Courses		
MATH 251–253	Calculus I-III	12
or MATH 261–263	Calculus with Theory I-III	
PHYS 251–253	Foundations of Physics I	12
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 290	Foundations of Physics Laboratory [1]	2
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Interdisciplinary Science Core		
Two from the following: [2]		8
CH 221	General Chemistry I	
CH 222	General Chemistry II	
CH 224H	Honors General Chemistry	
CH 225H	Honors General Chemistry	
BI 211	General Biology I: Cells	
BI 212	General Biology II: Organisms	
BI 213	General Biology III: Populations	
CIS 210	Computer Science I	
CIS 211	Computer Science II	
CIS 212	Computer Science III	
GEOL 201	Earth's Interior Heat and Dynamics	
HPHY 212	Evidence, Inference, and Biostatistics	
Physics Upper-Division Courses		
PHYS 411–413	Mechanics, Electricity, and Magnetism [3]	12
PHYS 414–415	Quantum Physics	8
PHYS 417	Topics in Quantum Physics	4
Three upper-division laboratory courses [4]		6
Total Credits		**92**

1. To be repeated, totaling 2 credits.
2. Students are strongly urged to complete this requirement in the first two years.
3. Mechanics, Electricity, and Magnetism (PHYS 411) and Mechanics, Electricity, and Magnetism (PHYS 412) are sometimes offered out of sequence.
4. Any combination of PHYS 424–425 or PHYS 431–432 or PHYS 491–493 or PHYS 401, to total 6 credits.

Physics Sample Program

First Year		Credits
CH 221–222	General Chemistry (or any two courses from the Interdisciplinary Science Core)	8
PHYS 251–253	Foundations of Physics I	12
PHYS 290	Foundations of Physics Laboratory (two or more terms)	2
MATH 251–253	Calculus I-III	12
Second Year		
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Third Year		
PHYS 411–413	Mechanics, Electricity, and Magnetism	12
Upper-division laboratory course from the following list: PHYS 424–425, PHYS 431–432, PHYS 491–493, or PHYS 401		2-4
Fourth Year		
PHYS 414–415	Quantum Physics	8
PHYS 417	Topics in Quantum Physics	4
Upper-division laboratory course from the following list: PHYS 424–425, PHYS 431–432, PHYS 491–493, or PHYS 401		2-4
	Total Credits:	**91-94**

Bachelor of Science: Physics

Code	Title	Credits
Physics Core Courses		
MATH 251–253	Calculus I-III	12
or MATH 261–263	Calculus with Theory I-III	
PHYS 251–253	Foundations of Physics I	12
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 290	Foundations of Physics Laboratory [1]	2
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Interdisciplinary Science Core		
Two from the following: [2]		8
CH 221	General Chemistry I	
CH 222	General Chemistry II	
CH 224H	Honors General Chemistry	
CH 225H	Honors General Chemistry	
BI 211	General Biology I: Cells	
BI 212	General Biology II: Organisms	
BI 213	General Biology III: Populations	
CIS 210	Computer Science I	

CIS 211	Computer Science II	
CIS 212	Computer Science III	
GEOL 201	Earth's Interior Heat and Dynamics	
HPHY 212	Evidence, Inference, and Biostatistics	
Physics Upper-Division Courses		
PHYS 411–413	Mechanics, Electricity, and Magnetism [3]	12
PHYS 414–415	Quantum Physics	8
PHYS 417	Topics in Quantum Physics	4
Three upper-division laboratory courses [4]		6
Total Credits		**92**

1 To be repeated, totaling 2 credits.

2 Students are strongly urged to complete this requirement in the first two years.

3 Mechanics, Electricity, and Magnetism (PHYS 411) and Mechanics, Electricity, and Magnetism (PHYS 412) are sometimes offered out of sequence.

4 Any combination of PHYS 424–425 or PHYS 431–432 or PHYS 491–493 or PHYS 401, to total 6 credits.

Physics Sample Program

First Year		Credits
CH 221–222	General Chemistry (or any two courses from the Interdisciplinary Science Core)	8
PHYS 251–253	Foundations of Physics I	12
PHYS 290	Foundations of Physics Laboratory (two or more terms)	2
MATH 251–253	Calculus I-III	12
Second Year		
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Third Year		
PHYS 411–413	Mechanics, Electricity, and Magnetism	12
Upper-division laboratory course from the following list: PHYS 424–425, PHYS 431–432, PHYS 491–493, or PHYS 401		2-4
Fourth Year		
PHYS 414–415	Quantum Physics	8
PHYS 417	Topics in Quantum Physics	4
Upper-division laboratory course from the following list: PHYS 424–425, PHYS 431–432, PHYS 491–493, or PHYS 401		2-4
	Total Credits:	**91-94**

Sample Programs for Transfer Students

These sample programs are for transfer students who have completed two years of college work including one year of calculus, one year of general physics with laboratories, one year of general chemistry, and as many as possible of the university requirements for the bachelor's degree. In addition to graduation requirements for the bachelor's degree, transfer students should plan to take the following courses, depending on their area of emphasis:

Applied Physics Emphasis

Third Year		Credits
MATH 256	Introduction to Differential Equations	4
MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Fourth Year		
PHYS 412–413	Mechanics, Electricity, and Magnetism	8
PHYS 422	Electromagnetism	4
PHYS 424 & PHYS 425	Classical Optics	8
Select one or two of the following:		4-8
PHYS 431	Analog Electronics	2-4
PHYS 432	Digital Electronics	2-4
PHYS 491	Research Project I	2-4
PHYS 492	Research Project II	2-4
PHYS 493	Research Project III	2-4
	Total Credits:	**52-56**

Teaching Physics Emphasis

Third Year		Credits
ASTR 321	Topics in Astrophysics	4
PHYS 362	Biological Physics	4
PHYS 409	Supervised Tutoring	6
PHYS 420	Physics Demonstrations	4
PHYS 431 & PHYS 432	Analog Electronics	8
Fourth Year		
PHYS 491–493	Research Project I-III	8
	Total Credits:	**34**

Physics Emphasis

Third Year		Credits
MATH 256	Introduction to Differential Equations	4

MATH 281–282	Several-Variable Calculus I-II	8
PHYS 351–353	Foundations of Physics II	12
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Fourth Year		
PHYS 411–413	Mechanics, Electricity, and Magnetism	12
PHYS 414–415	Quantum Physics	8
PHYS 417	Topics in Quantum Physics	4
PHYS 422	Electromagnetism	4
Select one or two of the following:		4-8
PHYS 424	Classical Optics	4
PHYS 425	Modern Optics	4
PHYS 431	Analog Electronics	4
PHYS 432	Digital Electronics	4
PHYS 491	Research Project I	4
PHYS 492	Research Project II	4
PHYS 493	Research Project III	4
Mathematics or physics electives or both		8
	Total Credits:	**68-72**

Honors

To be recommended by the faculty for graduation with honors in physics, a student must complete at least 46 credits in upper-division physics courses, of which at least 40 credits must be taken for letter grades, and earn at least a 3.50 grade point average in these courses.

As an alternative, undergraduate research leading to the defense of a thesis accompanied by at least a 3.30 grade point average can lead to recommendation for graduation with honors. Contact the director of undergraduate studies for more information.

Minor Requirements

Pre-Minor Requirements		
PHYS 251–253 or PHYS 201–203	Foundations of Physics I [1] / General Physics	12
Required Courses		
PHYS 351–353 or PHYS 411–413	Foundations of Physics II / Mechanics, Electricity, and Magnetism	12
Select one of the following:		4
PHYS 391	Physics Experimentation Data Analysis Laboratory	
400-level physics course		
Physics courses		8
Total Credits		**36**

[1] General Physics (PHYS 201–203) may fulfill requirements with the physics undergraduate advisor's approval.

Additional Requirements

Course work must be completed with grades of C– or better or P. At least 12 of the upper-division credits must be completed in residence at the University of Oregon.

Engineering

Students interested in engineering may complete preparatory course work at the University of Oregon before enrolling in a professional engineering program at another institution. The Department of Physics coordinates a three-plus-two program that allows a student to earn a bachelor's degree in physics from Oregon and one in engineering from another institution. For more information, see Preparatory Programs in the **Academic Advising** section of this catalog.

Engineering students interested in semiconductor process engineering or polymer science may be interested in the nationally recognized master's industrial internship program. For more information, visit internship.uoregon.edu.

Preparation for Kindergarten through Secondary School Teaching Careers

The College of Education offers a fifth-year program for middle-secondary teaching licensure in physics and integrated sciences and a program for elementary teaching. Students considering a career pathway to teaching should consider following the physics teaching emphasis to prepare for the licensure programs. More information is available from the department's education advisor, Dean Livelybrooks; see also the **College of Education** section of this catalog.

Four-Year Degree Plan

- **Applied Physics** (p. 8)
- **Teaching Physics** (p. 10)
- **Physics**

Bachelor of Arts in Physics: Applied Physics

Course	Title	Credits Milestones
First Year		
Fall		
PHYS 251	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 221	General Chemistry I (or any course from the Interdisciplinary Science Core)	4
MATH 251	Calculus I	4
WR 121	College Composition I	4
	Credits	**17**
Winter		
PHYS 252	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 222	General Chemistry II (or any course from the Interdisciplinary Science Core)	4
MATH 252	Calculus II	4
WR 122	College Composition II	4
	Credits	**17**
Spring		
PHYS 253	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1

MATH 253	Calculus III	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**17**
	Total Credits	**51**

Course	Title	Credits	Milestones
Second Year			
Fall			
PHYS 351	Foundations of Physics II	4	
MATH 256	Introduction to Differential Equations	4	
General education course in arts and letters		4	
General education course that also satisfies a multicultural requirement		4	
	Credits	**16**	
Winter			
PHYS 352	Foundations of Physics II	4	
PHYS 391	Physics Experimentation Data Analysis Laboratory	4	
MATH 281	Several-Variable Calculus I	4	
General education course in social science		4	
	Credits	**16**	
Spring			
PHYS 353	Foundations of Physics II	4	
MATH 282	Several-Variable Calculus II	4	
General education course in arts and letters		4	
General education course in social science		4	
	Credits	**16**	
	Total Credits	**48**	

Course	Title	Credits	Milestones
Third Year			
Fall			
PHYS 412	Mechanics, Electricity, and Magnetism	4	
First term of first-year second-language sequence		4	
General education course in arts and letters		4	
General education course that also satisfies a multicultural requirement		4	
	Credits	**16**	
Winter			
PHYS 413	Mechanics, Electricity, and Magnetism	4	
PHYS 431	Analog Electronics	4	
Second term of first-year second-language sequence		4	
General education course in social science		4	
	Credits	**16**	
Spring			
PHYS 432	Digital Electronics	4	
PHYS 491	Research Project I	2-4	
Third term of first-year second-language sequence		4	
Elective course		4	
	Credits	**14-16**	
	Total Credits	**46-48**	

Course	Title	Credits	Milestones
Fourth Year			
Fall			
PHYS 481	Design of Experiments	4	
First term of second-year second-language sequence		4	
Elective courses		8	
	Credits	**16**	
Winter			
PHYS 492	Research Project II	2-4	
Second term of second-year second-language sequence		4	
Elective courses		8	
	Credits	**14-16**	
Spring			
PHYS 493	Research Project III	2-4	
Third term of second-year second-language sequence		4	
Elective courses		8	
	Credits	**14-16**	
	Total Credits	**44-48**	

Bachelor of Science in Physics: Applied Physics

Course	Title	Credits	Milestones
First Year			
Fall			
PHYS 251	Foundations of Physics I	4	
PHYS 290	Foundations of Physics Laboratory	1	
CH 221	General Chemistry I (or any course from the Interdisciplinary Science Core)	4	
MATH 251	Calculus I	4	
WR 121	College Composition I	4	
	Credits	**17**	
Winter			
PHYS 252	Foundations of Physics I	4	
PHYS 290	Foundations of Physics Laboratory	1	
CH 222	General Chemistry II (or any course from the Interdisciplinary Science Core)	4	
MATH 252	Calculus II	4	
WR 122	College Composition II	4	
	Credits	**17**	
Spring			
PHYS 253	Foundations of Physics I	4	
PHYS 290	Foundations of Physics Laboratory	1	
MATH 253	Calculus III	4	
General education course in arts and letters		4	
General education course in social science		4	
	Credits	**17**	
	Total Credits	**51**	

Course	Title	Credits Milestones
Second Year		
Fall		
PHYS 351	Foundations of Physics II	4
MATH 256	Introduction to Differential Equations	4
General education course in arts and letters		4
General education course that also satisfies a multicultural requirement		4
	Credits	**16**
Winter		
PHYS 352	Foundations of Physics II	4
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
MATH 281	Several-Variable Calculus I	4
General education course in social science		4
	Credits	**16**
Spring		
PHYS 353	Foundations of Physics II	4
MATH 282	Several-Variable Calculus II	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**16**
	Total Credits	**48**

Course	Title	Credits Milestones
Third Year		
Fall		
PHYS 412	Mechanics, Electricity, and Magnetism	4
General education course in arts and letters		4
General education course that also satisfies a multicultural requirement		4
General education course in social science		4
	Credits	**16**
Winter		
PHYS 413	Mechanics, Electricity, and Magnetism	4
PHYS 431	Analog Electronics	4
Elective courses		8
	Credits	**16**
Spring		
PHYS 432	Digital Electronics	4
PHYS 491	Research Project I	2-4
Elective courses		8
	Credits	**14-16**
	Total Credits	**46-48**

Course	Title	Credits Milestones
Fourth Year		
Fall		
PHYS 481	Design of Experiments	4
Elective courses		12
	Credits	**16**
Winter		
PHYS 492	Research Project II	2-4
Elective courses		12
	Credits	**14-16**
Spring		
PHYS 493	Research Project III	2-4
Elective courses		12
	Credits	**14-16**
	Total Credits	**44-48**

Bachelor of Arts in Physics: Teaching Physics

Course	Title	Credits Milestones
First Year		
Fall		
PHYS 251	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 221	General Chemistry I (or any course from the Interdisciplinary Science Core)	4
MATH 251	Calculus I	4
WR 121	College Composition I	4
	Credits	**17**
Winter		
PHYS 252	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 222	General Chemistry II (or any course from the Interdisciplinary Science Core)	4
MATH 253	Calculus III	4
WR 122	College Composition II	4
	Credits	**17**
Spring		
PHYS 253	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
MATH 253	Calculus III	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**17**
	Total Credits	**51**

Course	Title	Credits Milestones
Second Year		
Fall		
PHYS 351	Foundations of Physics II	4
MATH 256	Introduction to Differential Equations	4
General education course in arts and letters		4
General education course that also satisfies a multicultural requirement		4
	Credits	**16**
Winter		
PHYS 352	Foundations of Physics II	4
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
MATH 281	Several-Variable Calculus I	4
General education course in social science		4
	Credits	**16**

Spring		
PHYS 353	Foundations of Physics II	4
MATH 282	Several-Variable Calculus II	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**16**
	Total Credits	**48**

Course	Title	Credits Milestones
Third Year		
Fall		
ASTR 321	Topics in Astrophysics	4
First term of first-year second-language sequence		4
General education course that also satisfies a multicultural requirement		4
General education course in arts and letters		4
	Credits	**16**
Winter		
PHYS 362	Biological Physics	4
PHYS 431	Analog Electronics	4
Second term of first-year second-language sequence		4
General education course in social science		4
	Credits	**16**
Spring		
PHYS 491	Research Project I	2-4
PHYS 432	Digital Electronics	4
Third term of first-year second-language sequence		4
Elective course		4
	Credits	**14-16**
	Total Credits	**46-48**

Course	Title	Credits Milestones
Fourth Year		
Fall		
PHYS 420	Physics Demonstrations	4
First term of second-year second-language sequence		4
Elective courses		8
	Credits	**16**
Winter		
PHYS 409	Supervised Tutoring	1-3
PHYS 492	Research Project II	2-4
Second term of second-year second-language sequence		4
Elective course		4
	Credits	**11-15**
Spring		
PHYS 409	Supervised Tutoring	1-3
PHYS 493	Research Project III	2-4
Third term of second-year second-language sequence		4
Elective course		4
	Credits	**11-15**
	Total Credits	**38-46**

Bachelor of Science in Physics: Teaching Physics

Course	Title	Credits Milestones
First Year		
Fall		
PHYS 251	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 221	General Chemistry I (or any course from the Interdisciplinary Science Core)	4
MATH 251	Calculus I	4
WR 121	College Composition I	4
	Credits	**17**
Winter		
PHYS 252	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 222	General Chemistry II (or any course from the Interdisciplinary Science Core)	4
MATH 253	Calculus III	4
WR 122	College Composition II	4
	Credits	**17**
Spring		
PHYS 253	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
MATH 253	Calculus III	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**17**
	Total Credits	**51**

Course	Title	Credits Milestones
Second Year		
Fall		
PHYS 351	Foundations of Physics II	4
MATH 256	Introduction to Differential Equations	4
General education course in arts and letters		4
General education course that also satisfies a multicultural requirement		4
	Credits	**16**
Winter		
PHYS 352	Foundations of Physics II	4
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
MATH 281	Several-Variable Calculus I	4
General education course in social science		4
	Credits	**16**
Spring		
PHYS 353	Foundations of Physics II	4
MATH 282	Several-Variable Calculus II	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**16**
	Total Credits	**48**

Course	Title	Credits Milestones
Third Year		
Fall		
ASTR 321	Topics in Astrophysics	4
General education course that also satisfies a multicultural requirement		4
General education course in arts and letters		4
Elective course		4
	Credits	**16**
Winter		
PHYS 362	Biological Physics	4
PHYS 431	Analog Electronics	4
General education course in social science		4
Elective course		4
	Credits	**16**
Spring		
PHYS 491	Research Project I	2-4
PHYS 432	Digital Electronics	4
Elective courses		8
	Credits	**14-16**
	Total Credits	**46-48**

Course	Title	Credits Milestones
Fourth Year		
Fall		
PHYS 420	Physics Demonstrations	4
Elective courses		12
	Credits	**16**
Winter		
PHYS 409	Supervised Tutoring	1-3
PHYS 492	Research Project II	2-4
Elective courses		8
	Credits	**11-15**
Spring		
PHYS 409	Supervised Tutoring	1-3
PHYS 493	Research Project III	2-4
Elective courses		8
	Credits	**11-15**
	Total Credits	**38-46**

Bachelor of Arts in Physics

Course	Title	Credits Milestones
First Year		
Fall		
PHYS 251	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 221	General Chemistry I (or any course from the Interdisciplinary Science Core)	4
MATH 251	Calculus I	4
WR 121	College Composition I	4
	Credits	**17**
Winter		
PHYS 252	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
CH 222	General Chemistry II (or any course from the Interdisciplinary Science Core)	4
MATH 252	Calculus II	4
WR 122	College Composition II	4
	Credits	**17**
Spring		
PHYS 253	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
MATH 253	Calculus III	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**17**
	Total Credits	**51**

Course	Title	Credits Milestones
Second Year		
Fall		
PHYS 351	Foundations of Physics II	4
MATH 281	Several-Variable Calculus I	4
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
General education course in arts and letters		4
	Credits	**16**
Winter		
PHYS 353	Foundations of Physics II	4
MATH 282	Several-Variable Calculus II	4
General education course in social science		4
General education course that also satisfies a multicultural requirement		4
	Credits	**16**
Spring		
PHYS 353	Foundations of Physics II	4
MATH 256	Introduction to Differential Equations	4
General education course in arts and letters		4
General education course in social science		4
	Credits	**16**
	Total Credits	**48**

Course	Title	Credits Milestones
Third Year		
Fall		
PHYS 411	Mechanics, Electricity, and Magnetism	4
General education course in arts and letters		4
General education course that also satisfies a multicultural requirement		4
First term of first-year second-language sequence		4
	Credits	**16**
Winter		
PHYS 412	Mechanics, Electricity, and Magnetism	4
General education course in social science		4

Second term of first-year second-language sequence		4
Elective course		4
	Credits	**16**
Spring		
PHYS 413	Mechanics, Electricity, and Magnetism	4
PHYS 422	Electromagnetism	4
Third term of first-year second-language sequence		4
Elective course		4
	Credits	**16**
	Total Credits	**48**

Course	Title	Credits	Milestones
Fourth Year			
Fall			
PHYS 414	Quantum Physics	4	
First term of second-year second-language sequence		4	
Elective courses		8	
	Credits	**16**	
Winter			
PHYS 415	Quantum Physics	4	
Second term of second-year second-language sequence		4	
Elective courses		8	
	Credits	**16**	
Spring			
PHYS 417	Topics in Quantum Physics	4	
Third term of second-year second-language sequence		4	
Elective courses		8	
	Credits	**16**	
	Total Credits	**48**	

Bachelor of Science in Physics

Course	Title	Credits	Milestones
First Year			
Fall			
PHYS 251	Foundations of Physics I	4	
PHYS 290	Foundations of Physics Laboratory	1	
CH 221	General Chemistry I (or any course from the Interdisciplinary Science Core)	4	
MATH 251	Calculus I	4	
WR 121	College Composition I	4	
	Credits	**17**	
Winter			
PHYS 252	Foundations of Physics I	4	
PHYS 290	Foundations of Physics Laboratory	1	
CH 222	General Chemistry II (or any course from the Interdisciplinary Science Core)	4	
MATH 252	Calculus II	4	
WR 122	College Composition II	4	
	Credits	**17**	
Spring			
PHYS 253	Foundations of Physics I	4	
PHYS 290	Foundations of Physics Laboratory	1	
MATH 253	Calculus III	4	
General education course in arts and letters		4	
General education course in social science		4	
	Credits	**17**	
	Total Credits	**51**	

Course	Title	Credits	Milestones
Second Year			
Fall			
PHYS 351	Foundations of Physics II	4	
PHYS 391	Physics Experimentation Data Analysis Laboratory	4	
MATH 281	Several-Variable Calculus I	4	
General education course in arts and letters		4	
	Credits	**16**	
Winter			
PHYS 352	Foundations of Physics II	4	
MATH 282	Several-Variable Calculus II	4	
General education course in social science		4	
General education course that also satisfies a multicultural requirement		4	
	Credits	**16**	
Spring			
PHYS 353	Foundations of Physics II	4	
MATH 256	Introduction to Differential Equations	4	
General education course in arts and letters		4	
General education course in social science		4	
	Credits	**16**	
	Total Credits	**48**	

Course	Title	Credits	Milestones
Third Year			
Fall			
PHYS 411	Mechanics, Electricity, and Magnetism	4	
General education course in arts and letters		4	
General education course that also satisfies a multicultural requirement		4	
General education course in social science		4	
	Credits	**16**	
Winter			
PHYS 412	Mechanics, Electricity, and Magnetism	4	
Elective courses		12	
	Credits	**16**	
Spring			
PHYS 413	Mechanics, Electricity, and Magnetism	4	
PHYS 422	Electromagnetism	4	
Elective courses		8	
	Credits	**16**	
	Total Credits	**48**	

Course	Title	Credits	Milestones
Fourth Year			
Fall			
PHYS 414	Quantum Physics	4	
Elective courses		12	
	Credits	**16**	
Winter			
PHYS 415	Quantum Physics	4	
Elective courses		12	
	Credits	**16**	
Spring			
PHYS 417	Topics in Quantum Physics	4	
Elective courses		12	
	Credits	**16**	
	Total Credits	**48**	

- **Master of Arts**
- **Master of Science: Physics**
- **Master of Science: Applied Physics**
- **Doctor of Philosophy**

Graduate Studies

The Department of Physics offers graduate programs leading to the master of science degree in applied physics or to the master of arts (MA), master of science (MS), and doctor of philosophy (PhD) degrees in physics with a variety of opportunities for research. Current research areas include astronomy and astrophysics, biophysics, condensed matter physics, elementary particle physics, and optical physics.

The interdisciplinary Institute of Theoretical Science houses theoretical research in some of the above areas as well as in areas of overlap between chemistry and physics.

The Center for High Energy Physics conducts research in particle physics, much of it in laboratories outside Oregon.

The Materials Science Institute and the Oregon Center for Optics provide facilities, support, and research guidance for graduate students and postdoctoral fellows in the interdisciplinary application of concepts and techniques from both physics and chemistry to understanding physical systems.

Cooperative programs of study are possible in molecular biology through the Institute of Molecular Biology.

Pine Mountain Observatory

Pine Mountain Observatory, operated by the Department of Physics for research and advanced instruction in astronomy, is located thirty miles southeast of Bend, Oregon, off Highway 20 near Millican, at an altitude of 6,300 feet above sea level. The observatory has three telescopes—fifteen inches, twenty-four inches, and thirty-two inches in diameter—the largest governed by computer. All are Cassegrain reflectors. A wide-field CCD camera is available on the thirty-two-inch telescope. The site has an astronomers' residence building and a caretaker's house. Professional astronomical research is in progress at the observatory on every partially or totally clear night of the year, and the site is staffed year round.

Admission and Financial Aid

For admission to graduate study, a bachelor's degree in physics or a related area is required with a minimum undergraduate grade point average (GPA) of 3.00 (B) in advanced physics and mathematics courses. Submission of scores on the Graduate Record Examinations (GRE), including the physics test, is required. Students from non-English-speaking countries must demonstrate proficiency in English by submitting scores from the Test of English as a Foreign Language (TOEFL). Information about the department and the Graduate Admission Application are available through the department's website.

Financial aid in the form of graduate teaching or research fellowships (GTFs) is available on a competitive basis to PhD students. GTFs require approximately sixteen hours of work a week and provide a stipend and tuition waiver. New students are typically eligible only for teaching fellowships.

The sequential nature of most physics courses makes it difficult to begin graduate study in terms other than Fall. Furthermore, financial aid is usually available only to students who begin their studies in the Fall.

To ensure equal consideration for fall term admission, the deadline for applications for financial aid is January 15. Late applications for admission may be considered until July 15.

Degree Requirements

Entering students should consult closely with their assigned advisors. Students showing a lack of preparation are advised to take the necessary undergraduate courses in order to remedy their deficiencies.

Students should consult the **Graduate School** section of this catalog for general university admission and degree requirements. Departmental requirements, outlined in a handbook for incoming students that is available in the department office and online, are summarized below.

Industrial Internships and the Applied Physics Master's Degree

The applied physics master's program leads to a professional MS degree, an alternative to the research-based PhD. It is designed to serve physics students whose primary interests lie in applied research and development rather than in basic research. An important component of this degree program is the industrial internship. These internships in local and regional industries are designed to enhance the ability of physics graduates to obtain good jobs after graduation. Qualified students can complete this program in one year. Students must apply via the Materials Science Institute for admission to the industrial internship program, which is a prerequisite for admission to the master's program in applied physics. Further information is available in the **Research Centers and Institutes** section of this catalog.

Master of Science: Applied Physics

500- or 600-level courses [1]	24
Industrial internship	10
Additional graduate-level physics courses	11-19
Total Credits	**45-53**

[1] At least 9 credits of 600-level courses are required.

Additional Requirements

A grade of B– or better must be achieved in each course applied to the graded-credit total. The overall GPA in physics courses must be 3.00 or better.

Graduate School requirements, including time limits, must be satisfied.

Total credits required for the degree depend on the number of graded credits and internship credits the student earns. This allows flexibility in adjusting the balance between course work and the internship experience. The more graded credits a student earns, the fewer total credits are required for the degree. The minimum total required is 45 credits if the student earns 32 or more graded credits. The minimum required is 53 credits if the student earns only 24 graded credits. In general, 1 credit is added to the minimum total of 45 for each graded credit less than 32 a student earns. For example, a student who earns 28 graded credits needs a minimum total of 49 credits

The internship requirement must be fulfilled through the industrial internship program. Internship credits are taken pass/no pass. A student typically earns 10 credits for every three months of full-time internship experience

Graded credits must be selected from an approved departmental list. This list includes the following:

PHYS 581	Design of Experiments	4

Other 600-level physics courses qualify, but may require additional prerequisites. Some graduate-level courses in chemistry may qualify. Other courses may be added or substituted with the approval of the applied physics program advisor.

Master of Science: Physics

Typically this degree is based on course work and the master's final examination. Detailed requirements can be found in the Graduate Student Handbook on the department's website.

Candidates must either pass the combined graduate exam at the master's level ***or*** submit a written thesis ***or*** take a program of specialized courses.

A combined graduate exam covering the four core subject areas—mechanics; electricity, magnetism, and optics; modern physics and quantum mechanics; and thermal and statistical physics—is used for both the master's and doctoral qualifying examinations. For the master's exam, a separate total score is obtained by removing, in each core area, the student's problem with the lowest score. Material covered by the combined exam is primarily at the level of advanced undergraduate physics, but as much as one-third of the exam tests core graduate-level material. The examination is given twice a year, and master's candidates must pass the examination by the end of summer session of their second year of graduate studies.

Thesis Option

Code	Title	Credits
Select one of the following:		9
PHYS 503	Thesis	
PHYS 503 & PHYS 601	Thesis and Research: [Topic]	
Total Credits		**9**

Specified-Course Option

The specified-courses option requires 40 graduate credits in physics, 36 of which must be selected from a list of courses approved by the department.

The master's degree program is typically completed in four terms, unless sufficient transfer credits are available, in which case it can be obtained in three.

Master of Arts

Typically this degree is based on course work and the master's final examination. Detailed requirements can be found in the Graduate Student Handbook on the department's website.

Candidates must either pass the combined graduate exam at the master's level ***or*** submit a written thesis ***or*** take a program of specialized courses.

A combined graduate exam covering the four core subject areas—mechanics; electricity, magnetism, and optics; modern physics and quantum mechanics; and thermal and statistical physics—is used for both the master's and doctoral qualifying examinations. For the master's exam, a separate total score is obtained by removing, in each core area, the student's problem with the lowest score. Material covered by the combined exam is primarily at the level of advanced undergraduate physics, but as much as one-third of the exam tests core graduate-level material. The examination is given twice a year, and master's candidates must pass the examination by the end of summer session of their second year of graduate studies.

Thesis Option

Code	Title	Credits
Select one of the following:		9
PHYS 503	Thesis	
PHYS 503 & PHYS 601	Thesis and Research: [Topic]	
Total Credits		**9**

Specified-Course Option

The specified-courses option requires 40 graduate credits in physics, 36 of which must be selected from a list of courses approved by the department.

The master's degree program is typically completed in four terms, unless sufficient transfer credits are available, in which case it can be obtained in three.

In addition to all the preceding requirements, candidates for the master of arts (MA) degree must demonstrate foreign-language proficiency.

Doctor of Philosophy

The doctor of philosophy degree (PhD) in physics is based primarily on demonstrated knowledge of physics and doctoral dissertation research. PhD students must achieve qualifying scores on the master's and doctoral combined examination, and are required to pass the qualifying exam by the end of the first term in their third year of study. Students also must take and pass the core graduate sequences, unless some of these are waived by the graduate director:

Core Sequences

PHYS 611–612	Theoretical Mechanics	6
PHYS 613–614	Statistical Physics	6
PHYS 622–623	Electromagnetic Theory	8
PHYS 631–633	Quantum Mechanics	12
Breadth Requirements		
Six breadth courses [1]		
Total Credits		**32**

[1] Breadth courses can be chosen from several areas of physics and allied areas such as mathematics, chemistry, and biology. At least two of the courses must be in a sequence.

Next, students must locate an advisor and an advisory committee, who then administer a comprehensive oral examination testing whether the student is ready to undertake dissertation research. The heart of the PhD requirements is research leading to a doctoral dissertation.

Detailed information is available in the *Graduate Student Handbook* on the department's website.