

UNDERGRADUATE HANDBOOK

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Purpose of this Document

The document is designed to help you, the undergraduate, guide your way through the undergraduate curriculum at WSU, and to help you graduate with the skills you need for your future career and academic aspirations. This booklet has information on prospective careers, semester-by-semester course pathways for every physics specialist degree, and a list of who to contact for help and guidance. This document does not replace the University Catalog. Where conflicts exist, the Catalog is to be taken as being correct.

Planning For Academic Success

An academic advisor is a student's personal connection with the university, its apparatus, rules, and regulations. The student and advisor share the responsibility for planning the best route to ensure the student's academic and career success. It is up to the student to see this plan through to its successful conclusion.

Responsibilities of the student

As a student, your responsibilities include, but are not limited to:

- Meet with your advisor for a minimum of 30 minutes, at least once each semester before your enrollment time opens, to plan for the next semester. You should meet with all your advisors, including those

in your major and minor degrees of study, and (if applicable) your advisors in the Honors College, athletic program, ROTC, pre-health, and/or pre-law.

- Know your current grade in all your classes at all times. If it appears that you are going to fail a class or, worse, to go academically deficient, then you should meet with your advisor as early as possible to discuss options. Practice “an ounce of prevention”.
- Meet with each of your instructors and find out what is expected of you to be successful in your current semester’s classes.
- Use the Student Information System website (my.wsu.edu) to:
 - view your account status,
 - sign up for classes using Schedule Surfer,
 - check your progress towards your degree using the Degree Requirements page.
- Obtain and use your WSU email account. Many faculty ignore messages sent from non-WSU domains in order to prevent identity theft.
- Become familiar with the WSU graduation requirements, the requirements of the College of Arts & Science, the requirements of the Physics major, and the requirements of any degree option or minor degree program you are interested in.
- Build positive and supporting relationships with the people in the Dept of Physics and Astronomy, including your instructors, advisors, teaching assistants, fellow classmates, and support staff. We are all here to help each other. Take advantage of the opportunities provided by the Physics & Astronomy club, and the Webster 7th floor undergraduate physics study room.
- Seek help when needed. Provide help when asked.

Responsibilities of your academic advisor

As advisors, our responsibilities include, but are not limited to, the following list.

- To assist you, the student, in choosing courses appropriate to your academic and career goals
- To inform you of the rules and regulations governing the university, college, and department.
- To advise you how to act in order to comply with these regulations.
- Put you in touch with university offices and officials who can help you reach your academic and career goals.

Admission to the major

Students may be admitted to the major by making their intention known to their academic advisor. Recommended preparation:

1. have earned 30 or more credit hours, including Phys 201 or 205, and Math 171,
2. have a cumulative WSU GPA above 2.0.

Scholarship deadline: January 31

Scholarships for physics undergrads are available from the College of Arts & Sciences via an online application form: cas.wsu.edu.

Student learning outcomes of the Physics & Astronomy degree program

The learning outcomes of the BS Physics degree program align with university-wide outcomes:

1. use scientific reasoning to form and test hypotheses (Critical and Creative Thinking)
2. think independently and question dogma by acquiring, reproducing, and assessing information from a variety of sources (Information Literacy)
3. recall and apply the important concepts in each of the four core areas of physics: mechanics, electricity and magnetism, modern and quantum physics, and thermal and statistical physics (Scientific Literacy)
4. design and conduct scientific experiments which test new ideas and theories (Quantitative Reasoning)
5. present concepts and results clearly, both orally and in writing (Communication)
6. be prepared for graduate study and/or careers in physics (Depth, Breadth and Integration of Learning)

Important academic dates

The website of the Registrar, www.registrar.wsu.edu, lists the following dates for every semester. You should know when these occur, and make timely decisions based upon them. The dates listed below are approximate, and do not include the summer terms.

First day of instruction for the term	Week 1
Last day to add a course online	Week 1
Deadline for dropping a course without record	Week 5
Deadline to apply for an undergrad degree	Week 8
Midterm grade submission	Week 8
Priority registration for the next semester	Week 12
Deadline to withdraw from a course	Week 13
Last day of instruction for the term	Week 15
Deadline for cancellation of enrollment	Week 15
Commencement	Week 16
Final examinations	Week 16
Final grade submission deadline	Week 17

List of university web resources

A-Z index:	index.wsu.edu
Academic Success and Career Center (ASCC):	ascc.wsu.edu
Admissions:	admission.wsu.edu
Campus Safety Plan:	safetyplan.wsu.edu
Cancellation of enrollment:	registrar.wsu.edu/cancel-enrollment/
College of Arts & Sciences:	cas.wsu.edu
Counseling/testing services:	cougarhealth.wsu.edu
Course catalog:	catalog.wsu.edu
Course schedules:	schedules.wsu.edu
Dean of Students Office:	deanofstudents.wsu.edu
Emergency alerts:	alert.wsu.edu
Emergency Management Office:	oem.wsu.edu
Financial aid and scholarships:	finaid.wsu.edu
Foreign Languages Dept:	forlang.wsu.edu
Global campus:	online.wsu.edu
Health and wellness:	cougarhealth.wsu.edu
International programs:	ip.wsu.edu
Libraries:	libraries.wsu.edu
Math and stats:	math.wsu.edu
Physics & Astronomy Dept:	physics.wsu.edu
Registrar:	registrar.wsu.edu
Student Conduct Office:	conduct.wsu.edu
Student information system:	my.wsu.edu
Student legal services:	studentinvolvement.orgsync.com/org/sls/
Student success Collaborative:	ssc.campus.wsu.edu
Summer session:	learn365.wsu.edu
Transfer credits:	transfercredit.wsu.edu
Winter session:	learn365.wsu.edu
Writing program:	writingprogram.wsu.edu

Careers for Physicists

Physics is the most fundamental science in the sense that laws of physics underlie all of the other physical sciences, including astronomy, chemistry, meteorology, oceanography, and geophysics. Physical theories also form the basis of all engineering and even the biological and medical sciences. Thus training in physics can lead to a career in any of the sciences.

The physics curriculum is not designed to train people for specific jobs. It is designed to encourage students to become well grounded in the basic theories and techniques of the science as well as the mathematics necessary to be a physicist. When this is accomplished there is usually no problem in finding a job.

Although many, if not most, physicists go on to graduate school to earn masters or doctoral degrees, there are many good jobs available to a person with a B.S. in physics, either in industry or government. The range of career opportunities is almost too wide to enumerate. Some of the jobs listed may require some academic work beyond the Bachelor's degree or on-the-job training or both.

Career resources are provided by many professional organizations:

American Institute of Physics	aip.org
American Physics Society	aps.org
American Astronomical Society	aas.org
Canadian Astronomical Society	casca.ca
Astrobites	astrobites.org
Astrobetter	astrobetter.com
Chronicle for Higher Education	chronicle.com
Society of Physics Students	spsnational.org
International Astronomical Union	www.iau.org/public/careers/

Undergraduate Research

Students in the physics major are invited to participate in research and gain course credits via Phys 490 (Thesis) and Phys 499 (Special Projects). Students are encouraged to speak with faculty members, graduates, and senior undergraduates, and learn about what opportunities are available. Faculty within the Dept of Physics & Astronomy specialize in four major areas of research:

- Astrophysics - theoretical and experimental gravity wave physics, stellar and galactic evolution
- Matter under extreme conditions - high pressure effects on semiconductors and organic solids, reduced-gravity acoustics
- Materials and optical physics - ultrafast phenomena, interactions between photons and matter in nanostructures and biological materials, nonlinear optics
- Novel states of matter - theoretical and experimental quantum physics, cold quantum gases, many-body physics, chaos, and complexity

General Information

University Graduation Requirements pre fall 2012: GER Students who entered post-secondary education BEFORE fall 2012 are required to meet WSU General Education Requirements (GERs) and College of Sciences Additional Graduation Requirements (AGRs) to graduate.

Communication proficiency [W][C]	Engl 101 or 105	3 cr
World Civilization [A]	GenEd 110/111 or History 120/121	6 cr
Mathematics proficiency [N]	Math 107 or Math 106/108	4 cr
Arts and Humanities [G][H]		3 cr
Social Sciences [S][K]		3 cr
Additional credits [G][H][S][K]		3 cr
Intercultural studies [I][G][K]		3 cr
Sciences lecture+lab [B][P][Q]		10 cr
American diversity [D]		3 cr
Tier III [T]		3 cr
University writing portfolio		milestone
Writing in the major [M]		6 cr
AGR: foreign language		milestone
AGR: [G][H][S][K][I]		6 cr
AGR: lecture+lab [B][P][Q]		2 cr

University Graduation Requirements post fall 2012: UCORE Students who entered post-secondary education AFTER fall 2012 are required to meet WSU University Common Requirements (UCORE). Transfer students entering WSU in fall 2012 through summer 2013 will be required to satisfy the old GER system.

Roots of contemporary issues [ROOT]	History 105 or 305	3 cr
Quantitative reasoning [QUAN]		3 cr
Written communication [WRTG]		3 cr
Communication [COMM][WRTG]		3 cr
Inquiry in the social sciences [SSCI]		3 cr
Inquiry in the humanities [HUM]		3 cr
Inquiry in the creative and professional arts [ARTS]		3 cr
Inquiry in the natural sciences [BSCI][PSCI][SCI]		7 cr
Diversity [DIVR]		3 cr
Integrative capstone [CAPS]		3 cr
University writing portfolio		milestone
Writing in the major		6 cr
AGR: foreign language		milestone
AGR: additional credits [ARTS][HUM][SSCI]		3 cr (12 total)
AGR: additional lab science [BSCI][PSCI]		1 cr (8 total)

NOTE: Holding an Associate of Arts or Associate Sciences degree does not automatically satisfy AGRs.

Foreign Language Requirement Effective Fall 2011, students in the College of Arts and Sciences and the College of Communication are required to demonstrate proficiency in all four language skills (i.e., reading, writing, listening, and speaking) at a novice level (e.g., SPAN 102). Acceptable demonstrations of proficiency include:

- two years at the high school level (transcript required),
- two college semesters (transcript required),

- residence abroad for two consecutive years during the last five (documentation required),
- study abroad for at least one year (documentation required),
- heritage speakers with at least one year of language studies at the high school level and who speak the language in the home (documentation required),
- STAMP test results (minimum score 2 in all three sections for European languages, minimum score 1 in all three sections for character-based languages).

Students may petition to substitute foreign language competency with an approved culture-related course based upon individual circumstances such as a learning disability, or for mature or returning students. The list of approved substitutions (April 2014) includes:

CATEGORY A: FOR L 101, 110, 120, 130, 410;

CATEGORY B: HIST 331, 335; PHIL 314, 315; ASIA/CHIN 111, 121, 131, 320; FREN 110, 120, 420, 430; GER 110; RUS 321; SPAN 110, 111, 120, 121, 420.

Upon approval, students must complete either TWO courses category A, or ONE course from each of category A and category B. All courses are taught in English.

The petition form, “WSU University and College Requirement Petition”, is available from the University College office in 519 CUE (Smith Center). You must follow the instructions on this form exactly.

Preparation for Graduate School in Physics Students planning to enter graduate school in physics should take more physics and mathematics courses than the minimum requirements for graduation. Recommended additional courses include physics and math courses at the 400 and 500 level. Mastering the material in these courses should prepare a student for any of the most rigorous graduate schools in the country.

Preparation for Graduate School in Subjects other than Physics A physics major is excellent preparation for graduate work in any of the physical and biological sciences, and engineering. Interdisciplinary fields, such as physical forensics, physical anthropology, and history of science, also include many physics majors.

The problem-solving skills learned in the physics major are valuable in professional school, including the medical, business, and legal fields. Students interested in pursuing higher education in areas other than physics are encouraged to identify these areas early, and enroll in elective coursework, pursue a minor degree, a certificate program, or a course concentration.

Working for a year before entering graduate/professional school is common, and sometimes encouraged. A work experience helps clarify career and life goals, provides an intellectual break, and aids financially.

Preparation for Employment Engineering firms, both large and small, employ physics graduates, often in jobs labeled “engineer”, but in areas requiring a broad mindset. It is not necessary to take specialized courses for these jobs, because the companies usually will train you for the particular job they have in mind. Note, however, that without an advanced degree it is difficult to rise far in field of research and development. Individuals with a bachelor’s degree may well start at the level of a technician. Many working physicists return to school after a few years in the work force. Many working physicists self-identify as computational physicists.

Basic Requirements for a Major in Physics at WSU

Students must meet the graduation requirements of the university, college, and department they are enrolled in. A description of courses is given at the end of this Handbook.

Physics Courses		Credits
Phys 188 and 189	First-Year Seminar I and II	1/1
Phys 201 and 202	Physics I and II	4/4
Phys 205 and 206	Physics I and II Honors (recommended)	5/5
Phys 303 and 304	Modern Physics I and II	3/3
Phys 320	Classical Mechanics	3
Phys 330	Thermal Physics	3
Phys 341 and 342	Electricity and Magnetism I and II	3/3
Phys 410	Electronics Laboratory	4
Phys 415 [M]	Quantum Lab	3
Phys 450	Quantum Mechanics	3
Phys 490 [M]	Undergraduate Thesis	1
Phys 499	Special Problems	1

Math Courses

Math 171, 172 or 182, and 273 or 283	Calculus I, II, and III	4/4/2
Math 220 or 230	Introductory Linear Algebra	2
Math 315	Differential Equations	3

Chemistry Courses

Chem 105 [PSCI] and 106	Chemistry I and II	4/4
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Computer Science Course (choose 1)

Cpt S 111 [QUAN]	Introduction to Computer Programming	3
Cpt S 121	Program Design and Development	4
EE 221	Numerical Computing for Engineers	2
Math 301 [M]	Mathematical Computing	3

Technical Writing (choose 1)

Engl 301 [WRTG]	Writing and rhetorical conventions	3
Com 400 [COMM]	Communicating Science and Technology	3
Engl 402 or 403 [WRTG][M]	Technical Writing	3

Choose one from the Standard Option, Applied Option, or the Astrophysics Option:

Standard option

Choose 15 credits from Astr 3xx or 4xx, or Phys 3xx or 4xx.

Choose 6 credits from Astr, Chem, Math, or Phys; at least 3cr must be from the upper division.

Choose 6 credits of Math 3xx or 4xx.

Applied option

Choose 21cr from the College of Engineering, including MSE 111 and Engr 120

Math 360 or 370; Phys 443

Astrophysics option

Astr 345, Astr 390, Astr 435, Astr 436

Choose 11 credits from Astr, Chem, Math, or Phys; at least 6cr must be from the upper division.

Choose 6 credits of Math 3xx or 4xx.

Minor Degree Programs in Physics and Astronomy

Upper division physics and astronomy courses have lower division physics and math prerequisites that must be met, typically consisting of higher calculus and general physics.

Students from outside the College of Sciences do not have to meet the College's Additional Graduation Requirements to obtain these minor degrees.

Requirements for Undergraduate Minor in Physics (20 credits)

The following courses are required (14 credit hours):

Phys 201 or 205	Physics I	4-5
Phys 202 or 206	Physics II	4-5
Phys 303	Modern Physics I	3
Phys 304	Modern Physics II	3

Choice of any two courses from the following (6 credit hours):

Phys 320	Mechanics	3
Phys 330	Thermal Physics	3
Phys 341	Electricity and Magnetism I	3
Phys 342	Electricity and Magnetism II	3
Phys 410	Electronics Laboratory	4
Phys 415	Quantum Lab	3
Phys 443	Optics	3
Phys 450	Quantum Mechanics	3
Phys 461	Atomic Physics	3
Phys 463	Solid State Physics	3
Phys 465	Nuclear Physics	3

Requirements for Undergraduate Minor in Astronomy (19 credits)

The following courses are required:

Math 273	Calculus III	2
Phys 303	Modern Physics I	3
Astr 345	Principles of Astronomy	3
Astr 435	Astrophysics I - Stellar Astrophysics	3
Astr 436	Astrophysics II - Extragalactic Astrophysics	3

At least two hours from the following:

Astr 390	The Night Sky	1
Phys 490	Thesis	1
Phys 499	Special Problems	1

Choice of three hours from the following:

Astr 135	Descriptive Astronomy	4
Astr 138	Planets and Planetary Systems	3
Hist 381	History of Science I	3
SOE 103	Other Worlds: Comparative Planetology	3

Projected Course Offerings

Fall and spring courses

Courses for majors

		Offering
Astr 345	Principles of astronomy	Every fall
Astr 390	Night sky	Summers only (irregular)
Astr 435	Astrophysics I	Even-numbered spring
Astr 436	Astrophysics II	Odd-numbered spring
Phys 188	First-Year Seminar I	Every fall
Phys 189	First-Year Seminar II	Every spring
Phys 201	Physics I	Every fall/spring/summer
Phys 202	Physics II	Every fall/spring/summer
Phys 205	Honors physics for sci/eng I	Every spring
Phys 206	Honors physics for sci/eng I	Every fall
Phys 303	Modern physics I	Every fall
Phys 304	Modern physics II	Every spring
Phys 320	Classical mechanics	Every fall
Phys 330	Thermal physics	Every spring
Phys 341	Electricity & magnetism I	Every fall
Phys 342	Electricity & magnetism II	Every spring
Phys 410	Electronics lab	Every spring
Phys 415	Quantum lab	Every spring
Phys 443	Optics	Every fall
Phys 450	Quantum mechanics	Every fall
Phys 461	Atomic	Odd-numbered spring
Phys 463	Solid state	Every spring
Phys 465	Nuclear	Even-numbered spring
Phys 466	Biophysics	Every fall
Phys 481	Special topics	Irregular
Phys 490	Thesis	Every fall
Phys 499	Special topics	By arrangement

Courses for non-majors

Astr 135	Descriptive astronomy	Every fall/spring
Astr 138	Planets & planetary systems	Every fall/spring
Astr 150	Science and the universe	Irregular
Astr 450	Life and the universe	Every spring
Phys 101	General physics I	Every fall/spring/summer
Phys 102	General physics II	Every fall/spring/summer
Phys 137	Physics and society	via WSU Global Campus only
Phys 150	Physics and your world	By arrangement
Phys 322	Sound waves and music	Every fall

Physics - Standard Option (120-124 hours)**FIRST YEAR**

Fall Semester	Hours	Spring Semester	Hours
Chem 105 [PSCI] Chemistry I	4	Chem 106 Chemistry II	4
Engl 101 [WRTG]	3	History 105 [ROOT]	3
Math 171 Calculus I	4	Math 172 Calculus II	4
Phys 188 First-Year Seminar I	1	Phys 189 First-Year Seminar II	1
Social sciences [SSCI]	3	Phys 201 or 205 Physics I	4-5

SECOND YEAR

Fall Semester	Hours	Spring Semester	Hours
Biological sciences [BSCI]	3	Humanities [HUM]	3
Math 220 Algebra	2	Math 315 Differential Equations	3
Math 273 Calculus III	4	Phys 304 Modern Physics II	3
Phys 202 or 206 Physics II	4-5	Phys 330 Thermal Physics	3
Phys 303 Modern Physics I	2	Phys 410 Electronics Lab	4
Assemble Junior Writing Portfolio			
Complete College foreign language requirement			

THIRD YEAR

Fall semester	Hours	Spring Semester	Hours
Computing requirement	2-4	Technical Writing	3
Diversity [DIVR]	3	Math elective	3
Math elective	3	Phys 342 Electricity & Magnetism II	3
Phys 320 Mechanics	3	Phys 415 [M] Quantum Lab	3
Phys 341 Electricity & Magnetism I	3	Phys 499 Special Problems	1
		Standard option elective	3

FOURTH YEAR

Fall Semester	Hours	Spring Semester	Hours
Additional [SSCI], [ARTS], or [HUM]	3	Capstone [CAPS]	3
Creative & professional arts [ARTS]	3	Standard option elective	9
Phys 450 Quantum Mechanics	3	Technical elective	3
Phys 490 [M] Undergraduate Thesis	1		
Standard option elective	3		
Technical elective	3		

NOTES:

1. Computing requirement must be selected from CPTS 111 (3), 121 (4), EE 221 (3), and MATH 300 [M] (2).
2. 15 hours of Standard option electives must be taken from PHYSICS 3XX or 4XX, or ASTRONOM 3XX or 4XX.
3. Additional [ARTS], [HUM], or [SSCI]: the College of Arts & Sciences requires 3 additional hours of UCORE.
4. UCORE = University Common Requirements. Refer to University Graduation Requirements in this handbook or in the WSU catalog.
5. Physics majors are recommended to enroll in the Honors sections of General Physics.
6. 6 hours of technical electives must include at least 3 hours at the upper division, and be chosen from ASTRONOM, CHEM, MATH, or PHYS.
7. For the Standard option, only 3 hours of UCORE [BSCI] biology lecture are required. A 4 hour lecture plus lab may be required for a minor or second major.
8. The Junior Writing Portfolio must be completed shortly after earning 60 credits; transfer students are held to the same requirement.
9. Six credit hours of Math 3XX or 4XX are required.
10. Phys 499 is a recommended prerequisite for Phys 490.

Physics - Standard Option - Pre-calculus path (122-124 hours)

Students who enter and not place into calculus in their first year will require 9 semesters to graduate.

FIRST YEAR

Fall Semester	Hours	Spring Semester	Hours
Chem 105 [PSCI] Chemistry I	4	Chem 106 Chemistry II	4
Engl 101 [WRTG]	4	History 105 [ROOT]	3
Math 106 College Algebra (as L/D elective)	3	Math 108 Trigonometry	2
Phys 188 First-Year Seminar	1	Phys 189 First-Year Seminar II	1
Arts [ARTS]	3	Humanities [HUM]	3

SECOND YEAR

Fall Semester	Hours	Spring Semester	Hours
Cpts 121 Computer Science	4	Math 172 Calculus II	4
Math 171 Calculus I	4	Phys 201 or 205 Physics I	4-5
Social Sciences [SSCI]	3	Diversity [DIVR]	3
Additional [ARTS], [HUM], or [SSCI]	3	Biological Science [BSCI]	3
Assemble Junior Writing Portfolio			
Complete College foreign language requirement			

THIRD YEAR

Fall semester	Hours	Spring Semester	Hours
Math 220 Algebra	2	Math 315 Differential Equations	3
Math 273 Calculus III	4	Phys 304 Modern Physics II	3
Math 360 Statistics (as math elective)	3	Phys 330 Thermal Physics	3
Phys 202 or 206 Physics II	4-5	Phys 410 Electronics Lab	4
Phys 303 Modern Physics I	2	U/D elective	3

FOURTH YEAR

Fall Semester	Hours	Spring Semester	Hours
Capstone [CAPS]	3	Phys 342 Electricity & Magnetism II	3
Phys 320 Mechanics	3	Phys 415 [M] Quantum Lab	3
Phys 341 Electricity & Magnetism I	3	Phys 499 Special Problems	1
Standard option electives	6	Standard option electives	9

FIFTH YEAR

Math elective	3
Technical Writing	3
Phys 450 Quantum Mechanics	3
Phys 490 [M] Undergraduate Thesis	1

NOTES:

1. See the notes to the Standard Option.
2. Math 106 counts as 3 hours towards Astr/Chem/Math/Phys electives; the other 3 hours must come from the upper division.
3. To finish in 9 semesters, it is essential to enroll in Math 360 in the junior year, because Math 360 is the only upper division Math course not to have Math 315 as a prerequisite.

Physics - Astrophysics Option (120-124 hours)**FIRST YEAR**

Fall Semester	Hours	Spring Semester	Hours
Chem 105 [PSCI] Chemistry I	4	Chem 106 Chemistry II	4
Math 171 Calculus I	4	Math 172 Calculus II	4
Phys 188 First-Year Seminar I	1	Phys 189 First-Year Seminar II	1
Engl 101 [WRTG]	3	Phys 201 or 205 Physics I	4-5
Social sciences [SSCI]	3	History 105 [ROOT]	3

SECOND YEAR

Fall Semester	Hours	Spring Semester	Hours
Math 220 Algebra	2	Astronom 390 [PSCI]	1
Math 273 Calculus III	4	Humanities [HUM]	3
Phys 202 or 206 Physics II	4-5	Math 315 Differential Equations	3
Phys 303 Modern Physics I	2	Phys 304 Modern Physics II	3
Biological sciences [BSCI]	3	Phys 330 Thermal Physics	3
		Phys 410 Electronics Lab	4

Assemble Junior Writing Portfolio

Complete College foreign language requirement

THIRD YEAR

Fall Semester	Hours	Spring Semester	Hours
Astronom 345 Principles	3	Astronom 435 or 436 Astrophysics	3
Computing requirement	2-4	Technical writing	3
Math elective	3	Math elective	3
Phys 320 Classical Mechanics	3	Phys 342 Electricity & Magnetism II	3
Phys 341 Electricity & Magnetism I	3	Phys 415 [M] Quantum Lab	3
		Phys 499 Special Problems	1

FOURTH YEAR

Fall Semester	Hours	Spring Semester	Hours
Additional [ARTS], [HUM], or [SSCI]	3	Astronom 435 or 436 Astrophysics	3
Creative & professional arts [ARTS]	3	Capstone [CAPS]	3
Phys 450 Quantum Mechanics	3	Diversity [DIVR]	3
Phys 490 [M] Thesis	1	Technical electives	6
Technical electives	6		

NOTES:

1. Read the notes to the Standard Option.
2. The recommended prerequisite to Astronom 345 is Phys 303.
3. Astronom 435 is offered in even-numbered years, Astronom 436 in odd-numbered years. They can be taken in any order.

Physics - Applied Option (120 hours)

The program of courses below is appropriate for students who wish to enter industry upon graduation.

FIRST YEAR

Fall Semester	Hours	Spring Semester	Hours
Chem 105 [PSCI] Chemistry I	4	Chem 106 Chemistry II	4
English 101 [WRTG]	3	Engr 120	2
Math 171 [QUAN] Calculus I	4	History 105 [ROOT]	3
MSE 110 Materials science	3	Math 172 Calculus II	4
Phys 188 First-year seminar	1	Phys 189 First-year seminar	1

SECOND YEAR

Fall Semester	Hours	Spring Semester	Hours
Econs 101 [SSCI]	3	Arts [ARTS]	3
Math 220 Linear algebra	2	Econs 102 [SSCI]	3
Math 273 Calculus III	2	Math 315 Differential Eq	3
Physics 201 Physics I	4	Phys 202 Physics II	4
Option elective	3	Option elective	3
Assemble Junior Writing Portfolio			
Complete College foreign language requirement			

THIRD YEAR

Fall Semester	Hours	Spring Semester	Hours
Physics 303 Modern I	3	Bio [BSCI]	3
Physics 320 Classical mechanics	3	Physics 304 Modern II	3
Physics 341 E&M I	3	Physics 330 Thermal physics	3
Stat 360 or 370	3	Physics 342 E&M II	3
Option elective	3	Physics 499 Special problems	1
		Option elective	3

FOURTH YEAR

Fall Semester	Hours	Spring Semester	Hours
Technical writing [WRTG]	3	Diversity [DIVR]	3
Humanities [HUM]	3	Capstone [CAPS]	3
Physics 443 Optics	3	Physics 415 [M] Quantum lab	3
Physics 450 Quantum mechanics	3	Physics elective	3
Physics 490 [M] Thesis	1	Option elective	3
Option elective	3		

NOTES:

- (1) See notes to the Standard Option.
- (2) Option Electives (18 credits): Choose from CE, CPT S, EE, ME, and MSE courses not used to fulfill other requirements.
- (3) Physics Electives (3 credits): Choose any 300-400-level ASTRONOM or PHYSICS courses not used to fulfill other requirements.

Physics - Honors College Curriculum

Admission to the Honors College requires a separate application. To apply, you must have applied to WSU or be enrolled as a student. Placement into the Honors College is competitive and the number of spaces is limited.

The Honors College program is an alternate 4-year program within the university. There are College-based graduation requirements. Foreign language competency is a graduation requirement, as tested by the STAMP test (a reading, writing, listening, and speaking test). Foreign language minor degrees are popular with Honors College students. All foreign language courses should be taken in consecutive semesters.

FIRST YEAR

Fall semester	Hours	Spring semester	Hours
Chem 105 Chemistry I	4	Chem 106 or 116 Chemistry II	4
Engl 298 Writing	3	Foreign Language 204	4
Foreign Language 203	4	Math 172 or 182 Calculus II	4
Math 171 Calculus I	4	Phys 201 or 205 Physics I	4-5
Phys 188 First-Year Seminar I	1	Phys 189 First-Year Seminar II	1

SECOND YEAR

Fall semester	Hours	Spring semester	Hours
Honors 270 Social Sciences	3	Honors 290 Science	3
Math 220 or 230 Algebra	2	Math 315 Differential Equations	3
Math 273 or 283 Calculus III	3	Phys 304 Modern II	3
Phys 202 or 206 Physics II	4-5	Phys 330 Thermal Physics	3
Phys 303 Modern I	2	Phys 410 Electronics lab	4
Assemble Junior Writing Portfolio			
Complete College foreign language requirement			

THIRD YEAR

Fall semester	Hours	Spring semester	Hours
Computing requirement	2-4	Technical Writing	3
Honors 280 Arts	3	Honors 398 Thesis Proposal	1
Math elective	3	Math elective	3
Phys 320 Mechanics	3	Phys 342 Electricity & Magnetism II	3
Phys 341 Electricity & Magnetism I	3	Phys 415 [M] Quantum Lab	3
		Phys 499 Special Problems	1

FOURTH YEAR

Fall semester	Hours	Spring semester	Hours
Honors 380 Case study: Arts	3	Honors 390 Case study: Science	3
Honors 450 Thesis	2	Honors 450 Thesis	1
Honors 370 Case study: Social Sci	3	Standard option electives	9
Phys 450 Quantum mechanics	3	Technical elective	3
Phys 490 [M] Thesis	1		
Standard option elective	3		
Technical elective	3		

NOTES:

1. Read the notes to the Standard Option.
2. Admittance to Foreign Language courses 203 and 204 requires as a prerequisite either 101 and 102, or AP credit, or test placement through the Dept of Foreign Languages and Cultures
3. Students should sign up to take the STAMP test after finishing the 204 course or "fourth semester" of their foreign language

Physics - ROTC Curriculum

WSU offers three ROTC programs: Air Force, Army, and Navy. The Air Force program is located in the Dept of Aerospace Studies at WSU, the Army in the Dept of Military Science at WSU, and the Navy in the Program in Naval Science at the University of Idaho (Moscow). The combined ROTC and Physics program takes 5 years (10 semesters) to complete. The program below is for the Aerospace Studies course prefix, Aero. Substitute course prefix Mil S for Military Science, or N S for Naval Studies, as appropriate.

FIRST YEAR

Fall Semester	Hours	Spring Semester	Hours
Aero 1xx	3	Aero 1xx	3
Chem 105 [PSCI] Chemistry I	4	Chem 106 Chemistry II	4
Math 171 Calculus I	4	Math 172 Calculus II	4
Phys 188 First-Year Seminar I	1	Phys 189 First-Year Seminar II	1
Engl 101 [WRTG] Writing	3	Phys 201 or 205 Physics I	4-5

SECOND YEAR

Fall Semester	Hours	Spring Semester	Hours
Aero 2xx	3	Aero 2xx	3
Math 273 Calculus III	2	Hist 105 [ROOT] Contemporary Issues	3
Math 220 Algebra	2	Math 315 Differential Equations	3
Phys 202 or 206 Physics II	4-5	Phys 304 Modern II	3
Phys 303 Modern I	3	Phys 410 Electronics lab	4
Assemble Junior Writing Portfolio			
Complete College foreign language requirement			

THIRD YEAR

Fall Semester	Hours	Spring Semester	Hours
Aero 3xx	5	Aero 3xx	5
Computing	2-4	Phys 342 Electricity & Magnetism II	3
Phys 320 Classical Mechanics	3	Phys 415 [M] Quantum Lab	3
Phys 341 Electricity & Magnetism I	3	Standard option elective	3
Biological science [BSCI]	3	Phys 330 Thermal Physics	3

FOURTH YEAR

Fall Semester	Hours	Spring Semester	Hours
Aero 4xx	5	Aero 4xx	5
Humanities [HUM]	3	Math elective	3
Math elective	3	Phys 499	1
Social science [SSCI]	3	Technical elective	3
Technical elective	3	Arts [ARTS]	3

FIFTH YEAR

Fall Semester	Hours	Spring Semester	Hours
Aero 499	1	Aero 499	1
Technical Writing	3	Standard option electives	9
Phys 450 Quantum Mechanics	3	Capstone [CAPS]	3
Phys 490 [M] Thesis	1	Additional [ARTS][HUM][SSCI]	3
Standard option elective	3		
Diversity [DIVR]	3		

NOTES:

1. Read the notes to the Standard Option.

Course Descriptions, Physics & Astronomy

Courses for Majors

On the following pages are descriptions of course offered in the Department of Physics and Astronomy, including a list of the textbooks used in recent years.

Phys 188 First-year Seminar

Phys 188 and 189: First-Year Seminar

A weekly seminar where students meet members of the Department of Physics & Astronomy and learn about opportunities for undergraduate research. Small assignments and projects teach academic skills.

Recent texts

Your College Experience, by Gardner, Jewler, and Barefoot (Bedford St. Martin's)

Phys 201 and 202: Physics for Scientists and Engineers

Phys 201 [P] Physics for Scientists and Engineers 4 (3-3) Prereq Math 171 or Math 181 with a grade of C or better or placement in Math 172 or higher. Calculus-based physics; topics in motion and dynamics of particles and rigid bodies, vibrations, wave phenomena, and the laws of thermodynamics.

Phys 202 [P] Physics for Scientists and Engineers 4 (3-3) Prereq Math 172 or Math 182 with a grade of C or better or placement into Math 273 or higher; Phys 201 with a grade of C or better. Calculus-based physics; topics in electricity, magnetism, electromagnetics, D/C and A/C circuits, optics, reflection refraction, interference, diffraction, polarization.

A fuller discussion of these courses follows the note on Physics 205 and 206.

Recent texts

University Physics, by Moebs, Ling, & Sanny (OpenStax)

Physics, by Knight

Physics, by Tipler

Physics, by Fishbane, Gasiorowicz and Thornton

Physics, by Walker

Phys 205 and 206: Honors Section of Physics for Scientists and Engineers

We encourage all of our Physics majors to enroll in the Honors versions of 201 and 202. The classes are much smaller than 201 and 202, and there is a recitation session built into the class where students learn to work problems with the instructor and our graduate students. The material is more challenging and the class overall is a better preparation for higher-level physics. Five credit hours are awarded for each of these classes.

Mathematics Prerequisites

This course makes use of integral and differential calculus, with the level and extent of usage gradually increasing from very little, in Physics 201 to full use in Physics 202. Calculus I (Math 171 or Math 181) must be completed before or taken concurrently with Physics 201 and Calculus II (Math 172 or Math 182) must be completed before Physics 202. If you have completed a high school physics course, concurrent enrollment in Math 171 is generally sufficient preparation for Physics 201, even if your high school course was not sufficient for you to bypass Math 171. If you have not had a high school calculus class, then you should complete Math 171 prior to taking Physics 201.

Designed for Engineers and Physical Scientists

Physics 201 and 202 are required for majors in mathematics, the physical sciences, and engineering; for biological science majors contemplating research careers; and generally for all students (with sufficient preparation in mathematics) who prefer these courses to less technical courses so as to make full use of their background.

Laboratory

Physics 201 (205) and 202 (206) both have a laboratory which is an integral part of the course. The purposes of the laboratory are to introduce basic measuring and data handling techniques, as well as to illustrate some of the principles of physics and to explore their limitations.

An Integrated Sequence: Phys 201, 202, 303, and 304

Physics 201 and 202 constitute a survey of classical physics; mechanics, heat, sound, electricity, magnetism, and light. Physics 303 and 304 survey the more recent theories of relativity, atomic physics, nuclear physics, and solid state physics. It is to be emphasized that Physics 303 and 304 are the continuation and culmination of Physics 201 and 202. It is hard to overestimate the impact of the fascinating and important ideas of modern physics. These ideas not only dominate our understanding of nature but also have far reaching applications in technology.

Phys 303 and 304: Modern Physics

Phys 303 Modern Physics I 3 (3-0) Prereq Math 220 or 230 or c//; Phys 202 or Phys 206 or c//. Quantum and relativity theories with applications to atomic, solid state, nuclear and elementary particle physics.

Phys 304 Modern Physics II 3 (3-0) Prereq Phys 303. Continuation of Phys 303.

Recent texts

Modern Physics, by Serway, Moses, & Morway

Modern Physics, by Harris

Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, by Eisberg and Resnick

Physics 320 Mechanics

Phys 320 Mechanics 3 (3-0) Prereq Math 315 or c//; Phys 202 or 206; Math 220 or 230 or c//. Particle motion in one-, two-, and three-dimensions; motions of systems of particles; rigid body motion; Lagrange's equations.

Recent texts

Classical Mechanics, by Taylor

Classical Dynamics of Particles and Systems, by Marion and Thornton

Classical Mechanics, by Barger and Olsson

Phys 330 Thermal Physics

Phys 330 Thermal Physics 3 (3-0) Prereq Math 273 or 283; Phys 202 or 206. Thermal behavior of systems; energy and entropy, equations of state; changes of phase; elements of continuum and statistical approaches.

Recent texts

Statistical physics: Berkeley physics course vol 5, by Reif

Statistical and thermal physics with computer applications, by Gould and Tobochnik

Thermal Physics, by Kittel and Kromer

Thermodynamics, Kinetic Theory and Statistical Mechanics, by Sears and Salinger

Heat and Thermodynamics, by Zemansky and Dittman

Phys 341 and 324 Electricity & Magnetism

Phys 341 Electricity and Magnetism I 3 (3-0) Prereq Math 315 or c//; Phys 202. Electrostatic fields, magnetic fields, dielectric and magnetic media

Phys 342 Electricity and Magnetism II 3 (3-0) Prereq Phys 341. Continuation of Phys 341. Maxwell's equations; electromagnetic waves, special relativity

Recent texts

Introduction to Electrodynamics, by Griffiths

Astr 345 Principles of Astronomy

Phys 345 [P] Principles of Astronomy 3 (3-0) Prereq Phys 202 or 206; Math 172 or 182. Rec Phys 303. Planets, the sun, stars, and galaxies; current topics in astrophysics and planetary research. Same as Phys 345.

Recent texts

Introduction to High Energy Astrophysics, by Rosswog (Cambridge University Press)

Cosmic Catastrophies, by Wheeler

Moons and Planets, by Hartmann

Introduction to Astronomy and Astrophysics, by Zeilik & Gregory

Astronomy, A Physical Perspective, by Kutner

Foundations of Astrophysics, by Ryden and Peterson

Phys 410 Electronics Laboratory

Phys 410 Electronics 4 (2-6) Prereq Phys 202 or 206. Laboratory construction and investigation of electronic circuits employed in research instruments.

Recent texts

Basic Electronics: An Introduction to Electronic for Science Students, by Meyer

Analog Electronics for Scientific Applications, by Barnall

Digital and Microprocessor Electrical Science, by Barnall

Phys 415 Quantum Physics Laboratory

Phys 415 [M] Quantum Physics Laboratory 3 (2-3) May be repeated for credit; cumulative maximum 6 hours. Prereq Phys 304. Experiments in modern and quantum physics, fundamental interactions of radiation with matter.

Recent Texts

Experiments in Modern Physics, by Melissinos

An Introduction to Error Analysis, by Taylor

Astr 435 and 436 Astrophysics

Astr 435 Astrophysics I 3 (3-0) Prereq Phys 202 or 206; Math 172 or 182. Planets, solar systems, and stars.

Astr 436 Astrophysics II 3 (3-0) Prereq Phys 202 or 206; Math 172 or 182. Exotic objects, galaxies, and cosmology.

These courses are offered in alternate spring semesters and may be taken in any order.

Recent texts

An Introduction to Modern Astrophysics, by Carroll and Ostlie

Introduction to Cosmology, by Ryden

Phys 443 Optics

Phys 443 Optics 3 (3-0) Prereq Phys 341 or c//. Polarization, interference, coherence, and diffraction phenomena of the electromagnetic spectrum; optics of solids; laser resonators; Gaussian beams; ABCD matrices

Recent texts

Optics, by Hecht (Addison Wesley)

Modern Optics, by Guenther

Introduction to Modern Optics, by Fowles

Phys 450 Quantum Mechanics

Phys 450 Introduction to Quantum Mechanics 3 (3-0) Prereq Math 315, Phys 303. Introduction to quantum theory with applications to atomic physics.

Recent texts

Principles of Quantum Mechanics, by Shankar

Introduction to Quantum Mechanics, by Griffiths

Introductory Quantum Mechanics, by Liboff

Quantum Mechanics, by Gasiorowitz

Physics 461 Atomic and Molecular Physics

Phys 461 Introduction to Atomic and Molecular Physics 3 (3-0) Prereq Phys 304. Introduction to atomic and molecular physics; spectroscopy.

Recent texts

Atomic Physics, by Foot

Atomic Physics, by Jones

Phys 463 Solid State Physics

Phys 463 Introduction to Solid State and Materials Physics 3 (3-0) Prereq Phys 304. Introduction to the physics of solids; crystal structures, lattice vibrations, and electron theory.

Recent texts

Solid State Physics, by Ashcroft & Mermin

Introduction to Solid State Physics, by Kittel

Solid State Physics, by Burns

Phys 465 Nuclear Physics

Phys 465 Introductory Nuclear Physics 3 (3-0) Prereq Phys 304. Nuclear systematics, apparatus of nuclear research, radioactivity, nuclear atomic interactions, nuclear reactions and scattering; introductory particle physics.

Recent texts

Introductory Nuclear Physics, by Krane

Phys 481 Special topics

Phys 481 is offered on an irregular basis, depending upon the availability of instructors.

Recent topics

Applications of Mathematica to the Physical Sciences

Phys 466 Biological Physics

Phys 466 Biological Physics 3 (3-0) Prereq Chem 106 or 116; Math 172 or 182; Phys 202 or 206. Fundamental physics and thermodynamics of the cell, mechanics of biomolecular machines. Same as Phys 566.

Recent texts

Biological Physics - Energy, Information, Life, by Nelson

Physical Biology of the Cell, by Phillips, Kondev, & Theriot

Physics 490 Undergraduate Thesis

Phys 490 [M] Undergraduate Thesis 1 (1-0)

Undergraduate Thesis is required of all senior physics majors and satisfies a portion of the University's writing in the major requirement. Students work with on a project supervised by a faculty member. A lecture component may be required in which students learn how to read and write the scientific literature.

Physics 499 Special Problems

Phys 499 Special Problems V 1-4. May be repeated for credit. S, F grading

At least one hour credit of Phys 499 is required of all physics majors. The purpose of the requirement is to involve students in an active research program. Each student must make arrangements with a faculty member to undertake some specific project under his/her direction. This project may be anything, such as building research apparatus, taking data or writing or running computer programs. A paper is not always required, but may be, when appropriate.

Credit of from 1 to 4 hours can be earned each semester and may be repeated in other semesters. In general, three hours of work per week per semester (45 hours) earns one hour credit.

Any student who registers for Phys 499 must file a contract in the Physics and Astronomy Main Office with the academic secretary. This contract form is available in the Physics office and is to be completed with the supervising faculty member.

Other Physics & Astronomy Courses

Other courses offered by the Dept of Physics and Astronomy are not typically taken for credit by Physics majors. They are offered to satisfy university GER/UCORE requirements for other majors, or for Physics and Astronomy minor degrees.

Astr 135 Descriptive Astronomy

Astr 135 [PSCI] [P] Descriptive Astronomy 4 (3-2) Overview of the solar system, stars, galaxies, cosmology, and the history of astronomy. Includes a lab component with occasional evening meetings. Credit not granted for both Astr 135 and Astr 150.

Recent texts

Astronomy, by Fraknoi, Morrison, & Wolfe (OpenStax)

Understanding Our Universe, by Kay, Palen, Smith, & Blumenthal

21st Century Astronomy, by Hester

Lecture-Tutorials for Introductory Astronomy, by Adams et al.

Astr 138 Planets and Planetary Systems

Astr 138 [PSCI] [P] Planets and Planetary Systems 3 (3-0) Formation and dynamics of planetary systems; major planets: interiors, surfaces, atmospheres; minor planets: moons, asteroids, comets; science missions; extrasolar planets.

Recent texts

Astronomy, by Fraknoi, Morrison, & Wolfe (OpenStax)

The Planetary System, by Morrison and Owen

Astronomy Today: The Solar System, by Chaisson and McMillan

Lecture-Tutorials for Introductory Astronomy, by Adams et al.

Astr 150 Science and the Universe

Astr 150 [PSCI] [Q] Science and the Universe 3 (3-0) Basic structure and history of science and science reasoning with emphasis on astronomy, observational practice, and data analysis. Credit not granted for both Astr 135 and Astr 150.

Recent texts

Discovering the Cosmos, by Bless

The Cosmic Perspective, by Bennett

Lecture-Tutorials for Introductory Astronomy, by Adams et al.

Astr 390 The Night Sky

Astr 390 [PSCI] [P] The Night Sky 1 (0-3) Prereq UCORE [BSCI], [PSCI], or [SCI]. Star names, magnitude scales, constellation identification, astronomical coordinates, solar, lunar and planetary motions, practical astronomy. Some outdoor evening time required.

This course is required for the Astrophysics degree option, and is an option for the Astronomy minor degree.

Recent texts

The National Audubon Society Field Guide to the Night Sky

To Measure the Sky: An Introduction to Observational Astronomy, by Chromey

An Introduction to Observational Astrophysics, by Gallaway

Observational Astronomy, by Birney, Gonzalez, and Oesper

Astr 450 Life in the Universe

Astr 450 [CAPS] Life in the Universe 3 (3-0) Prereq UCORE [QUAN]; junior standing; rec completion of UCORE [BSCI], [PSCI], or [SCI]. The natural history of life on Earth and prospects for life elsewhere; includes chemistry, biology, geology, physics, and astronomy.

Recent texts

Life in the Solar System and Beyond, by Jones

Life in the Universe, by Bennett and Shostak

The Search for Life in the Universe, by Goldsmith and Owen

The Origins of Life in the Universe, by Jastrow and Rampino

Phys 101 and 102 General Physics

Phys 101 [PSCI] [P] General Physics 4 (3-3) Prereq Math 107 or Math 108 with a grade of C or better, or math placement score $\geq 75\%$, or passing Math 140, 171, 202, or 206. Algebra/trigonometry-based physics; topics in mechanics, wave phenomena, temperature and heat; oriented towards non-physical science majors.

Phys 102 [PSCI] [P] General Physics 4 (3-3) Prereq Phys 101 with a grade of C or better; Prereq Math 107 or Math 108 with a grade of C or better, or math placement score $\geq 75\%$, or passing Math 140, 171, 202, or 206. Algebra/trigonometry-based physics; topics in electricity, magnetism, optical phenomena, relativity, and quantum theory; oriented towards non-physical science majors.

Recent texts

College Physics, by Orone and Hinrichs (OpenStax)

Physics, by Walker

Study Guide to Accompany Physics, by Walker

Schaum's Guide: Beginning Physics I

Real Time Physics, Module 1 (Mechanics), by Sokoloff

Phys 137 Physics and Society

** via WSU Global Campus only **

Physics and Society 3 (3-0) Interactions of physics with society; energy; air and water pollution; recycling; communications and computers; physics and war; physics and art.

Previous listings: Physics 408 [CAPS], Phys 380 [P].

Recent texts

Physics: concepts & connections, by Hobson

Phys 150 Physics and your World

Phys 150 [PSCI] [Q] Physics and your World 3 (2-2) Survey of physics as found in everyday phenomena, including many hands-on activities and home experiments. Field trips required.

This course is designed for majors in the College of Education.

Phys 322 Sound waves and music

322 [PSCI] Sound Waves and Music 4 (3-3) Course Prerequisite: MATH 103 or higher with a C or better or a minimum ALEKS math placement score of 45%. Multi-disciplinary introduction to the acoustics of musical sound with a hands-on approach, including human hearing and perception.