



Undergraduate Handbook

Academic Year 2016-2017



DEPARTMENT OF
PHYSICS & ASTRONOMY



Undergraduate Handbook

2016-2017

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If you need course adaptations or accommodations because of a documented disability or if you have emergency information to share, please contact the Office of Disability Services, 2227 Dunford Hall, at 974-6087. This will ensure that you are properly registered for services.

Introduction

The UT Physics Department offers a flexible undergraduate program that teaches the fundamentals of physics while allowing students to tailor a curriculum that best suits their interests. This handbook outlines degree requirements, policies, and opportunities in the department, but it should be considered a supplement to the University's *Undergraduate Catalog* rather than a substitute. (The catalog is available at catalog.utk.edu). University policies and requirements on course hours, transfer credits, graduation deadlines, etc., override any information in this document. Students are also encouraged to meet with their advisors regarding course registration and graduation requirements.

Physics is the study of matter and energy and their interactions, from the workings of elementary particles to the death of massive stars. It is the most fundamental physical science: the laws of physics form the foundation of all natural sciences. The undergraduate physics major provides a thorough introduction to the core areas of physics with customization through our academic, astronomy, or general concentrations.

The **academic concentration** is intended for students interested in professional employment or graduate work in physics or closely related fields such as astronomy, engineering, laser technology, or computational science.

The **astronomy concentration** is designed for students who may wish to do graduate work in astronomy or astrophysics.

The **general concentration** is intended for students who wish to apply a substantial knowledge of physics to fields such as secondary education, medicine, law, journalism, business, or any field of their choice.

- Students who wish to apply physics to other career goals such as chemistry, mathematics, education, law, medicine, or journalism should consult with the department curriculum chair about appropriate alternate courses.
- Students interested in one of the many health professions should be aware that pre-health curricula vary widely, and should consult specific pre-health programs for details. Most medical schools expect students to complete BCMB 401, BIOL 240 and CHEM 350-CHEM 360; any twelve hours drawn from these four courses may be used to satisfy the 12-hour elective requirement for the general concentration in physics.
- Students planning careers in science communication may, with approval of the department curriculum chair, apply a limited number of upper-division JREM courses to the 12-hour elective requirement for the general concentration in physics.

Degree Requirements

College of Arts & Sciences Requirements

To earn a Bachelor of Arts or Bachelor of Science degree, these requirements must be completed.

- All university degree requirements as described in the section Academic Policies and Procedures – General Requirements for a Bachelor’s Degree (Undergraduate Catalog).
- A minimum of 120 credit hours.
- At least 42 credit hours in courses numbered 300 or above.
- Appropriate work to satisfy the Foundations, Perspectives, and Upper-Level Distribution requirements. (These three requirements do not apply to students in the College Scholars Program.)
- Completion of any required course work designed to prepare students for their chosen major(s). This work may be described as “preparation for” or “prerequisites to” or “corequisites to” the major(s) chosen by a student.
- Completion of at least one major consisting of 30 to 48 credit hours at 200-level or above. Courses used for the major may also be used to satisfy Foundations and Perspectives requirements as described below.

Students may choose to complete one or more minors. A minor in the college consists of 15 or more hours at the 200-level or above.

Students may take up to 20 hours of courses graded Satisfactory/No Credit subject to the regulations described in the undergraduate catalog.

The physics major consists of 41 hours. Students who wish to apply physics to other career goals such as chemistry, mathematics, education, law, medicine, or journalism should consult with the department curriculum chair about appropriate alternate courses.

Physics Major Prerequisites (20-22 hours)

Complete:

COSC 102 - Introduction to Computer Science

MATH 141 - Calculus I

MATH 142 - Calculus II

Complete A, B, or C as follows:

A.
PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I
PHYS 136 - Introduction to Physics for Physical Science and Mathematics Majors II

B.
PHYS 137 - Honors: Fundamentals of Physics for Physics Majors I
PHYS 138 - Honors: Fundamentals of Physics for Physics Majors II

C.
EF 151 - Physics for Engineers I
EF 152 - Physics for Engineers II
PHYS 231 - Fundamentals of Physics: Electricity and Magnetism
PHYS 232 - Fundamentals of Physics: Wave Motion, Optics, and Modern Physics

Physics Major Requirements (29 hours)

Complete:

PHYS 250 - Fundamentals of Physics: Modern Physics
PHYS 311 - Mechanics
PHYS 321 - Thermal Physics
PHYS 361 - Electronics Laboratory
PHYS 411 - Introduction to Quantum Mechanics
PHYS 421 - Modern Optics
PHYS 431 - Electricity and Magnetism
PHYS 461 - Modern Physics Laboratory

Concentration Requirements

Academic Concentration (12 hours)

Students planning graduate work in physics are advised to take the following courses.

Complete:

PHYS 312 - Mechanics
PHYS 412 - Introduction to Quantum Mechanics II
PHYS 432 - Electricity and Magnetism II
and one 300-400 level physics or 200-400 level astronomy course

Recommended Courses:

MATH 403 - Mathematical Methods for Engineers and Scientists
MATH 435 - Partial Differential Equations
MATH 443 - Complex Variables

Astronomy Concentration (12 hours)

Students planning graduate work in astronomy should take the following courses.

Complete:

ASTR 217 - Honors: Introductory Astronomy
ASTR 218 - Honors: Introductory Astronomy
ASTR 411 - Stellar Structure and Stellar Evolution
ASTR 490 - Special Topics in Astronomy

General Concentration (12 hours)

Select 12 hours:

300-400 level physics or 200-400 level astronomy courses

or

Coordinated coursework in an area of the student's special interest to be chosen by the student in consultation with a departmental advisor.

or

Any minor or second major.

Honors Concentration

Students who complete all requirements for the academic, applied, or astronomy concentrations will be awarded a degree with honors if their cumulative GPA is at least 3.25, their GPA in 300- and 400-level mathematics and physics courses is at least 3.5, they complete a minimum of 12 hours in honors courses, and they complete a written senior thesis reporting results of research conducted under faculty supervision and defended before a committee of three physics faculty members. A minimum of 3 credit hours of PHYS 493 (Research and Independent Study) is required.

Minors

Astronomy Minor

An astronomy minor consists of 24 hours.

Select one sequence:

ASTR 151 - A Journey through the Solar System Lecture
ASTR 152 - Stars, Galaxies, and Cosmology Lecture

or

ASTR 217 - Honors: Introductory Astronomy
ASTR 218 - Honors: Introductory Astronomy

or

EF 151 - Physics for Engineers I
EF 152 - Physics for Engineers II
PHYS 231 - Fundamentals of Physics: Electricity and Magnetism
PHYS 232 - Fundamentals of Physics: Wave Motion, Optics, and Modern Physics

Complete:

ASTR 411 - Stellar Structure and Stellar Evolution
ASTR 490 - Special Topics in Astronomy (3 hrs)
PHYS 311 - Mechanics
PHYS 312 - Mechanics
PHYS 421 - Modern Optics

Physics Minor

A physics minor consists of 24-26 hours.

Select one sequence:

PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I
PHYS 136 - Introduction to Physics for Physical Science and Mathematics Majors II

or

PHYS 137 - Honors: Fundamentals of Physics for Physics Majors I
PHYS 138 - Honors: Fundamentals of Physics for Physics Majors II

or

EF 151 - Physics for Engineers I
EF 152 - Physics for Engineers II
PHYS 231 - Fundamentals of Physics: Electricity and Magnetism
PHYS 232 - Fundamentals of Physics: Wave Motion, Optics, and Modern Physics

Complete:

PHYS 250 - Fundamentals of Physics: Modern Physics

Select 12 hours:

Physics and astronomy courses numbered 300 and above.

Physics Minor (Five-Year BS/MS Program)

Qualified students completing a BS degree from a department of the College of Engineering or the College of Arts and Sciences may add a physics minor by completing the requirements listed below. Six hours of 400-level courses required for a minor in physics combined with a BS engineering degree may be applied toward a master's degree (project option or non-thesis option) in physics during a fifth year following the award of the BS. This program is designed for students attending the University of Tennessee for their Master of Science degree because other universities may not accept these courses for graduate credit since they were used to satisfy requirements for an undergraduate program. Significant components of the program are:

- Students must have an overall GPA of 3.4 in required course work. Conditional admission may be granted after completing the required 100- and 200-level requirements for the minor while full admission is granted after enrolling in the final semester of courses required for all BS and minor course requirements with a minimum overall GPA of 3.4.
- Students must at least be conditionally admitted to the program prior to taking graduate courses for both their minor and master's degree. All courses taken for graduate credit must be approved by the graduate program director. Students admitted to the program must request permission from the Graduate School to take approved courses for graduate credit. (Requirements continued next page.)

- Students admitted to the program must also follow the normal procedure for admission to the Graduate School. Admission of students into this program must be approved by the department and the Graduate School. Students will not be eligible for assistantships until they are enrolled as graduate-level students in the Graduate School.

Requirements for the 5-Year BS/MS

The physics minor component of the 5-Year BS/MS program consists of 24 to 31 hours.

Complete A, B, or C below:

A.

EF 151 - Physics for Engineers I **or**
EF 157 - Honors: Physics for Engineers I

EF 152 - Physics for Engineers II **or**
EF 158 - Honors: Physics for Engineers II

PHYS 231 - Fundamentals of Physics: Electricity and Magnetism
PHYS 232 - Fundamentals of Physics: Wave Motion, Optics, and Modern Physics

B.

PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I
PHYS 136 - Introduction to Physics for Physical Science and Mathematics Majors II

C.

PHYS 137 - Honors: Fundamentals of Physics for Physics Majors I
PHYS 138 - Honors: Fundamentals of Physics for Physics Majors II

Complete:

PHYS 250 - Fundamentals of Physics: Modern Physics
PHYS 311 - Mechanics
PHYS 432 - Electricity and Magnetism II

Select one course:

PHYS 312 - Mechanics
PHYS 341 - Introduction to Nuclear Physics

Select one course:

ECE 341 - Fields
PHYS 431 - Electricity and Magnetism

VolsTeach

Students pursuing a major in selected programs in the College of Arts and Sciences are eligible to participate in the University's VolsTeach program (volsteach.utk.edu), which permits students to simultaneously complete a major in mathematics or science and receive secondary education teaching licensure within this 4-year undergraduate program. For more information about VolsTeach, including advising associated with teaching licensure requirements, contact the Center for Enhancing Education in Mathematics and Science (101 Greve Hall).

Scholarships, Honors Programs, and Financial Assistance

Both the university and the physics department offer means to help students finance an undergraduate education. The following are some useful contacts to get you started.

The physics department offers scholarships to outstanding undergraduate candidates who commit to major in physics. The UT One Stop Web site also provides information about scholarships, loans, and need-based aid (onestop.utk.edu).

Each spring, the department awards honors to deserving undergraduates: the Outstanding First Year Physics Student, the James W. McConnell Award for Academic Excellence, the Douglas V. Roseberry Distinguished Upper Class Major Award, and the Robert Talley Awards for Outstanding Undergraduate Research and Outstanding Undergraduate Leadership. The faculty selects the winners based on student dedication to scholarship, leadership, and excellence.

The university is also home to a number of honors programs (honors.utk.edu), including the Chancellor's Honors and Haslam Scholars programs that could well suit the physics major. The College of Arts and Sciences offers outstanding students the opportunity to tailor a curriculum through the College Scholars Program (scholars.utk.edu), an interdisciplinary honors program for highly motivated and academically talented students who have clear goals for their undergraduate education, and who cannot attain those goals within the traditional requirements structure of the College.

Undergraduate physics majors also have the opportunity to earn extra money and professional experience by working for the department, with responsibilities such as helping set up physics labs, etc.

Research Opportunities

Undergraduate physics majors have the opportunity to gain valuable research experience as they pursue their respective degrees. The department administers a Summer Research Fellowship program to give outstanding undergraduate students the opportunity to gain experience in physics research with members of our faculty, both on campus and at nearby Oak Ridge National Laboratory. Students learn research procedures and techniques and present their findings to other summer fellows at the end of the program. Each research fellow spends 10 weeks working on a full-time research project supervised by a physics faculty member. Dr. Marianne Breinig (mbreinig@utk.edu) is the contact person for the program. You can see details of the 2016 program at: electron4.phys.utk.edu/summer-fellows.

Many students also find research positions with faculty members working as close as Oak Ridge National Laboratory and as far away as the Large Hadron Collider experiment in Geneva. Students may wish to contact faculty members working in fields of interest to them.

Internships & Careers

The problem-solving skills developed by an undergraduate physics education help students learn to analyze and deal logically and effectively with complex issues in any setting. There are a number of resources to help physics graduates get started when looking for a job.

The American Physical Society career information page (www.aps.org/careers/index.cfm) provides career guidance resources and links to employment sites relating to science.

Physics Today has a jobs website at jobs.physicstoday.org. AIP also maintains statistical information on employment trends for physicists: www.aip.org/statistics/employment.

The university provides help in matching students with prospective employers through UT Career Services, located at 100 Dunford Hall. You may contact Career Services at 974-5435, or by visiting the Website at career.utk.edu.

The Pathways to Science Web site helps undergraduate students find summer research opportunities, scholarships, internships, and more (www.pathwaystoscience.org).

The National Science Foundation funds a large number of research opportunities in physics for undergraduates through their REU program. Find out more at: www.nsf.gov/crssprgm/reu/list_result.jsp.

The Department of Energy sponsors Science Undergraduate Laboratory Internships at labs such as ORNL: science.energy.gov/wdts/suli.

Oak Ridge Associated Universities (ORAU) maintains a list of undergraduate research opportunities in the sciences: orau.org/science-education/internships-scholarships-fellowships/undergraduates.aspx.

Undergraduate Student Research Opportunities at Oak Ridge National Laboratory are listed at: www.orau.org/ornl/undergraduates.

The Physics Community

Undergraduate students are important members of the physics department. Room 604 in the Nielsen Physics Building is the undergraduate physics lounge and is equipped with computers, study tables, lockers, and a snack area. Keys to this room, and the physics mail/copy room, are available from the front office.

The physics department has organized an undergraduate liaison committee to meet with the department head concerning issues of importance to physics majors. This committee typically comprises five students, including a chairperson. Undergraduate students are invited to actively participate in other departmental affairs, including colloquia, the annual spring picnic, and activities sponsored by the Society of Physics Students.

SPS/Sigma Pi Sigma

The Society of Physics Students (SPS) is a professional association that introduces students to people with similar professional interests and goals. Membership through collegiate chapters is open to anyone interested in physics. The UT SPS chapter fosters interactions between students and faculty while at the same time encouraging participation in the wider physics community.

Sigma Pi Sigma is the official honor society of the physics profession, recognizing distinctive achievement and scholarship in physics. To be considered for membership at UT, students must have at least a junior standing with an overall grade point average of 3.25 and a physics GPA of 3.5. Both undergraduate and graduate students who meet the qualifications are invited to join.

Contacts

<p>Dr. Hanno Weitering Professor & Head</p>	<p>Undergraduate liaison committee; student complaints regarding courses</p>	<p>hanno@utk.edu Office: 401 Nielsen Phone: 974-3342</p>
<p>Dr. Stu Elston Professor</p>	<p>Departmental undergraduate advising</p>	<p>selston@utk.edu Office: 216 Nielsen Phone: 974-7818</p>
<p>Dr. Marianne Breinig Professor</p>	<p>Summer Research Fellowship Program</p>	<p>mbreinig@utk.edu Office: 202 Nielsen Phone: 974-7842</p>
<p>Ms. Showni Medlin-Crump Senior Administrative Specialist</p>	<p>Keys and employment paperwork</p>	<p>smedlin@utk.edu Office: 401 Nielsen Phone: 974-3342</p>
<p>Dr. Kate Jones Associate Head & Associate Professor</p>	<p>Scholarships</p>	<p>kgrzywac@utk.edu Office: 406A Nielsen Phone: 974-4022</p>
<p>Arts & Sciences Advising Services</p>	<p>Academic advising, problems or dean's signature</p>	<p>asadvising@utk.edu Office: 313 Ayres Hall Phone: 974-4481 artsci.utk.edu/advising</p>

Appendix

uTrack Sample Schedules

Universal Tracking (uTrack) is an academic monitoring system designed to help students stay on track for timely graduation. In order to remain on track, students must complete the minimum requirements for each tracking semester, known as milestones. Milestones may include successful completion of specified courses and/or attainment of a minimum GPA. **uTrack requirements only affect full-time, degree-seeking students who first entered Fall 2013 or later. uTrack does not apply to transfer students who entered prior to Fall 2015.**

Following the sample academic plan and its uTrack milestones will help students stay on track to graduate in four years. For specific course requirements, refer to the program requirements above and the link to the Arts and Sciences requirements, and consult an academic advisor.

Connections and Global Challenges

In completing the Connections requirement of the college, students undertake a focused educational experience that complements in-depth study in their chosen major field. Courses that satisfy the Global Challenges requirement provide students with the opportunity for focused inquiry into the historical origins of, or contemporary thought regarding, one of the critical international or transnational issues facing today's world. For details, please see the *Undergraduate Catalog*, College-wide requirements for Arts and Sciences.

Requirements for Physics Major – Academic Concentration

Term 1	Hours	Milestone Notes
ENGL 101 (or equivalent)	3	MATH 119 or MATH ACT 25
MATH 141 or MATH 147	4	
PHYS 135 or PHYS 137	4-5	
Social Sciences	3	
Elective	1	
Term 2		
COSC 102	4	ENGL 101
ENGL 102 (or equivalent)	3	MATH 130 or MATH ACT 28
MATH 142 or MATH 148	4	
PHYS 136 or PHYS 138	4-5	
Elective	1	

Continued on next page

Academic Concentration uTrack Requirements, Continued

Term 3

Foreign Language (intermediate level)	3	MATH 141
MATH 231	3	PHYS 135
Non-U.S. History	3	
PHYS 250	4	
Social Sciences	3	

Term 4

Foreign Language (intermediate level)	3	ENGL 102
MATH 241	4	MATH 142
Non-U.S. History (contin. of sequence)	3	PHYS 136
PHYS 321	3	COSC 102
PHYS 421	4	

Term 5

Arts and Humanities (List A or B)	3	MATH 231
Communicating Orally Elective	3	MATH 241
MATH 435	3	PHYS 250
PHYS 311	3	
PHYS 361	3	

Term 6

Arts and Humanities (List A)	3	Completion of at least 9 upper-division (300-400 level) hours
PHYS 312	3	
PHYS 461	3	
Connections	6	

Term 7

Communicating through Writing Elective	3	Completion of at least 24 upper-division (300-400 level) hours
PHYS 411	3	
PHYS 431	3	
Physics (major)	3	
Connections	3	

Term 8

PHYS 412	3	Completion of at least 42 upper-division (300-400 level) hours
PHYS 432	3	
Global Challenges	3	
Electives	3-6	

TOTAL (minimum) 120

Requirements for Physics Major – Astronomy Concentration

Term 1	Hours	Milestone Notes
ENGL 101 (or equivalent)	3	MATH 119 or MATH ACT 25
MATH 141 or MATH 147	4	
PHYS 135* or PHYS 137	4-5	
Social Sciences	3	
Term 2		
COSC 102	4	ENGL 101
ENGL 102 (or equivalent)	3	MATH 130 or MATH ACT 28
MATH 142 or MATH 148	4	
PHYS 136 or PHYS 138	4-5	
Term 3		
ASTR 217	4	MATH 141
Foreign Language (intermediate level)	3	PHYS 135
MATH 231	3	
Non-U.S. History	3	
PHYS 250	4	
Term 4		
ASTR 218	4	COSC 102
Foreign Language (intermediate level)	3	ENGL 102
MATH 241	4	MATH 142
PHYS 321	3	PHYS 136
Term 5		
Arts and Humanities (List A or B)	3	MATH 231
MATH 435	3	MATH 241
Non-U.S. History (contin. of sequence)	3	PHYS 250
PHYS 311	3	
PHYS 361	3	
Term 6		
Arts and Humanities (List A)	3	Completion of at least 9 upper-division (300-400 level) hours
PHYS 421	4	
Social Sciences	3	
Connections	3	
Elective	2	
Term 7		
ASTR 490	3	Completion of at least 24 upper-division (300-400 level) hours
Communicating through Writing Elective	3	
PHYS 411	3	
PHYS 431	3	
Connections	3	

Continued on next page

Astronomy Concentration uTrack Requirements, Continued

Term 8

ASTR 411	3	Completion of at least 42 upper-division (300-400 level) hours
Communicating Orally Elective	3	
PHYS 461	3	
Connections	3	
Global Challenges	3	

TOTAL (minimum) 120

Requirements for Physics Major – General Concentration

Term 1

	Hours	Milestone Notes
ENGL 101 (or equivalent)	3	MATH 119 or MATH ACT 25
MATH 141 or MATH 147	4	
PHYS 135 or PHYS 137	4-5	
Social Sciences	3	
Elective	1	

Term 2

COSC 102	4	ENGL 101 MATH 130 or MATH ACT 28
ENGL 102 (or equivalent)	3	
MATH 142 or MATH 148	4	
PHYS 136 or PHYS 138	4-5	
Elective	0-1	

Term 3

Foreign Language (intermediate level)	3	MATH 141 PHYS 135
MATH 231	3	
Non-U.S. History	3	
PHYS 250	4	
PHYS 311	3	

Term 4

Foreign Language (intermediate level)	3	ENGL 102 MATH 142 PHYS 136 COSC 102
MATH 241	4	
Non-U.S. History (cont. of sequence)	3	
PHYS 321	3	
PHYS 421	4	

Term 5

Arts and Humanities (List A or B)	3	MATH 231 MATH 241 PHYS 250
Communicating Orally Elective	3	
Communicating through Writing Elective	3	
MATH 435	3	
PHYS 361	3	

Term 6

Arts & Humanities (List A)	3	Completion of at least 9 upper-division (300-400 level) hours
Physics (major)	3	
Social Sciences	3	
Connections	6	

Term 7

PHYS 411	3	Completion of at least 24 upper-division (300-400 level) hours
PHYS 431	3	
Physics (major)	6	
Connections	3	

Term 8

PHYS 461	3	Completion of at least 42 upper-division (300-400 level) hours
Physics (major)	3	
Global Challenges	3	
Electives	3-6	

TOTAL (minimum) 120