

# **HANDBOOK FOR UNDERGRADUATE MAJORS**

## **Department of Physics and Astronomy**

Roster and Directory  
Departmental Committees, Duties, and Organizations  
Honors and Awards

### **Curricula and Suggested Schedules for**

**BACHELOR OF ARTS IN ASTRONOMY**

**BACHELOR OF SCIENCE IN ASTRONOMY**

**BACHELOR OF ARTS IN PHYSICS**

**BACHELOR OF SCIENCE IN PHYSICS**

**BACHELOR OF SCIENCE IN ENGINEERING PHYSICS**

**Planned Schedule of Courses Open to Majors**

**Course Numbering System**

**Research and Graduate Programs**

**The University of Kansas**

**Lawrence, Kansas 66045**

**Fall 2018-Spring 2019**

## ROSTER AND DIRECTORY

<i>PHONE*</i>	<i>NAME</i>	<i>ROOM**</i>
3953	Baringer, Philip S., Prof. (Ph.D. Indiana, 1985) <i>Experimental Physics; Elementary Particle Physics</i> <a href="mailto:baringer@ku.edu">baringer@ku.edu</a>	4075 Mal
4742	Bean, Alice L., Distinguished Prof. (Ph.D. Carnegie–Mellon, 1987) <i>Experimental Physics; Elementary Particle Physics</i> <a href="mailto:abean@ku.edu">abean@ku.edu</a>	4087 Mal
4741	Besson, David, Prof. (Ph.D. Rutgers, 1986) <i>Experimental Physics; Elementary Particle Physics</i> <a href="mailto:zedlam@ku.edu">zedlam@ku.edu</a>	5069 Mal
6413	Chan, Wai-Lun, Assoc. Prof. (Ph.D. Brown, 2007) <i>Condensed Matter Physics</i> <a href="mailto:wlchan@ku.edu">wlchan@ku.edu</a>	2121 CDS1
4739	Cravens, Thomas E., Prof. (Ph.D. Harvard, 1975) <i>Space Physics; Plasma Physics</i> <a href="mailto:cravens@ku.edu">cravens@ku.edu</a>	6050L Mal
4740	Feldman, Hume Prof. (Ph.D. State Univ. of New York, Stony Brook, 1989) <b>DEPARTMENT CHAIRPERSON</b> <i>Cosmology, Astrophysics</i> <a href="mailto:feldman@ku.edu">feldman@ku.edu</a>	1082b Mal
4579	Fischer, Chris, Assoc. Prof. (Ph.D. Univ. of Michigan, 2000) <b>DIRECTOR ENGINEERING PHYSICS ASSOCIATE CHAIRPERSON</b> <i>Biophysics</i> <a href="mailto:shark@ku.edu">shark@ku.edu</a>	2056a1 Mal
5831	Han, Siyuan, Prof. (Ph.D. Iowa State, 1986) <i>Experimental Condensed-Matter Physics</i> <a href="mailto:han@ku.edu">han@ku.edu</a>	2112 CDS1
0481	Kirkpatrick, Allison, Asst. Prof. (Ph.D. Univ. Massachusetts, 2016) <i>Active Galactic Nuclei</i> <a href="mailto:akirkpatrick@ku.edu">akirkpatrick@ku.edu</a>	2056a-Mal
6356	Kong, Kyoungchul (K.C.) Asst. Prof. (Ph.D. Univ. of Florida, 2006) <i>Theoretical Particle Physics</i> <a href="mailto:kckong@ku.edu">kckong@ku.edu</a>	6050c Mal
6017	Lewis, Ian, Asst. Prof. (Ph.D. Univ. of Wisconsin-Madison, 2011) <i>Theoretical High Energy Physics</i> <a href="mailto:ian.lewis@ku.edu">ian.lewis@ku.edu</a>	6050J Mal
4025	Medvedev, Mikhail V. (Misha), Prof. (Ph.D. San Diego, California, 1996) <i>Theoretical Astrophysics, Plasma and Space Physics</i> <a href="mailto:medvedev@ku.edu">medvedev@ku.edu</a>	6070d Mal
3949	Murray, Michael J., Prof. (Ph.D. Pittsburgh, PA, 1989) <i>Relativistic Heavy Ion Physics</i> <a href="mailto:mjmurray@ku.edu">mjmurray@ku.edu</a>	4088b Mal
0471	Peealers, Hartwin; Asst. Prof. (Ph.D. Univ. Antwerp, 2009) <i>Computational Condensed Matter &amp; Materials</i> <a href="mailto:peelaers@ku.edu">peelaers@ku.edu</a>	2119 CDS1
3408	Ralston, John P., Prof. (Ph.D. Oregon, 1980) <i>Elementary Particle Physics and Particle Astrophysics</i> <a href="mailto:ralston@ku.edu">ralston@ku.edu</a>	6050h Mal
4268	Rogan, Christopher, Asst. Prof. (Ph.D. California Institute of Technology, 2013) <i>Experimental High Energy Physics</i> <a href="mailto:crogan@ku.edu">crogan@ku.edu</a>	4073 Mal

2627	Royon, Christophe, Foundation Prof. (Ph.D. University of Paris, 1994) <i>Nuclear Physics</i> <a href="mailto:christophe.royon@ku.edu">christophe.royon@ku.edu</a>	4086 Mal
4099	Rudnick, Gregory, Prof. (Ph.D. Tucson, AZ 2001) <i>Astrophysics, Observational Galactic Astronomy</i> <a href="mailto:grudnick@ku.edu">grudnick@ku.edu</a>	2056b Mal
6224	Rush, Sarah, ----. (Ph.D. University of Kansas, 2018) <i>Teaching Specialist</i> <a href="mailto:slegres@ku.edu">slegres@ku.edu</a>	1075 Mal
4933	Sanders, Stephen J., Prof. (Ph.D. Yale, 1977) <i>Experimental Nuclear Physics</i> <a href="mailto:ssanders@ku.edu">ssanders@ku.edu</a>	4088a Mal
5274	Shandarin, Sergei, F., Prof. (Ph.D. Moscow Physical Technical Institute, 1971) <a href="mailto:sergei@ku.edu">sergei@ku.edu</a> <i>Cosmology, Large-Scale Structure, Non-Linear Dynamics</i>	6070c Mal
5273	Shi, Jicong (Jack), Assoc. Prof. (Ph.D. Houston, 1991) <i>Non-Linear Dynamics, Accelerator Beam Dynamics</i> <a href="mailto:jshi@ku.edu">jshi@ku.edu</a>	5073 Mal
1272	Tapia Takaki, Daniel, Asst. Prof. (PhD, University of Birmingham, UK, 2008) <i>Experimental Particle Physics</i> <a href="mailto:jdt@ku.edu">jdt@ku.edu</a>	6070b Mal
5163	Twarog, Bruce A., Prof (Ph.D. Yale, 1980) <i>Astrophysics of Galaxies</i> <a href="mailto:btwarog@ku.edu">btwarog@ku.edu</a>	2058d Mal
5231	Wilson, Graham W., Assoc. Prof. (Ph.D. University of Lancaster, 1989) <i>Experimental Physics, Elementary Particle Physics</i> <a href="mailto:gwwilson@ku.edu">gwwilson@ku.edu</a>	5071 Mal
3240	Wu, Judy Zhihong, Distinguished Prof. (Ph.D. Houston, 1993) <i>Many-Body Theory, Superconductivity, Liquid Helium</i> <a href="mailto:jwu@ku.edu">jwu@ku.edu</a>	2114 CDS1
1938	Zhao, Hui, Assoc. Prof. (Ph.D. Beijing China, 2000) <i>Condensed Matter Physics</i> <a href="mailto:huizhao@ku.edu">huizhao@ku.edu</a>	2120 CDS1

#### Administrative Staff

4637	Rennells, Kristin (Business Manager) <a href="mailto:tatekris@ku.edu">tatekris@ku.edu</a>	1082cMal
1226	Hunt-Ward, Tizby (Program Asst.) <a href="mailto:tizby@ku.edu">tizby@ku.edu</a>	6050k Mal
1225	Sauerwein, Joel (Graduate Coordinator) <a href="mailto:joelSauer@ku.edu">joelSauer@ku.edu</a>	1082Mal
4626	Wegley, Kayla (Undergraduate Coordinator) <a href="mailto:k.wegley@ku.edu">k.wegley@ku.edu</a>	1082 Mal

#### Director of Laboratories

1943	Delgado, Jennifer <a href="mailto:jenniferad@ku.edu">jenniferad@ku.edu</a>	2061 Mal
------	--	----------

\*These are the last four digits of the campus telephone numbers, e.g. 785-864-3801.

\*\*Building indicates Malott Hall (Mal) or Central District Science Building 1 (CDS1)

## Departmental Committees and Organizations

**Astronomy Associates Of Lawrence:** Astronomy Associates of Lawrence is an organization of students and townspeople interested in Astronomy for the fun of it. This organization elects its own officers. Faculty Advisor: Prof. Bruce Twarog

**Departmental Assembly:** The constituted body for full departmental meetings is the “Departmental Assembly.” The Department provides for the inclusion of regularly enrolled students in both its Departmental Assembly and its policy-making committees. The number of students in each body is at least 20 percent of the number of faculty members who hold the rank of instructor or above and who serve on that body. The Departmental Assembly consists of: entire faculty, plus the student members of the Committees on Graduate Studies, Undergraduate Studies plus one “at-large” student member.

**Engineering Council:** A representative elected each year by students majoring in Engineering Physics.

**Engineering Physics Student Organization:** Hawkworks, the engineering physics student organization, is a club for students with interests in physics, engineering, or both fields of study. Prof. Chris Fischer is the adviser.

**Graduate Studies:** Seven faculty members appointed by the department chairman and two graduate students from physics elected by the Society of Physics Students.

**ΣΠΣ And SPS:** The Society of Physics Students is open to all persons with an interest in physics. Sigma Pi Sigma (ΣΠΣ) is the physics honor society, within SPS, with scholastic requirements for membership. SPS/ΣΠΣ is a member society of the *American Institute of Physics* This organization elects its own officers. Faculty Adviser, Prof. Ian Lewis.

**Undergraduate Studies:** Six members appointed by the department chairman, two students elected by the Society of Physics Students, plus the Associate Chair, Prof. Chris Fischer, and Laboratory Director, Ms. Jennifer Delgado.

## Faculty Advisers for Students Majoring in the Department

Coordinator	Prof. Steve Sanders	<a href="mailto:ssanders@ku.edu">ssanders@ku.edu</a>
U.G. Astronomy <i>B.A. and B.S.</i> – Profs.	Prof. Allison Kirkpatrick Prof. Bruce Twarog	<a href="mailto:allison.kirkpatrick@ku.edu">allison.kirkpatrick@ku.edu</a> <a href="mailto:btwarog@ku.edu">btwarog@ku.edu</a>

**Engineering physics and physics majors are assigned to advisors based on students’ last names:**

<b>Engineering Physics:</b>	A-K: Prof. Jack Shi	<a href="mailto:jshi@ku.edu">jshi@ku.edu</a>
	L-Z: Prof. Chris Fischer	<a href="mailto:shark@ku.edu">shark@ku.edu</a>

<b>Physics (College) <i>B.A. and B.S.:</i></b>	A - E: Prof. Tapia Takaki	<a href="mailto:jdt@ku.edu">jdt@ku.edu</a>
	F - L: Prof. Cravens	<a href="mailto:cravens@ku.edu">cravens@ku.edu</a>
	M - P: Prof. Murray**	<a href="mailto:mjmurray@ku.edu">mjmurray@ku.edu</a>
	Q - Z: Prof. Lewis	<a href="mailto:ian.lewis@ku.edu">ian.lewis@ku.edu</a>

\*\*Students assigned to Prof. Murray during FA18 are reassigned as follows: Freshmen- Lewis; Sophomores/Juniors-Cravens; Seniors-Tapia Takaki.

Physics Graduate Students –	Prof. KC Kong	<a href="mailto:kckong@ku.edu">kckong@ku.edu</a>
Departmental Honors Coordinator –	Prof. Ian Lewis	<a href="mailto:ian.lewis@ku.edu">ian.lewis@ku.edu</a>

## Undergraduate General Information

The Department occupies Malott Hall. The main office for the Department is in 1082. This is the place to go if you need to change a section, (though you will have to document a necessity) or leave a message or paper for a faculty member or teaching assistant. The office is generally open from 8:00 a.m. through 5:00 p.m. and is managed by Mrs. Kristin Rennells (1082c). You are likely to first meet the Undergraduate Coordinator, Ms. Kayla Wegley, or the Graduate Coordinator, Mr. Joel Sauerwein, as you walk in. The Department coordinates most of its homepage links through our "front door" home page at <http://www.physics.ku.edu>.

**The Chair of the Department:** Professor Hume Feldman; Ms. Kayla Wegley ([k.wegley@ku.edu](mailto:k.wegley@ku.edu)) keeps his appointment calendar. The Associate Chair is Professor Chris Fischer; his office is located in 2056a1.

**Director of Laboratories:** Dr. Jennifer Delgado. Email: [jenniferad@ku.edu](mailto:jenniferad@ku.edu). Her office is 2061 Malott.

### Make Up Lab:

The make-up lab is only for making up points on missed assignments or to redo a poor assignment. There are 7 total "regular" labs (labs that are not tests, the final or the make-up itself.) You can only use the scores from 7 attempts at each of objectives 1-5 and 4 attempts for objective 6. **What this means is that the make-up lab cannot be used as extra credit.** It will only "swap out" a zero or other previously earned score. However, if you earned a poor score on some of the objectives, the make-up is a good way to try to get those missed points. The make-up is available for everyone. There will be only **one** make up offered. If you miss the final or a test, you can take the make up as a test or final, but will not have the chance at a "regular" make up. An additional make up for extenuating circumstances are at the discretion of the lab director and require documentation.

**Concealed Carry:** Individuals who choose to carry concealed handguns **are solely responsible to do so in a safe and secure manner in strict conformity with [state and federal laws](#) and [KU weapons policy](#).** Safety measures outlined in the KU weapons policy specify that a concealed handgun:

- Must be under the constant control of the carrier.
- Must be out of view, concealed either on the body of the carrier, or backpack, purse, or bag that remains under the carrier's custody and control.
- Must be in a holster that covers the trigger area and secures any external hammer in an un-cocked position
- Must have the safety on, and have no round in the chamber.

Instructors are allowed by Kansas Board of Regents policy, to require backpacks, purses and other bags be placed away from students during exams and quizzes, and as such those items will not be under the constant control of the individual. Laboratory courses take place in spaces that require students to leave belongings such as backpacks and purses away and unattended for the duration of class time. Students who choose to carry a concealed handgun in a purse, backpack, or bag must review and plan each day accordingly, and are responsible for making alternate arrangements as necessary. Neither the university nor the department provides appropriate secured storage for concealed handguns. Individuals who violate the KU weapons policy may be asked to leave campus with the weapon and may face disciplinary action under the appropriate university code of conduct.

**Where to Hand Things in:** Lab reports for the introductory Physics courses go in ***wooden drop boxes on the wall near the drinking fountain at the north end of the 2nd floor hallway, closest to room 2070.*** Other instructors may specify alternate procedures about handing work in, such as asking you to put papers into their mailbox. Mailboxes are all in the Department office, 1082 Malott. Turn to your left as you enter the main office, and you'll see a rack of wooden mail boxes. Faculty boxes are towards the right end. If you need something date-stamped before you turn it in, or aren't sure how to find the correct mailbox, ask one of the office staff for help.

**Tutoring:** Location: Malott 2057 (hours to be determined). The Department keeps a list of names of persons who arrange for private tutoring; the list can be found inside the Department office. **You may not contract with someone who is grading your work for a class or is your TA for a lab.**

**Departmental Assessments and Awards:** All courses, including our laboratory courses, are assessed by surveys at the end of the semester. Your constructive criticisms are very important. Teaching Assistants may receive awards based on student comments, and there is an award given to a teaching faculty member each spring as well. Watch for nomination materials near the end of the semester.

**Academic Misconduct, Fairness and Privacy Issues:** Any work presented as your own, must be your own. Beyond the obvious requirements that quizzes and tests must be completed without consultation or conversation with classmates, this also applies to homework (it must be your work, and identifiable as your own work, even if you have studied with friends) and to term papers, in which published material must be properly attributed. Penalties imposed by the College for violations of these policies range from reduction of grade, to suspension and expulsion.

The complementary issue to misconduct is fairness; you have a right to expect that your work is evaluated fairly and impartially. You may also expect to have adequate feedback about your performance in the course throughout the semester. You have a right to know, in advance, the criteria by which grades are determined in the class. Any concerns you have about the fairness with which your work is evaluated ought to be addressed to your instructor and, if necessary, to the Department chair or associate chair.

You also have a right to expect protection of your privacy -- for that reason, your grade cannot be given out over the telephone or by email, and can only be given by our office staff if you have your ID with you.

**University Policies Concerning Consenting Relationships:** University policy and accepted professional standards of ethics mean that there should be no romantic or sexual relationships between a student and an instructor (this includes faculty and teaching assistants) with grading or supervisory authority over that student. The university also has strong rules prohibiting ethnic, racial, sexual or gender identity harassment. The Department of Physics and Astronomy is committed to a safe, equitable learning environment and equitable and respectful treatment for all of our students, and we stand firmly behind these rules. Further information can be found in the student handbook at:

<http://www.studenthandbook.ku.edu/>. More information about KU rules is at <http://policy.ku.edu/IOA/nondiscrimination>

**Students with Disabilities:** The staff of Disability Services (part of the Academic Achievement and Access Center) 22 Strong, (785) 864-2620, coordinates accommodations and services for KU courses. If you have a disability for which you may request accommodation in KU classes and have not contacted them, please do as soon as possible. Please also see the professor privately in regards to that particular course.

**Student Organizations:** Successful completion of a challenging major is more likely if you develop friendships and connections with others in your discipline. There are three organizations designed for student participation: Society of Physics Students (SPS), Hawkworks for Engineering Physics, and Astronomy Associates of Lawrence (AAL)

**If You Have Problems or Concerns:** You should feel free to consult ANY faculty member of this Department if you have any questions or concerns about possible misconduct or harassment on the part of any member of the Department. A full list of faculty names and office numbers is available from the office staff or at <http://www.physics.ku.edu/faculty/>. Concerns may always be brought to the Undergraduate Coordinator as well, for further help or delegation.

# Honors and Awards for Undergraduates

## The University Honors Program

The University Honors Program offers special, smaller and deeper “honors” sections of many classes and additional enrichment programs to students identified as gifted and well prepared. Incoming freshmen and transfer students may be offered admission to the University Honors Program; it is also possible for current students to apply to the UHP. Opportunities include early enrollment and access to smaller, more advanced class sections. Requirements include participation in honors-designated courses or other activities. Several of the courses designed for our majors are also designated honors courses and open to students in the UHP; these include PHSX 213, PHSX 214, ASTR 391 and PHSX/EPHX 501

## And now, something distinct -- Departmental Honors

A student who plans to graduate with departmental honors in engineering physics, or physics & astronomy, must file a ***Declaration of Intent Form*** with the Departmental Honors Coordinator, preferably during his/her junior year but in any case no later than enrollment for the final undergraduate semester. All of our department’s honors requirements include student research, for which results shall be presented in at least one of the following forms:

- a written research summary, read by three faculty members in physics & astronomy or closely related fields, or authorship on a peer-reviewed manuscript;
- a research-based oral presentation at an appropriate venue (e.g., Undergraduate Research Symposium, presentation in an advanced departmental seminar class, a discipline-specific regional or national meeting;
- presentation of a research-based poster at an appropriate venue.

Presentations or posters designed to fulfill requirements for coursework in the major are not typically suitable for this requirement.

Additional requirements for engineering physics and CLAS majors (physics and astronomy) follow:

**Physics and Astronomy:** Qualified students earning either a B.A. or a B.S. degree in the College of Liberal Arts and Sciences with a major in astronomy or physics may graduate with Honors in Physics & Astronomy by fulfilling the following requirements: (1) By the end of the candidate's final semester, achieve a minimum GPA of 3.25 overall and 3.5 in the major, in all courses taken in residence and elsewhere; (2) Complete at least 24 semester hours of astronomy and physics courses numbered 500 or above, including undergraduate research represented by two hours of credit in ASTR 597, ASTR 503, PHSX 501 or PHSX 503. A grade of B or better must be earned in ASTR 597, 503, PHSX 501 or 503 to count towards this requirement; the research results must be presented in one of the ways described above.

**Engineering Physics:** Qualified students earning a B.S. in engineering physics may graduate with Departmental Honors by fulfilling the following requirements: (1) By the end of the candidate’s final semester, achieve a minimum GPA of 3.5 in major courses taken in residence and elsewhere; (2) complete at least 1 credit hour of undergraduate research as represented by achievement of a grade of B or better in PHSX/EPHX 501 or 503. This requirement is subject to the reporting requirement described above

**N. Wyman Storer Award For Service To Astronomy:** This award, a memorial to the late *Professor N. Wyman Storer*, is presented to the senior in the Department expected to graduate in May or the following December who has provided services to the astronomy program at the University of Kansas in excess of what can be expected of a good student or has an outstanding record as a student in Astronomy. The Director of the *Tombaugh Observatory* and another faculty member shall select the recipient and report their selection to the Committee on Undergraduate Studies.

**Stranathan Award:** A gift by the late *Professor James D. Stranathan* enables the Department to designate its outstanding senior-to-be physics major as a recipient of the *Stranathan Award* which includes a cash stipend for each of the students' remaining two semesters. The award is based primarily on the student's overall grade point average. The recipient must (1) have completed sufficient work to be classified officially as a senior, (2) have somewhat more than one semester's work remaining for the Bachelor's degree, (3) have at least 30 semester-hours of credit for work taken at the University of Kansas, and (4) have at least ten semester – hours credit in physics courses open only to juniors and seniors taken at the University of Kansas.

**Francis W. Prosser Award:** This award, established through the generosity of the late Professor Frank Prosser, is given annually to a major in physics or engineering physics with at least 30 but no more than 59 credit hours completed after the spring term, and an overall GPA of 3.5 or better.

**Tombaugh Scholarship:** Alumni of the astronomy program have generously contributed to the Clyde W. Tombaugh Fund, enabling a scholarship for students majoring in astronomy.

**Badgley Scholarship:** Mrs. Esther Weik Badgley has funded a scholarship to support the study of a young woman studying physics or a related field. This renewable scholarship will normally be awarded to an incoming freshman student in the department.

**Feaster Scholarship:** Dr. Gene Feaster (KU, 1940) has generously endowed a fund to enable tuition support for a meritorious undergraduate physics student. Additional criteria for the Feaster Scholarship include selection from declared majors poised to begin 3<sup>rd</sup> year physics coursework and a preference extended to native Kansans as indicated by the wishes of the donor. This scholarship may be renewed for eligible recipients. Continuing eligibility requirements include maintenance of an overall GPA of 3.25 or better as well as making appropriate progress in the major curriculum.

**Talty Scholarship:** Thanks to a provision in the estate of Dorothy and Robert Talty, a fund has been established to support undergraduate students studying physics. This scholarship may be renewed for eligible recipients. Continuing eligibility requirements include maintenance of an overall GPA of 3.25 or better as well as making good progress in the major curriculum.

**Other Honors Or Awards:** Opportunities for off-campus awards such as the national annual Society of Physics Students/Sigma Pi Sigma Scholarship and other opportunities for honors, awards, scholarships, etc. for undergraduates that become available will be responded to by the Committee on Undergraduate Studies. The Committee will disseminate the information about such awards and consult those members of the faculty who may have special knowledge of the students being considered so that they can make appropriate recommendations.



## Advanced Placement Credit in Physics

### Exam – Physics 1

<b>AP Grade</b>	KU equivalent credit awarded :
4-5	4 credit hrs PHSX 114

### Exam – Physics 2

<b>AP Grade</b>	KU equivalent credit awarded :
4-5	4 credit hrs PHSX 115

### Exam – Physics C - Mechanics

<b>AP Grade</b>	KU equivalent credit awarded :
4 - 5	4 credit hrs, PHSX 211, 1 credit hr PHSX 216

### Exam – Physics C – Electricity & Magnetism

<b>AP Grade</b>	KU equivalent credit awarded
4 - 5	3 credit hrs, PHSX 212, 1 credit hr PHSX 236

## International Baccalaureate Program Credit in Physics

<b>IB Grade</b>	KU equivalent credit awarded :
HL 5, 6, or 7	8 credit hrs, PHSX 114 and 115.
SL 5, 6, or 7	3 credit hrs, PHSX 111

## DANTES Subject Tests Program

The University of Kansas awards equivalent credit to students who receive appropriate scores in the DANTES Subject Tests program. At present, established credit equivalences include:

<b>Dantes Grade</b>	Subject Area:	KU equivalent credit awarded
<input type="checkbox"/> 48	Astronomy	3 credit hours, Astronomy 191

## Credit by Examination Policy

In principle, University rules permit students to seek credit by examination. Here's what is laid out at the University level:

The Registrar's Office assesses a fee for any attempt by a student for credit by examination (CbyE).

- ❑ The student may NOT be enrolled in the class for which they seek credit
- ❑ may not have previously completed the class here or elsewhere,
- ❑ may not have taken courses ABOVE the desired course in the same department or field.

In addition, it is important to know that some medical schools will NOT accept credit for physics courses obtained by examination.

Beyond those general rules, authority rests with departments and the Dean of CLAS to assign a grade and credit hours that result from a successful examination.

The department of physics and astronomy sets the following additional guidelines:

- ❑ Students requesting CbyE should plan to provide some basis for a prior **university-level** course in the material for the course
- ❑ We don't offer CbyE for PHSX 111 or ASTR 191; these courses are not taught to fixed syllabi and do not routinely include a comprehensive final. If a student has a reasonable case for a course taken elsewhere at a university level, the approach to take is more properly to request transfer credit. Please consult your adviser or the director of undergraduate studies (Prof. Graham Wilson) or the chair of the undergraduate committee (Prof. Michael Murray)
- ❑ The mechanism will be for students to take the comprehensive final set by the current semester's instructors at the end of the semester at the time and place that the final is administered for that course. Students should expect to provide photo identification at the time of the examination.
- ❑ We cannot award laboratory credit by this mechanism, so students required to complete the 4 credit hours courses PHSX 114, 115, 211, or 212, will still be short the required laboratory credit in the event of a successful CbyE.

## Bachelor of Arts in Astronomy

<b>KU Core requirements not met by major requirements (~24 credits or equivalent experiences)</b>		<b>Estimated Hours</b>
Goal 2	Written (2 units) and Oral Communication (1 unit)	9
Goal 3A 3B	Fundamental knowledge in Humanities, Social Sciences (1 unit each area)	6
Goal 4	Human Diversity and Cultural Understanding and Global Awareness (2 units)	6
Goal 5	Social responsibility and ethical behavior (1 unit)	3
<i>Goals 1 &amp; 3C</i>	<i>Met by foundational courses in mathematics and physics</i>	

<b>CLAS BA requirements not met by major requirements:</b>		<b>Hours</b>
Foreign Language	Fourth semester proficiency or 3 <sup>rd</sup> semester proficiency plus one semester of another foreign language	16
Writing Courses	Credit (not exemption) for TWO writing courses: <ul style="list-style-type: none"> <li>• If not exempt from ENGL 101 due to ACT/SAT score, then this is fulfilled by completing ENGL 101 AND ENGL 102</li> <li>• If exempt from ENGL 101 due to ACT/SAT score, then this is fulfilled by completing ENGL 102/105 AND ENGL 203/205/211 or other Goal 2.1 approved course.</li> </ul>	6

<b>Additional general science requirement:</b>		<b>Hours</b>
Chemistry	CHEM 130, Foundations of Chemistry I or CHEM 170, Chemistry for the Chemical Sciences or CHEM 190 Foundations of Chemistry I, Honors together with CHEM 191 Foundations of Chemistry I Laboratory, Honors.	5

<b>Foundational Mathematics (8 credits)</b>		<b>Hours</b>
MATH 125	Calculus I	4
MATH 126	Calculus II	4

<b>Foundational Physics for major (9.5 credits)</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy and Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4

<b>Astronomy requirements for major (11 credits, all at jr/sr level)</b>		<b>Hours</b>
ASTR 391	Physical Astronomy	3
ASTR 591	Stellar Astronomy	3
ASTR 596	Observational Astrophysics	2
ASTR 592	Galactic & Extragalactic Astronomy	3

<b>Additional astronomy, astrophysics or physics coursework required for major</b>		<b>Hours</b>
In addition to the above specifically required courses, Astronomy BA candidates must complete <u>at least 5 additional credits</u> in physics or astronomy at the 300+ level. Students may enroll in ASTR 390 for undergraduate problems for 1 or more credit hours and in ASTR 503 (501 honors) for research credit. ASTR 394 is highly recommended. Other recommended courses include ASTR 691 and 692, PHSX 594, GEOL 572, PHSX 313/316 and other PHSX courses 500 and above; most of these course have pre-requisites that may require additional preparation in mathematics and/or physics.		≥ 5

**Additional Notes:**

- Students may satisfy the Integrative Knowledge (Goal 6) requirement by
  - participating in research for credit (ASTR 501/503) in addition to ASTR 596 completion
  - satisfying requirements for more than one major or a major and minor combination
  - satisfying requirements for Research Experience Certification
- 24 credits in the major are required by Regents' rules for a major. The Foundational Physics and Astronomy requirements total 25.5 credits at minimum.
- 120 credits are required for graduation, of which 45 must be at junior/senior level (courses numbered 300 or higher). Specific requirements for the astronomy BA include at least 16 jr/sr credit hours; students must take 29 additional credit hours at the junior senior level to satisfy the regents' requirement.

## Suggested Schedule B.A. Astronomy

Fall Semester

Spring Semester

### Freshman Year

MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
KU Core Goal 2, outcome 1	3	KU Core Goal 2, outcome 1	3
CHEM 130, <i>General Chemistry I</i> or <b>CHEM 170</b> , <i>Chemistry for the Chem. Sci. I</i>	5	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213</b> , <i>General Physics I, honors</i> (majors are encouraged to take 213)	5
<b>PHSX 150</b> , <i>Seminar in Physics, Astronomy &amp; Engineering Physics</i>	0.5		
Electives/KU Core	3	Electives/KU Core	3
	<b>15.5</b>		<b>15</b>

### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214</b> , <i>General Physics II, honors</i>	4	<b>ASTR 391</b> , <i>Physical Astronomy</i>	3
Foreign Language 1	5	Electives/KU Core	6
KU Core Goal 2, outcome 2	3	Foreign Language II	5
Elective/KU Core	3		
	<b>15</b>		<b>14</b>

### Junior Year

<b>ASTR 591</b> or astronomy elective	3	<b>ASTR 592</b> or astronomy elective	3
<b>**ASTR 596</b> , <i>Observational Astrophysics</i>	2	ASTR 390	1
Foreign Language III	3	Foreign Language IV	3
Elective/KU Core	6	Elective/KU Core	3
<b>**ASTR 596</b> will be offered in fall semesters of odd-numbered years.	<b>14</b>		<b>16</b>

### Senior Year

<b>ASTR 591</b> or astronomy elective	3	<b>ASTR 592</b> or astronomy elective	3
Elective/KU Core	12	Elective/KU Core	9-12
	<b>15</b>		<b>12-15</b>

**Courses that are only offered in semester listed are annotated in boldface type.**

## Bachelor of Science in Astronomy

<b>KU Core requirements not met by major requirements (~24 credits or equivalent experiences)</b>		<b>Hours</b>
Goal 2	Written (2 units) and oral communication (1 unit)	9
Goal 3A 3B	Fundamental knowledge in Humanities, Social Sciences	6
Goal 4	Human Diversity and Cultural Understanding and Global Awareness	6
Goal 5	Social responsibility and ethical behavior	3
<i>Goals 1 &amp; 3C</i>	<i>Met by foundational courses in chemistry, mathematics and physics</i>	

<b>Foundational Physics &amp; Mathematics (17.5 credits)</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy & Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
MATH 125	Calculus I	4
MATH 126	Calculus II	4

<b>General Science Requirements (8 to 9 credits)</b>		<b>Hours</b>
Chemistry	CHEM 130, Foundations of Chemistry I or CHEM 170, Chemistry for the Chemical Sciences or CHEM 190 Foundations of Chemistry I, Honors together with CHEM 191 Foundations of Chemistry I Laboratory, Honors.	5
Computer Sci.	EECS 138 (3), Intro. to Computing or EECS 168 (4) Programming I	3-4

<b>Advanced Mathematics (12 credits, 3 – 6 at jr/sr level)</b>		<b>Hours</b>
MATH 127	Calculus III	4
MATH 290	Elementary Linear Algebra	2
MATH 320	Elem. Differential Equations.	3
<b>Math elective</b>	<b>ONE Course from the following list PHSX 518, 718, MATH 465, 526, 530, 558, 581, 590, 628, 646, 647, 648, 660, 661, OR any 700-level MATH lecture course except for MATH 701 and 715.</b>	3

<b>Advanced Physics requirements for major (23 credits, all at jr/sr level)</b>		<b>Hours</b>
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory (with or after PHSX 313)	1
PHSX 511	Intro. Quantum Mechanics	3
PHSX 516 or 536	Physical Measurements or Electronic Circuits & Measurements	4
PHSX 521	Mechanics I	3
PHSX 531	Electricity & Magnetism	3
PHSX 671	Thermal Physics	3
PHSX elective	Any physics lecture or laboratory course at 500 level or higher. PHSX 693 is recommended. GEOL 572 , PHSX/ASTR 792 and 795 are also accepted for this requirement. <b>PHSX 594 will not be accepted for BS astronomy majors to fulfill this elective requirement.</b>	3

<b>Astronomy requirements for major (18 credits, all at jr/sr level)</b>		<b>Hours</b>
ASTR 391	Physical Astronomy	3
ASTR 503	Undergraduate Research. 1 credit is required for major; more may be taken. More than 1 credit of research may be required for departmental honors.	1
ASTR 591	Stellar Astronomy	3
ASTR 596	Observational Astrophysics	2
ASTR 592	Galactic & Extragalactic Astronomy	3
ASTR 691	Astrophysics I	3
ASTR 692	Astrophysics II	3

## **Additional Notes:**

These requirements total 103.5 -104.5 credit hours assuming that each KU core requirement is met by 3 credit classes. 120 credits are now required for graduation, so 16.5 to 17.5 is left for elective choices. The specific requirements include 47 jr/sr course credits so the Regents requirements for 45 jr/sr credits is met by degree-specific requirements.

ASTR 596 will be taught in odd-numbered fall semesters concurrent with ASTR 591.

Students who wish to major in both physics and astronomy must meet the requirements of both degrees, plus the additional requirement that 15 credit hours must be completed that are unique to each degree.

Fulfillment of the Integrative Knowledge (Goal 6) core requirement will be met by

- completion of ASTR 596 and at least one credit of research in astronomy (ASTR 503 or 501, honors)
- completion of requirements for this major in addition to those of another major or minor program
- completion of requirements for the Research Certification (REP) program.

## Suggested Schedule B.S. Astronomy

### Fall Semester

### Spring Semester

#### Freshman Year

MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
<b>PHSX 150</b> , <i>Seminar in Physics, Astronomy &amp; Engineering Physics</i>	0.5	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i>	5
CHEM 130, <i>General Chemistry I</i> or <b>CHEM 170</b> , <i>Chemistry for the Chem. Sci. I</i>	5	or <b>PHSX 213</b> , <i>General Physics I, honors</i> (majors are encouraged to take 213)	
Elective/ KU Core	6	Elective/KU Core	6
	<b>15.5</b>	KU Core Goal 2, outcome 1	<b>15</b>

#### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214</b> , <i>General Physics II, honors</i>	4	MATH 320, <i>Differential Equations</i>	3
		PHSX 313, <i>General Physics III</i>	3
MATH 290, <i>Elem. Linear Algebra</i>	2	PHSX 316, <i>Intermediate Physics Lab</i>	1
MATH 127, <i>Calculus III</i>	4	Elective/KU Core	6
EECS 138, <i>Intro to Computing</i> or EECS 168, <i>Programming I</i>	3-4	<b>ASTR 391</b> , <i>Physical Astronomy</i>	3
Elective/KU Core	3		
	<b>16-17</b>		<b>16</b>

#### Junior Year

<b>PHSX 521</b> , <i>Mechanics I</i>	3	<b>PHSX 511</b> , <i>Intro. Quantum Mechanics</i>	3
Math elective	3	Elective/KU Core	6
<b>ASTR 591 and 596</b> or <b>691 and</b> elective	5/6	<b>ASTR 592/692</b>	3
<b>PHSX 516</b> , <i>Physical Measurements</i> or electives	4	<b>PHSX 536</b> , <i>Elec. Circ. Meas. &amp; Design</i> or electives (Astronomy B.S. majors take PHSX 536 or 516)	4/3
	<b>15/16</b>		<b>16/15</b>

#### Senior Year

<b>PHSX 671</b> , <i>Thermal Physics</i>	3	ASTR 503, <i>Undergraduate Research</i>	1
<b>PHSX 531</b> , <i>Electricity &amp; Magnetism</i>	3	<b>ASTR 592/692</b>	3
<b>ASTR 691 and</b> elective or <b>591+596</b>	6/5	Elective/KU Core	9
Elective/KU Core	3	PHSX elective	3
	<b>15/14</b>		<b>16</b>

**Courses that are only offered in semester listed are annotated in boldface type.**



## Bachelor of Arts in Physics

<b>KU Core requirements not met by major requirements (~24 credits or equivalent experiences)</b>		<b>Estimated Hours</b>
Goal 2	Written (2 units) and Oral Communication (1 unit)	9
Goal 3A 3B	Fundamental knowledge in Humanities, Social Sciences (1 unit each area)	6
Goal 4	Human Diversity and Cultural Understanding and Global Awareness (2 units)	6
Goal 5	Social responsibility and ethical behavior (1 unit)	3
Goals 1 & 3C	<i>Met by foundational courses in mathematics and physics</i>	

<b>CLAS BA requirements not met by major requirements:</b>		<b>Hours</b>
Foreign Language	Fourth semester proficiency or 3 <sup>rd</sup> semester proficiency plus one semester of another foreign language	16
Writing Courses	Students must complete six credit hours (two courses) of collegiate writing-level instruction. Students must complete ENGL 101, Composition and ENGL 102/ENGL 105, Critical Reading and Writing /Freshman Honors English.  Students who place in ENGL 102/ENGL 105 by examination, must complete ENGL 102/ENGL 105 and another course meeting Goal 2, Learning Outcome 1 of the KU Core.	6

<b>Foundational Physics &amp; Mathematics (17.5 credits)</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy & Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
MATH 125	Calculus I (MATH 145 is honors equivalent)	4
MATH 126	Calculus II (MATH 146 is honors equivalent)	4

<b>Advanced Physics requirements for major (20 credits)</b>		<b>Hours</b>
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Lab (take with or after PHSX 313)	1
PHSX 511	Intro. Quantum Mechanics	3
PHSX 521	Mechanics I	3
PHSX 531	Electricity & Magnetism	3
PHSX 516 or PHSX 536	Physical Measurements or Electronic Circuit Measurement & Design	4
PHSX elective	Any physics lecture or laboratory course numbered 500 or higher	3

<b>Advanced Mathematics requirements for major (9 credits)</b>		<b>Hours</b>
MATH 127	Calculus III (MATH 147 is honors equivalent)	4
MATH 290	Elementary Linear Algebra (MATH 291 is honors equivalent)	2
MATH 220 or 320	Applied or Elementary Differential Equations. (MATH 221 is honors equivalent)	3

### Additional Notes:

- Students may satisfy the Integrative Knowledge (Goal 6) KU Core requirement by
  - satisfying requirements for more than one major or a major and minor combination
  - taking PHSX 601 as the elective
  - satisfying requirements for Research Experience Certification
- 120 credits are required for graduation, of which 45 must be at junior/senior level (courses numbered 300 or higher). Specific requirements for this major comprise 109.5 credit hours, including 20 jr/sr credit hours (increased by 3 if MATH 320 is taken). Students must take 22 to 25 additional hours as electives at the jr/sr level to satisfy this regents' requirement.
- The department also offers a Bachelor of Arts in Computational Physics. These requirements are listed in the Undergraduate Catalog of the University.

## Suggested Schedule B.A. Physics

Fall Semester

Spring Semester

### Freshman Year

MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
ENGL 101, <i>Composition</i>	3	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213, <i>General Physics I, honors</i></b> (majors are encouraged to take 213)	5
<b>PHSX 150, <i>Seminar in Physics &amp; Astronomy &amp; Engineering Physics</i></b>	0.5	Elective/KU Core	6
CHEM 130, <i>General Chemistry I</i>	5		
Elective/KU Core	3		
	<b>15.5</b>		<b>15</b>

### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214, <i>General Physics II, honors</i></b>	4	PHSX 313, <i>General Physics III</i>	3
Elective/KU Core	3	PHSX 316, <i>Intermediate Physics Lab</i>	1
MATH 127, <i>Calculus III</i>	4	MATH 220 or 320, <i>Differential Equations</i>	3
MATH 290, <i>Linear Algebra</i>	2	Foreign Language II	5
Foreign Language I	5	Elective/KU Core	3
	<b>18</b>		<b>15</b>

### Junior Year

<b>PHSX 521, <i>Mechanics I</i></b>	3	<b>PHSX 511, <i>Intro Quantum Mechanics</i></b>	3
Foreign Language III	3	PHSX 536, <i>Elect. Circuits Measurement. &amp; Design</i> or Elective/KU Core	3-4
Elective/KU Core	9	Foreign Language IV	3
		Elective/KU Core	6
	<b>15</b>		<b>15-16</b>

### Senior Year

<b>PHSX 531, <i>Electricity &amp; Magnetism</i></b>	3	Physics elective course	3
PHSX 516, <i>Physical Measurements</i> or Elective/KU Core	3-4	Elective/KU Core	12
Elective/KU Core	9		
	<b>15-16</b>		<b>15</b>

**Courses that are only offered in the semester listed are annotated in boldface type.**

## **Bachelor of Science in Physics (Common Requirements)**

<b>KU Core requirements not met by major requirements (~24 credits or equivalent experiences)</b>		<b>Hours</b>
Goal 2	Written (2 units) and oral communication (1 unit)	9
Goal 3A 3B	Fundamental knowledge in Humanities, Social Sciences	6
Goal 4	Human Diversity and Cultural Understanding and Global Awareness	6
Goal 5	Social responsibility and ethical behavior	3
<i>Goals 1 &amp; 3C</i>	<i>Met by foundational courses in chemistry, mathematics and physics</i>	

<b>Foundational Physics &amp; Mathematics (17.5 credits)</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy and Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
MATH 125	Calculus I (MATH 145 is the honors equivalent)	4
MATH 126	Calculus II (MATH 126 is the honors equivalent)	4

<b>General Science Requirements (5 credits)</b>		<b>Hours</b>
Chemistry	CHEM 130 (or 150 or 170 or 190&191) General Chemistry I	5

<b>Advanced Mathematics (9 credits)</b>		<b>Hours</b>
MATH 127	Calculus III (MATH 147 is the honors equivalent)	4
MATH 290	Elementary Linear Algebra (MATH 291 is the honors equivalent)	2
MATH 320	Elem. Differential Equations.	3

<b>Advanced Physics required for all options (17 credits)</b>		<b>Hours</b>
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory (with or after PHSX 313)	1
PHSX 511	Intro. Quantum Mechanics	3
PHSX 521	Mechanics I	3
PHSX 531	Electricity & Magnetism	3
PHSX 671	Thermal Physics	3
PHSX research	PHSX 503, Undergraduate Research, or 501 (Honors). 1 credit is required for majors; more may be taken. More than 1 credit of research may be required for departmental honors	1

**B.S. Physics candidates select one of the following options:**  
**Pre-professional, Interdisciplinary, or Pre-medicine**

<b>Pre-Professional Option Requirements (26-27 credits)</b>		<b>Hours</b>
PHSX 621	Mechanics II	3
PHSX 631	Electromagnetic Theory	3
PHSX 711	Quantum Mechanics	3
PHSX 516	Physical Measurements	4
PHSX 536	Electronic Circuits & Measurements	4
PHSX elective	Any physics lecture or laboratory course numbered 500 or higher and <b>not part</b> of other specific requirements for the major.	3
Math elective	<b>ONE</b> Course from the following list PHSX 518, 718, MATH 526, 530, 558, 581, 590, 628, 646, 647, 648, 660, 661, <b>OR</b> any 700-level MATH lecture course except for MATH 701 and 715.	3
Computer Science	EECS 138 (3), Intro. to Computing or EECS 168 (4) Programming I	3-4

<b>Interdisciplinary Option Requirements (25 to 29 credits)</b>		<b>Hours</b>
Advanced Laboratory	PHSX 516, Physical Measurements or PHX 536 Electronic Circuits & Measurements	4
Advanced Physics Elective	<b>TWO</b> of: PHSX 621, PHSX 631, PHSX 711, PHSX 516/536. Note that PHSX 516/536 cannot count as one of the electives if it is already counted toward the advanced laboratory elective	6-7
PHSX elective	Any physics lecture or laboratory course numbered 500 or higher and <b>not part</b> of other specific requirements for the major.	3
Math elective	<b>ONE</b> Course from the following list PHSX 518, 718, MATH 465, 526, 530, 558, 581, 590, 628, 646, 647, 648, 660, 661, <b>OR</b> any 700-level MATH lecture course except for MATH 701 and 715.	3
Computer Science	EECS 138 (3), Intro. to Computing or EECS 168 (4) Programming I	3-4
Interdisciplinary science electives	Two semesters coursework in an allied science at 300-level or higher. Students must meet any prerequisites for these courses as part of elective hours. Courses approved to date are:	6-8
	CHEM 598, 622 or 646 (CHEM 598 open only to UKanTeach students)	
	BIOL 350, 400, 408, 412, 416, 600, 636, 638	
	GEOL 360, 562, 572, 575, 576, 577	
	EECS 622, 628, 670, 713, 721, 728	

<b>Pre-Medicine Option Requirements (56 to 60 credits)</b>		<b>Hours</b>
Advanced Laboratory	PHSX 516, Physical Measurements or PHX 536 Electronic Circuits & Measurements	4
Introductory Biology	BIOL 150, Principles of Molecular and Cellular Biology	4
	BIOL 152, Principles of Organismal Biology	4
Genetics	BIOL 350, Principles of Genetics	4
	BIOL 595, Human Genetics	3
Advanced Biology	BIOL 400, Fundamentals of Microbiology	3
	BIOL 503, Immunology	3
	BIOL 546, Mammalian Physiology	3
Biochemistry	BIOL 600 Introductory Biochemistry or BIOL 636 Biochemistry I	3-4
	BIOL 601, Principles of Biochemistry Laboratory or BIOL 637 Introductory Biochemistry Laboratory	2
Chemistry	CHEM 135 (or 175 or 195&196), General Chemistry II	5
	CHEM 330, Organic Chemistry I	3
	CHEM 331, Organic Chemistry I Laboratory	2
	CHEM 335, Organic Chemistry II	3
	CHEM 336, Organic Chemistry II Laboratory	2
	CHEM 520, Biological Physical Chemistry with Laboratory, or CHEM 530, Physical Chemistry I together with CHEM 537, Physical Chemistry Laboratory	5 - 7
Elective	Any BIOL, MATH, or PHSX course above 400 level	3-4
Social Sciences	SOC 104 and PSYC 104 are recommended, but not required. Both courses can satisfy requirements of the KU Core.	

#### **Additional Notes:**

- Students may satisfy the Integrative Knowledge (Goal 6) KU Core requirement by
  - satisfying requirements for more than one major or a major and minor combination
  - taking PHSX 601 as the elective
  - satisfying requirements for Research Experience Certification
- Specific requirements for the physics B.S. comprise 101.5 to 102.5 credits for the pre-professional option, 100.5 to 104.5 credits for the interdisciplinary option, and 104.5 to 108.5 for the pre-medicine option, leaving 14.5 to 11.5 credits usable for elective courses; 120 credits are presently required for bachelor's degrees.
- Specific requirements for this degree include a minimum of 42 credit hours at the junior/senior level if MATH 320 is taken as recommended. A few additional hours of elective coursework at the junior/senior level may be required to meet the separate requirement set by the Regents for 45 credit hours of junior/senior coursework.

## Suggested Schedule B.S. Physics, Pre-Professional Option

### Fall Semester

### Spring Semester

#### Freshman Year

MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
CHEM 130, <i>General Chemistry I</i>	5	Elective/KU Core	3
<b>PHSX 150</b> <i>Seminar in Physics, Astronomy &amp; Engineering Physics</i>	0.5	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213</b> , <i>General Physics I, honors</i> (majors are encouraged to take 213)	5
Elective/KU Core	6	Elective/KU Core	3
	<b>15.5</b>		<b>15</b>

#### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214</b> , <i>General Physics II, honors</i>	4	MATH 320, <i>Differential Equations</i>	3
MATH 290, <i>Elem. Linear Algebra</i>	2	PHSX 501/503 <i>Undergrad Research</i>	1
MATH 127, <i>Calculus III</i>	4	PHSX 313, <i>General Physics III</i>	3
EECS 138, <i>Intro to Computing</i> or EECS 168, <i>Programming I</i>	3-4	PHSX 316, <i>Intermediate Physics Lab</i>	1
Elective/KU Core	3	Elective/KU Core	6
	<b>16-17</b>		<b>14</b>

#### Junior Year

<b>PHSX 521</b> , <i>Mechanics I</i>	3	<b>PHSX 511</b> , <i>Intro. Quantum Mechanics</i>	3
Math elective	3	<b>PHSX 621</b> , <i>Mechanics II</i>	3
<b>PHSX 516</b> , <i>Physical Measurements</i>	4	<b>PHSX 536</b> , <i>Elec. Circ. Meas. &amp; Design</i>	4
Elective/KU Core	6	Elective/KU Core	6
	<b>16</b>		<b>16</b>

#### Senior Year

<b>PHSX 711</b> , <i>Quantum Mechanics</i>	3	<b>PHSX 631</b> , <i>Electromagnetic Theory II</i>	3
<b>PHSX 531</b> , <i>Electricity &amp; Magnetism</i>	3	PHSX elective	3
<b>PHSX 671</b> , <i>Thermal Physics</i>	3	Elective/KU Core	10-11
Elective/KU Core	6		
	<b>15</b>		<b>16-17</b>

**Courses that are only offered in the semester listed are annotated in boldface type.**

## Suggested Schedule B.S. Physics, Interdisciplinary Science Option

### Fall Semester

### Spring Semester

#### Freshman Year

MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
CHEM 130, <i>General Chemistry I</i>	5	Elective/KU Core	3
<b>PHSX 150 Seminar in Physics, Astronomy &amp; Engineering Physics</b>	0.5	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213, <i>General Physics I, honors</i></b> (majors are encouraged to take 213)	5
Elective/KU Core	6	Elective/KU Core	3
	<b>15.5</b>		<b>15</b>

#### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214, <i>General Physics II, honors</i></b>	4	MATH 320, <i>Differential Equations</i>	3
MATH 290, <i>Elem. Linear Algebra</i>	2	General Science background (further chemistry, intro. Biology or geology)	3-5
MATH 127, <i>Calculus III</i>	4	PHSX 313, <i>General Physics III</i>	3
EECS 138, <i>Intro to Computing</i> or EECS 168, <i>Programming I</i>	3-4	PHSX 316, <i>Intermediate Physics Lab</i>	1
Elective/KU Core	3	Elective/KU Core	3
		PHSX 501/503 <i>Undergrad Research</i>	1
	<b>16-17</b>		<b>14-16</b>

#### Junior Year

<b>PHSX 521, <i>Mechanics I</i></b>	3	<b>PHSX 511, <i>Intro. Quantum Mechanics</i></b>	3
Math elective	3	Elective/KU Core	9
Elective/KU Core	9	Physics lab or lecture (536, 621)	3-4
	<b>15</b>		<b>15-16</b>

#### Senior Year

Physics lab or lecture course (516,711)	3-4	Interdisciplinary science elective	3-4
<b>PHSX 531, <i>Electricity &amp; Magnetism</i></b>	3	PHSX elective	3
<b>PHSX 671, <i>Thermal Physics</i></b>	3	Physics course – lab or lecture (631,621,536)	3-4
Interdisciplinary science elective	3-4	Elective/ KU Core	6
Elective/KU Core	3		
	<b>15-17</b>		<b>15-17</b>

**Courses that are only offered in the semester listed are annotated in boldface type.**

## Suggested Schedule B.S. Physics, Pre-Medicine Option

### Fall Semester

### Spring Semester

#### Freshman Year

MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
PHSX 150 <i>Seminar in Physics, Astronomy &amp; Engineering Physics</i>	0.5	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213, <i>General Physics I, honors</i></b> (majors are encouraged to take 213)	5
CHEM 130, <i>General Chemistry I</i>	5		
BIOL 150, <i>Principles of Molecular and Cellular Biology</i>	4	CHEM 135, <i>General Chemistry II</i>	5
Elective/KU Core	3	Elective/KU Core	3
	<b>16.5</b>		<b>17</b>

#### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214, <i>General Physics II, honors</i></b>	4	MATH 320, <i>Differential Equations</i> , or MATH 220, <i>Applied Differential Equations</i>	3
MATH 127, <i>Vector Calculus</i>	4	PHSX 313, <i>General Physics III</i>	3
BIOL 152, <i>Principles of Organismal Biology</i>	4	CHEM 335 <i>Organic Chemistry II</i>	3
CHEM 330, <i>Organic Chemistry I</i>	3	CHEM 336 <i>Organic Chemistry II, Laboratory</i>	2
CHEM 331, <i>Organic Chemistry I, Laboratory</i>	2	BIOL 350, <i>Principles of Genetics</i>	4
		MATH 290, <i>Elem. Linear Algebra</i>	2
	<b>17</b>		<b>17</b>

#### Junior Year

PHSX 521, <i>Mechanics I</i>	3	PHSX 511, <i>Intro. Quantum Mechanics</i>	3
BIOL 595, <i>Human Genetics</i>	3	BIOL 400, <i>Fundamentals of Microbiology</i>	3
PHSX 316, <i>Intermediate Physics Lab</i>	1	BIOL 546, <i>Mammalian Physiology</i>	3
BIOL 600, <i>Introductory Biochemistry</i> or BIOL 636, <i>Biochemistry I</i>	3-4	PHSX 501 or PHSX 503, <i>Undergrad Research</i>	1
BIOL 601, <i>Principles of Biochemistry Laboratory</i> or BIOL 637, <i>Introductory Biochemistry Laboratory</i>	2	Elective/KU Core	4-6
Elective/KU Core	3-4		
	<b>15-17</b>		<b>14-16</b>

#### Senior Year

PHSX 531, <i>Electricity &amp; Magnetism</i>	3	BIOL 503, <i>Immunology</i>	3
PHSX 671, <i>Thermal Physics</i>	3	BIOL, MATH, or PHSX Elective (above 400 level)	3-4
CHEM 520, <i>Biological Physical Chemistry with Laboratory</i>	5	PHSX 516, <i>Physical Measurements</i>	4
Elective/KU Core	4-6	Elective/KU Core	4-8
	<b>15-17</b>		<b>14-19</b>



## **Engineering Physics Required Courses and Suggested Schedules**

Engineering Physics is a collaborative degree program between the School of Engineering and the Department of Physics and Astronomy. The Department of Physics and Astronomy has responsibility for management of the program, however, students intending to major in Engineering Physics must be accepted into the School of Engineering. The Bachelor of Science in Engineering Physics is offered in four design concentrations – Aerospace Systems, Chemical Systems, Digital Electronic Systems, and Electromechanical Control Systems. This section of the Handbook lists the required courses and offers suggested schedules for meeting the requirements of the different concentrations. The required credits vary slightly depending on the concentration chosen, but are each approximately 128 – 130 hours. All Engineering Physics degree concentrations meet or exceed the minimum requirements for math, science, engineering and engineering-related courses specified by ABET. Graduating with a BS in Engineering Physics is contingent upon completing or having credit for all required courses or approved course substitutions, rather than completion of a specific number of credit hours.

Students who enrolled in or after Fall 2013 are subject to the requirements of the KU Core Curriculum. By completing the required courses listed for the different Engineering Physics concentrations, the requirements of the KU Core Curriculum for Goal 1 Outcomes 1 and 2, Goal 3 (natural science), Goal 5, and Goal 6 are fulfilled. The remaining requirements of the KU Core can be met by an additional 15 credit hours of course work. Credit from advanced placement or course transfers may be used to satisfy KU Core requirements. Proposed places in the curriculum for taking courses satisfying the remaining KU Core requirements are included in the Suggested Schedules. In some cases the requirements of the KU Core Curriculum can be met by a non-course educational experience. Students who were admitted prior to the implementation of the KU Core or who had the option to opt out of the KU Core are required to satisfy the 15 credit hours of general education courses specific to Engineering Physics. For students to whom this applies, check with your advisor to see what courses have been preapproved to meet the general education requirements.

The following Suggested Schedules are built on the assumption that entering freshmen in Engineering Physics come to KU with the preparation in high school math, chemistry, physics to allow enrollment in MATH 125 and CHEM 130 or CHEM 150. If MATH 125, CHEM 130/150, or PHSX 211/213 is postponed the schedule can be significantly affected resulting in an increased probability of needing more than four years to complete the requirements for the degree. Students transferring into EPHX after two years elsewhere will need to have credit for the pre-requisite courses in order to complete the remaining requirements in two additional years. Courses taken elsewhere can transfer for KU credit. Students interested in transferring credit from another institution can find additional information at <http://admissions.ku.edu/apply/credits>. All students in Engineering Physics are encouraged to consider taking at least one summer of course work.

The Engineering Physics curriculum is challenging and it is important to be aware that many of the required courses, particularly at the junior/senior level, are offered only once a year. Students are urged to plan ahead in consultation with their advisor. Advising is required of Engineering Physics majors and enrollment every semester is restricted until advising is complete. Although the Department makes every effort to keep the curriculum information current, it is important to be aware that the schedule of course offerings is subject to change, particularly within the School of Engineering, with the potential that suggested courses may not be available as listed here or may be in time conflict with other suggested courses. It is also possible that enrollment in some courses may be limited. Again, the advisor can be helpful at exploring options in these cases. In general, substitutions for the required courses are not available, although in a few cases substitutions have been approved, such as ME 312 Thermodynamics instead of C&PE 221 Thermodynamics. To assist in planning, the following suggested schedules include pre-approved alternatives where they exist. **Also, courses that are only offered in the semester listed are annotated in boldface type.**

## Bachelor of Science in Engineering Physics, Aerospace Systems

<b>General Education Requirements</b>		<b>Hours</b>
KU Core 2.1	(Normally ENGL 101 and ENGL 102)	6
Chemistry	CHEM 130, Foundations of Chemistry I, or CHEM 150 Chemistry for Engineers, or CHEM 190 Foundations of Chemistry I, Honors together with CHEM 191 Foundations of Chemistry I Laboratory, Honors.	5
KU Core requirements*	Courses approved to satisfy Goals 2.2, 3S, 3H, 4.1, and 4.2. Note that PHSX 594 satisfies Goal 4.2.	15

<b>Core Physics</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy and Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory (with or after PHSX 313)	1
EPHX 516	Physical Measurements	4
EPHX 521	Mechanics I	3
EPHX 531	Electricity & Magnetism	3
EPHX 601	Design of Physical & Electronic Systems	4

<b>Mathematics</b>		<b>Hours</b>
MATH 125	Calculus I (MATH 145 is honors equivalent)	4
MATH 126	Calculus II (MATH 146 is honors equivalent)	4
MATH 127	Calculus III (MATH 147 is honors equivalent)	4
MATH 290	Elementary Linear Algebra (MATH 291 is honors equivalent)	2
MATH 220 or 320	Applied or Elementary Differential Equations. (MATH 221 is honors equivalent)	3

<b>Requirements specific for this option: Design Option in Aerospace Systems</b>		<b>Hours</b>
Engineering Physics	EPHX 536, Electronic Circuit Measurement & Design or EECS 316 Circuits, Electronic and Instrumentation together with EECS 318 Circuits and Electronics Lab	4
Aerospace Engineering	AE 245, Intro. to Aerospace Engineering	3
	AE 345, Fluid Mechanics or C&PE 511, Momentum Transfer or ME 510, Fluid Mechanics	3
	AE 421, Aerospace Computer Graphics (4) or ME 228, Computer Graphics (3)	3-4
	AE 445, Aircraft Aerodynamics and Performance	3
	AE 507, Aerospace Structures I	3
	AE 508 (or AE 509) Aerospace Structures II (3) and AE 521, Aerospace System Design I (4) or AE 560 Spacecraft Systems (3) and AE 523, Space Systems Design (4)	3-4
	AE 545, Fundamentals of Aerodynamics	5
	AE 550, Dynamics of Flight I	3
	AE 551, Dynamics of Flight II (AE 552 is the honors equivalent)	4
	AE 572, Fundamentals of Jet Propulsion (AE 573 is the honors equivalent)	3
Other Engineering	AE 211 Computing for Engineers or EECS 138, Intro. to Computing	3
	C&PE 221 Chemical Engineering Thermodynamics or ME 312, Basic Engineering Thermodynamics	3
	CE 301, Statics & Dynamics	5
	CE 310, Strength of Materials (CE 312 is the honors equivalent)	4

\*Goal 1.1, Goal 1.2, Goal 3N, Goal 5, and Goal 6 are all satisfied by major requirements.

## Suggested Schedule B.S. Engineering Physics, Aerospace Systems

(A)=aircraft track, (S)=spacecraft track

Fall Semester

Spring Semester

### Freshman Year

<b>AE 245</b> , <i>Intro To Aerospace Engineering</i>	3	AE 211, <i>Computing for Engineers.</i> , or EECS 138, <i>Intro To Computing</i>	3
<b>PHSX 150</b> , <i>Seminar in Physics, Astronomy, &amp; Engineering Physics</i>	0.5	KU Core Goal 2 Outcome 1	3
MATH 125, <i>Calculus I</i>	4	MATH 126, <i>Calculus II</i>	4
KU Core Goal 2 Outcome 1	3	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213</b> , <i>General Physics I, honors</i> (majors are encouraged to take 213)	5
CHEM 130, <i>General Chemistry I</i> , or <b>CHEM 150</b> , <i>General Chemistry I For Engineers</i>	5		
	<b>15.5</b>		<b>15</b>

### Sophomore Year

<b>AE 345</b> , <i>Fluid Mechanics</i>	3	<b>AE 445</b> , <i>Aircraft Aerodyn. &amp; Perform.</i>	3
CE 301, <i>Statics &amp; Dynamics</i>	5	CE 310, <i>Strength of Materials</i>	4
PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214</b> , <i>General Physics II, honors</i>	4	<b>C&amp;PE 221</b> , <i>Basic Engineering Thermodynamics.</i> or ME 312, <i>Basic Engineering Thermodynamics</i>	3
MATH 127, <i>Calculus III</i>	4	MATH 220/320, <i>Differential Equations</i>	3
MATH 290, <i>Linear Algebra</i>	2	PHSX 313, <i>General Physics III</i>	3
		PHSX 316, <i>Intermediate Physics Lab</i>	1
	<b>18</b>		<b>17</b>

### Junior Year

<b>AE 507</b> , <i>Aerospace Structures I</i>	3	<b>AE 421</b> , <i>Aero. Computer Graphics</i>	4
<b>AE 545</b> , <i>Fund. Of Aerodyn.</i>	5	<b>AE 551</b> , <i>Dynamics of Flight II</i>	4
<b>AE 550</b> , <i>Dynamics of Flight I</i>	3	<b>AE 572</b> , <i>Fund. Of Jet Propulsion</i>	3
<b>EPHX 521</b> , <i>Mechanics I</i>	3	<b>AE 508</b> , <i>Aerospace Structures II (A)</i> or EPHX 536, <i>Elec. Circ. Ms&amp;Dsn (S)</i>	3-4
Electives/KU Core <sup>1</sup>	3		
	<b>17</b>		<b>14-15</b>

### Senior Year

<b>AE 521</b> , <i>Aero. Sys. Design I (A)</i> or <b>AE 560</b> , <i>Spacecraft Systems (S)</i>	4-3	EPHX 536, <i>Elec. Circ. Ms &amp; Dsgn (A)</i> or <b>AE 523</b> , <i>Space Systems Design (S)</i>	4
EPHX 516, <i>Physical Measurements</i>	4	<b>EPHX 601</b> , <i>Dsgn. Phys. &amp; Elect. Systems</i>	4
<b>EPHX 531</b> , <i>Electricity &amp; Magnetism</i>	3	Electives/KU Core <sup>1</sup>	6
Electives/KU Core <sup>1</sup>	6		
	<b>16-17</b>		<b>14</b>

**Courses that are only offered in semester listed are annotated in boldface type.**

Note 1: The requirement is completion of the KU Core Curriculum Goal 2 Outcome 2, Goal 3 (arts and humanities, social sciences) and Goal 4 Outcomes 1 and 2. In some cases the requirements of the KU Core Curriculum can be met by a non-course educational experience.

## Bachelor of Science in Engineering Physics, Chemical Systems

<b>General Education Requirements</b>		<b>Hours</b>
KU Core 2.1	(Normally ENGL 101 and ENGL 102)	6
Chemistry	CHEM 170 Chemistry for the Chemical Sciences or CHEM 130, Foundations of Chemistry I or CHEM 190 Foundations of Chemistry I, Honors together with CHEM 191 Foundations of Chemistry I Laboratory, Honors.	5
KU Core requirements*	Courses approved to satisfy Goals 2.2, 3S, 3N, 4.1, and 4.2. Note that PHSX 594 satisfies Goal 4.2.	15

<b>Core Physics</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy and Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory (with or after PHSX 313)	1
EPHX 516	Physical Measurements	4
EPHX 521	Mechanics I	3
EPHX 531	Electricity & Magnetism	3
EPHX 601	Design of Physical & Electronic Systems	4

<b>Mathematics</b>		<b>Hours</b>
MATH 125	Calculus I (MATH 145 is honors equivalent)	4
MATH 126	Calculus II (MATH 146 is honors equivalent)	4
MATH 127	Calculus III (MATH 147 is honors equivalent)	4
MATH 290	Elementary Linear Algebra (MATH 291 is honors equivalent)	2
MATH 220 or 320	Applied or Elementary Differential Equations. (MATH 221 is honors equivalent)	3

<b>Requirements specific for this option: Design Option in Chemical Systems</b>		<b>Hours</b>
Engineering Physics	EPHX 536, Electronic Circuit Measurement & Design or EECS 316 Circuits, Electronic and Instrumentation together with EECS 318 Circuits and Electronics Lab	4
	EPHX 511*, Intro Quantum Mechanics	3
Chemistry	CHEM 175, Chemistry for Chemical Sciences II or CHEM 135, Foundations of Chemistry II, or CHEM 195, Foundations of Chemistry II Honors together with CHEM 196, Foundations of Chemistry II Laboratory Honors	5
	CHEM 330, Organic Chemistry I	3
	CHEM 525, Physical Chemistry for Engineers or CHEM 530 Physical Chemistry I	4
Chemical & Petroleum Engineering	C&PE 211, Material & Energy Balances	4
	C&PE 221 Chemical Engineering Thermodynamics or ME 312, Basic Engr. Thermodynamics	3
	C&PE 325, Numerical Methods	3
	C&PE 511, Momentum Transfer, or AE 345/ME 510 Fluid Mechanics	3
	C&PE 512, Chemical Engineering Thermodynamics II	3
	C&PE 522, Economic Appraisal of Chemical & Petroleum Projects	2
	C&PE 524, Chemical Engineering Kinetics & Reactor Design	3
	C&PE 525, Heat & Mass Transfer or C&PE 521 Heat Transfer together with C&PE 523 Mass Transfer	4
	C&PE 613, Chemical Engr. Design I	4
	C&PE 615, Intro. to Process Dynamics and Control	3
	C&PE 616, Chemical Engr. Lab I	3
	C&PE 623, Chemical Engr. Design II	2

\*Goal 1.1, Goal 1.2, Goal 3N, Goal 5, and Goal 6 are all satisfied by major requirements.

## Suggested Schedule B.S. Engineering Physics, Chemical Systems

### Fall Semester

### Spring Semester

#### Freshman Year

<b>PHSX 150</b> , Seminar in Physics, Astronomy & Engineering Physics	0.5	KU Core Goal 2 Outcome 1	3
<b>CHEM 170</b> , Chemistry for the Chem. Sci. I or CHEM 130, General Chemistry I	5	<b>CHEM 175</b> , Chemistry for the Chem. Sci. II or <b>CHEM 135</b> , General Chemistry II	5
KU Core Goal 2 Outcome 1	3	MATH 126, Calculus II	4
MATH 125, Calculus I	4	PHSX 211, General Physics I and PHSX 216, General Physics I Laboratory or <b>PHSX 213</b> , General Physics I, honors (majors are encouraged to take 213)	5
Electives/KU Core <sup>1</sup>	3		
	<b>15.5</b>		<b>17</b>

#### Sophomore Year

<b>C&amp;PE 211</b> , Material & Energy Balances	4	PHSX 313, General Physics III	3
PHSX 212, General Physics II and PHSX 236, General Physics II Laboratory or <b>PHSX 214</b> , General Physics II, honors	4	PHSX 316, Intermediate Physics Lab	1
MATH 127, Calculus III	4	MATH 220/320, Differential Equations	3
MATH 290, Linear Algebra	2	C&PE 325, Numerical Methods	3
CHEM 330, Organic Chemistry I	3	<b>C&amp;PE 221</b> , Chem. Engr. Thermodynamics	3
	3	Electives/KU Core <sup>1</sup>	3
	<b>17</b>		<b>16</b>

#### Junior Year

<b>CHEM 525</b> , Physical Chemistry for Engineers	4	<b>C&amp;PE 522</b> , Econ. Apprais. C&PE Proj.	2
<b>C&amp;PE 511</b> , Momentum Transfer	3	<b>C&amp;PE 524</b> , Kinetics & Reactor Design	3
<b>C&amp;PE 512</b> , Chem. Engr. Thermo.II	3	<b>C&amp;PE 525</b> , Heat & Mass Transfer	4
<b>EPHX 521</b> , Mechanics I	3	EPHX 536, Elec. Circ. Meas. & Dsgn	4
Electives/KU Core <sup>1</sup>	3	Electives/KU Core <sup>1</sup>	3
	<b>16</b>		<b>16</b>

#### Senior Year

EPHX 516, Physical Measurements	4	<b>EPHX 511</b> , Intro. Quantum Mechanics	3
<b>EPHX 531</b> , Electricity & Magnetism	3	<b>EPHX 601</b> , Dsgn. Phys & Elect. Systems	4
<b>C&amp;PE 613</b> , Chem. Eng. Design I	4	<b>C&amp;PE 623</b> , Chem. Engr. Design II	2
<b>C&amp;PE 615</b> , Int. Proc. Dyn & Cnt.	3	Electives/KU Core <sup>1</sup>	6
<b>C&amp;PE 616</b> , Chem. Eng. Lab I.	3		
	<b>17</b>		<b>15</b>

**Courses that are only offered in semester listed are annotated in boldface type.**

Note 1: The requirement is completion of the KU Core Curriculum Goal 2 Outcome 2, Goal 3 (arts and humanities, social sciences) and Goal 4 Outcomes 1 and 2. In some cases the requirements of the KU Core Curriculum can be met by a non-course educational experience.

## Bachelor of Science in Engineering Physics, Digital Electronic Systems

<b>General Education Requirements</b>		<b>Hours</b>
KU Core 2.1	(Normally ENGL 101 and ENGL 102)	6
Chemistry	CHEM 130, Foundations of Chemistry I, or CHEM 150 Chemistry for Engineers, or CHEM 190 Foundations of Chemistry I, Honors together with CHEM 191 Foundations of Chemistry I Laboratory, Honors.	5
KU Core requirements*	Courses approved to satisfy Goals 2.2, 3S, 3N, 4.1, and 4.2. Note that PHSX 594 satisfies Goal 4.2.	15

<b>Core Physics</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy and Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory (with or after PHSX 313)	1
EPHX 516	Physical Measurements	4
EPHX 521	Mechanics I	3
EPHX 531	Electricity & Magnetism	3
EPHX 601	Design of Physical & Electronic Systems	4

<b>Mathematics</b>		<b>Hours</b>
MATH 125	Calculus I (MATH 145 is honors equivalent)	4
MATH 126	Calculus II (MATH 146 is honors equivalent)	4
MATH 127	Calculus III (MATH 147 is honors equivalent)	4
MATH 290	Elementary Linear Algebra (MATH 291 is honors equivalent)	2
MATH 220 or 320	Applied or Elementary Differential Equations. (MATH 221 is honors equivalent)	3

<b>Requirements specific for Design Option in Digital Electronic Systems</b>		<b>Hours</b>
Physics	EPHX 511, Intro Quantum Mechanics	3
Mathematics	MATH 526 Applied Mathematical Statistics or MATH 628 <sup>1</sup> Mathematical Theory of Statistics	3
Electrical Engineering & Computer Science	EECS 140, Intro to Digital Logic Design (EECS 141 is the honors equivalent)	4
	EECS 168, Programming I (EECS 169 is the honors equivalent)	4
	EECS 211, Circuits I	3
	EECS 212, Circuits II	4
	EECS 268, Programming II	4
	EECS 312, Electronic Circuits I.	3
	EECS 360, Signal and System Analysis	4
	EECS 388, Computer Systems & Assembly Language	4
	EECS 443, Digital Systems Design	4
	EECS 448, Software Engineering I	4
	EECS 470, Electronic Devices & Properties of Materials	3
	EECS 541, Computer Systems Design Lab I	3
	EECS 542, Computer Systems Design Lab II	3
EECS 645 Computer Architecture	3	
EECS elective	3	

<sup>1</sup>MATH 628 is offered only in the spring and requires MATH 627 as a pre-requisite.

\*Goal 1.1, Goal 1.2, Goal 3N, Goal 5, and Goal 6 are all satisfied by major requirements.

## Suggested Schedule B.S. Engineering Physics, Digital Electronic Systems

### Fall Semester

### Spring Semester

#### Freshman Year

CHEM 130, <i>General Chemistry I</i> , or <b>Chem 150, <i>Chemistry for Engineers</i></b>	5	KU Core Goal 2 Outcome 1	3
KU Core Goal 2 Outcome 1	3	MATH 126, <i>Calculus II</i>	4
MATH 125, <i>Calculus I</i>	4	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213, <i>General Physics I, honors</i></b> (majors are encouraged to take 213)	5
<b>PHSX 150, <i>Seminar in Physics, Astronomy &amp; Engineering Physics</i></b>	0.5		
Electives/KU Core <sup>1</sup>	3	EECS 168, <i>Programming I</i>	4
	<b>15.5</b>		<b>16</b>

#### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214, <i>General Physics II, honors</i></b>	4	PHSX 313, <i>General Physics III</i>	3
		PHSX 316, <i>Intermediate Physics Lab</i>	1
MATH 290, <i>Linear Algebra</i>	2	MATH 127, <i>Calculus III</i>	4
MATH 220, <i>Applied Differential Equations</i>	3	EECS 212, <i>Circuits II</i>	4
EECS 140, <i>Intro. To Digital Logic Design</i>	4	EECS 268, <i>Programming II</i>	4
EECS 211, <i>Circuits I</i>	3		
	<b>16</b>		<b>16</b>

#### Junior Year

<b>EPHX 521, <i>Mechanics I</i></b>	3	<b>EPHX 511, <i>Intro. Quantum Mechanics</i></b>	3
EECS 360, <i>Signal &amp; System Analysis</i>	4	<b>EECS 443, <i>Digital Systems Design</i></b>	4
EECS 388, <i>Comp. Syst &amp; Assemb. Lang.</i>	4	EECS 448, <i>Software Engineering I</i>	4
EECS 312, <i>Electronic Circuits I</i>	3	<b>MATH 526, <i>Applied Mathematical Statistics</i></b>	3
Electives/KU Core <sup>1</sup>	3	Electives/KU Core <sup>1</sup>	3
	<b>17</b>		<b>17</b>

#### Senior Year

EPHX 516, <i>Physical Measurements</i>	4	<b>EECS 542, <i>Comp. Syst. Design Lab II</i></b>	3
<b>EPHX 531, <i>Electricity &amp; Magnetism</i></b>	3	<b>EPHX 601, <i>Dsgn. Phys &amp; Elect. Systems</i></b>	4
<b>EECS 470, <i>Electronic Devices &amp; Properties of Materials</i></b>	3	EECS 645, <i>Computer Architecture</i>	3
<b>EECS 541, <i>Comp. Syst. Design Lab I</i></b>	3	Electives/KU Core <sup>1</sup>	6
EECS elective	3		
	<b>16</b>		<b>16</b>

**Courses that are only offered in semester listed are annotated in boldface type.**

Note 1: The requirement is completion of the KU Core Curriculum Goal 2 Outcome 2, Goal 3 (arts and humanities, social sciences) and Goal 4 Outcomes 1 and 2. In some cases the requirements of the KU Core Curriculum can be met by a non-course educational experience.

## Bachelor of Science in Engineering Physics, Electromechanical Control Systems

<b>General Education Requirements</b>		<b>Hours</b>
KU Core 2.1	(Normally ENGL 101 and ENGL 102)	6
Chemistry	CHEM 130, Foundations of Chemistry I, or CHEM 150 Chemistry for Engineers, or CHEM 190 Foundations of Chemistry I, Honors together with CHEM 191 Foundations of Chemistry I Laboratory, Honors.	5
KU Core requirements*	Courses approved to satisfy Goals 2.2, 3S, 3N, 4.1, and 4.2. Note that PHSX594 satisfies Goal 4.2.	15

<b>Core Physics</b>		<b>Hours</b>
PHSX 150	Seminar in Physics, Astronomy and Engineering Physics	0.5
PHSX 211&216 or PHSX 213	General Physics I and General Physics I Lab (213 is honors/majors equivalent)	5
PHSX 212&236 or PHSX 214	General Physics II and General Physics II Lab (214 is honors/majors equivalent)	4
PHSX 313	General Physics III	3
PHSX 316	Intermediate Physics Laboratory (with or after PHSX 313)	1
EPHX 516	Physical Measurements (considered equivalent to ME 455 for pre-requisite purposes)	4
EPHX 521	Mechanics I (considered equivalent to ME 320 for pre-requisite purposes)	3
EPHX 531	Electricity & Magnetism	3
EPHX 601	Design of Physical & Electronic Systems	4

<b>Mathematics</b>		<b>Hours</b>
MATH 125	Calculus I (MATH 145 is honors equivalent)	4
MATH 126	Calculus II (MATH 146 is honors equivalent)	4
MATH 127	Calculus III (MATH 147 is honors equivalent)	4
MATH 290	Elementary Linear Algebra (MATH 291 is honors equivalent)	2
MATH 220 or 320	Applied Elementary Differential Equations or Elementary Differential Equations. (MATH 221 is honors equivalent)	3

<b>Requirements specific for Design Option in Electromechanical Control Systems</b>		<b>Hours</b>
Physics	EPHX 511, Intro Quantum Mechanics	3
Electrical Engineering & Computer Science	EECS 140, Intro to Digital Logic Design (EECS 141 is the honors equivalent)	4
	EECS 168, Programming I (EECS 169 is the honors equivalent)	4
	EECS 211, Circuits I	3
	EECS 212, Circuits II	4
	EECS 268, Programming II	4
	EECS 312, Electronic Circuits I.	3
	EECS 360, Signal and System Analysis	4
	EECS 444 Control Systems or ME 682, System Dynamics & Control Systems	3
Mechanical Engineering	ME 228, Computer Graphics	3
	ME 210, Introduction to Mechanics	1
	ME 311 (3 credits), Mechanics of Materials or CE 310 (4 credits), Strength of Materials together with ME 309 (1 credit)	3-5
	ME 312 Basic Engr. Thermodynamics	3
	ME 501, Mechanical Engr. Design Process	2
	ME 628, Mechanical Design I.	3
	ME 640, Design Project or ME 627 Automotive Design	2-3
ME 641, ME 642, or 643 Project A, B, C (see notes below for engineering elective). Note that ME 642, Design Project B – Formula Car, is 4 credit hours and requires ME 627 to be taken in the previous semester.	2-4	
Elective	ASTR, ENGR, MATH or PHSX elective (500 level or above). Note that ME 643 (Design Project C – Biomechanics) requires ME 633 to be taken in the previous semester as the engineering elective.	3

\*Goal 1.1, Goal 1.2, Goal 3N, Goal 5, and Goal 6 are all satisfied by major requirements.



## Suggested Schedule B.S. Engineering Physics, Electromechanical Control Systems

### Fall Semester

### Spring Semester

#### Freshman Year

CHEM 130, <i>General Chemistry I</i> , or <b>CHEM 150, <i>Chemistry for Engineers</i></b>	5	KU Core Goal 2 Outcome 1	3
KU Core Goal 2 Outcome 1	3	MATH 126, <i>Calculus II</i>	4
MATH 125, <i>Calculus I</i>	4	PHSX 211, <i>General Physics I</i> and PHSX 216, <i>General Physics I Laboratory</i> or <b>PHSX 213, <i>General Physics I, honors</i></b> (majors are encouraged to take 213)	5
<b>PHSX 150, <i>Seminar in Physics, Astronomy &amp; Engineering Physics</i></b>	0.5		
<b>ME 228, <i>Computer Graphics</i></b>	3	EECS 168, <i>Programming I</i>	4
	<b>15.5</b>		<b>16</b>

#### Sophomore Year

PHSX 212, <i>General Physics II</i> and PHSX 236, <i>General Physics II Laboratory</i> or <b>PHSX 214, <i>General Physics II, honors</i></b>	4	PHSX 313, <i>General Physics III</i>	3
		PHSX 316, <i>Intermediate Physics Lab</i>	1
MATH 220, <i>Applied Differential Equations</i>	3	MATH 127, <i>Calculus III</i>	4
MATH 290, <i>Linear Algebra</i>	2	EECS 212, <i>Circuits II</i>	4
EECS 140, <i>Intro. To Digital Logic Design</i>	4	EECS 268, <i>Programming II</i>	4
EECS 211, <i>Circuits I</i>	3	ME 210, <i>Introduction to Mechanics</i>	1
	<b>16</b>		<b>17</b>

#### Junior Year

<b>EPHX 521, <i>Mechanics I</i></b>	3	<b>EPHX 511, <i>Intro. Quantum Mechanics</i></b>	3
EECS 360, <i>Signal &amp; System Analysis</i>	4	EECS 312, <i>Electronic Circuits I</i>	3
ME 311, <i>Mechanics of Materials</i>	3	<b>ME 501, <i>Mech. Eng. Design Process</i></b>	2
ME 312, <i>Basic Engr. Thermo.</i>	3	<b>ME 628, <i>Mechanical Design</i></b>	3
Electives/KU Core <sup>1</sup>	3	Electives/KU Core <sup>1</sup>	3
	<b>16</b>		<b>14</b>

#### Senior Year

EPHX 516, <i>Physical Measurements</i>	4	<b>EPHX 601, <i>Dsgn. Phys &amp; Elect. Systems</i></b>	4
<b>EPHX 531, <i>Electricity &amp; Magnetism</i></b>	3	<b>ME 641, 642, 643, <i>Design Project A, B, or C</i></b>	2-4
<b>ME 640, <i>Design Project</i></b> or <b>ME 627 <i>Automotive Design</i></b>	2-3	EECS 444, <i>Sys Dyn &amp; Cntl Sys</i> or ME 682, <i>Control Systems (FALL ONLY)</i>	3
ASTR, ENGR, MATH, or PHSX Elective	3		
Electives/KU Core <sup>1</sup>	3	Electives/KU Core <sup>1</sup>	6
	<b>15-16</b>		<b>15-17</b>

**Courses that are only offered in semester listed are annotated in boldface type.**

Note 1: The requirement is completion of the KU Core Curriculum Goal 2 Outcome 2, Goal 3 (arts and humanities, social sciences) and Goal 4 Outcomes 1 and 2. In some cases the requirements of the KU Core Curriculum can be met by a non-course educational experience.

## Department Courses in the KU Core

ASTR 177	First Year Seminar	Goal 1.1
ASTR 191	Contemporary Astronomy	Goal 3N
ASTR 293	Astronomy Bizarre	Goal 3N
ASTR 390	Undergraduate Problems	Goal 6.1
ASTR 391	Physical Astronomy, Honors	Goal 1.2 Goal 3N
ASTR 394	Quest for Extraterrestrial Life	Goal 1.1
ASTR 503	Undergraduate Research	Goal 6.1
ASTR 596	Observational Astrophysics	Goal 6.1
ASTR 597	Analysis in Astrophysics	Goal 6.1
PHSX 111	Introductory Physics	Goal 1.1 Goal 3N
PHSX 112	Concepts in Physics, Honors	Goal 3N
PHSX 114	College Physics I	Goal 1.1 Goal 1.2 Goal 3N
PHSX 177	First Year Seminar	Goal 1.1
PHSX 210	General Physics I for Engineers	Goal 1.1 Goal 3N
PHSX 211	General Physics I	Goal 1.1 Goal 1.2 Goal 3N
PHSX 212	General Physics II	Goal 3N
PHSX 213	General Physics I, Honors	Goal 1.1 Goal 1.2 Goal 3N
PHSX 313	General Physics III	Goal 3N
PHSX 420	Science and Policy	Goal 5.2
PHSX 500	Special Problems	Goal 6.1
PHSX 501	Honors Research	Goal 6.1
PHSX 503	Undergraduate Research	Goal 6.1
PHSX 594	Cosmology and Culture	Goal 4.2
PHSX 601	Design of Physical and Electronic Systems	Goal 6.1

## Minors in Physics & Astronomy

### Requirements for the Minor

Minors in the College of Liberal Arts and Sciences are constructed with the following basic requirements: 18 hours in the minor field, with 12 of those hours required to be at a junior/senior level. The specific requirements for the physics minor and the astronomy minor follow:

#### The physics minor

PHSX 211 (or PHSX 213) General Physics I.....	4
PHSX 212 (or PHSX 214) General Physics II.....	4
PHSX 313 General Physics III .....	3
PHSX 316 Intermediate Physics Laboratory .....	1
PHSX 521 Mechanics I.....	3
PHSX 531 Electricity and Magnetism.....	3
Any PHSX course numbered 500 or above .....	3

21 credit hours, of which 13 are at the junior/senior level of work.

#### The astronomy minor

PHSX 211 (or PHSX 213) General Physics I.....	4
PHSX 212 (or PHSX 214) General Physics II.....	4
PHSX 313 General Physics III .....	3
PHSX 316 Intermediate Physics Laboratory .....	1
Astronomy and related field electives at the jr/sr level	8 or more

Students are strongly advised to take Astronomy 391 as their introductory course in astronomy; if students have already taken Astronomy 191 as an introductory astronomy course, they should inquire about taking 3 credit hours of Astronomy 390 instead. Be aware that Astronomy 591 and 592 are only taught in alternate years (Fall odd / Spring even) semesters.

#### The astrobiology minor

Courses in astronomy, biology, chemistry, geology or physics (ABCGP) are required as follows:

- BIOL 150, Principles of Molecular and Cellular Biology (4)
- GEOL 101, Intro. to Geology, GEOL 105, History of the Earth, or GEOL 121, Prehistoric Life (3)
- ASTR 391, Physical Astronomy (3)
- ASTR 394, Extraterrestrial Life (3) or 3 credits of undergraduate research in astrobiology.
- 6 credits of coursework in ABCGP at the 300-level or higher and not in the student's major field

## Planned Schedule of Courses

### Courses Normally Offered Both Fall and Spring Semesters

<b>Course Number and Title</b>	<b>Prerequisites</b>
ASTR 191 Contemporary Astronomy	High School alg. and geom.
ASTR 390 Undergraduate Problems	Permission
ASTR 503 Undergraduate Research	Permission
ASTR 597 Analysis in Astrophysics	ASTR 592 or ASTR 692
PHSX 111 Introductory Physics	Eligibility for MATH 104
PHSX 114 College Physics I	MATH 104
PHSX 115 College Physics II	PHSX 114
PHSX 116 Introductory Physics Lab	PHSX 111 (Co.)
PHSX 211 General Physics I	MATH 125 or 116
PHSX 212 General Physics II	PHSX 211, MATH 126 (Co.)
PHSX 213 General Physics I Honors	MATH 125 and permission
PHSX 216 General Physics I Lab	
PHSX 236 General Physics II Lab	
PHSX 313 General Physics III	
	PHSX 212/214 or EECS 220
PHSX 316 Intermediate Physics Laboratory	MATH 220/320 (Co.)
PHSX 500 Special Problems	PHSX 313 (pre- or co-requisite)
PHSX/EPHX 501 Honors Research	Permission, see catalog
PHSX/EPHX 503 Undergraduate Research	Permission, see catalog
PHSX 700 Colloquium	Permission, see catalog
PHSX/ASTR 791 Seminar in Astrophysics	None
PHSX 800 Graduate Problems	Permission, see catalog
PHSX/ASTR 897 Seminar in Plasma and Space Physics	Permission, see catalog
PHSX 899 Master's Research/Thesis	Permission, see catalog
PHSX 917 Seminar in Theoretical Physics	Permission, see catalog
PHSX 947 Seminar in Nuclear Physics	Permission, see catalog
PHSX 967 Seminar in Particle Physics	Permission, see catalog
PHSX 987 Seminar in Solid State Physics	Permission, see catalog
PHSX 999 Ph.D. Dissertation Research	Permission, see catalog

### Courses Normally Offered in Summer

<b>Course Number and Title</b>	<b>Prerequisites</b>
ASTR 390 Undergraduate Problems	Permission
ASTR 503 Undergraduate Research	Permission
ASTR 597 Analysis in Astrophysics	ASTR 592 or ASTR 692
PHSX 114 College Physics I	MATH 104
PHSX 115 College Physics II	PHSX 114
PHSX 211 General Physics I	
PHSX 500 Special Problems	Permission, see catalog
PHSX/EPHX 501 Honors Research	Permission, see catalog
PHSX/EPHX 503 Undergraduate Research	Permission, see catalog
PHSX 800 Graduate Problems	Permission, see catalog
PHSX 899 Master's Research/Thesis	Permission, see catalog
PHSX 999 Ph.D. Dissertation Research	Permission, see catalog

## Courses Normally Offered Each Fall Semester

<b>Course Number and Title</b>	<b>Prerequisites</b>
PHSX 214 General Physics II Honors	PHSX 211/213, MATH 126 (Co.)
PHSX/EPHX 516 Physical Measurements	PHSX 313, 316, 521 (coreq)
PHSX/EPHX 521 Mechanics I	PHSX 211/213, MATH 127, 290, 220/320
PHSX/EPHX 531 Electricity & Magnetism	PHSX 212/214, MATH 127, 290, 220/320, PHSX 521/permis.
PHSX/EPHX 671 Thermal Physics	PHSX 511
PHSX 711 Quantum Mechanics I	PHSX 511, MATH 320
PHSX 717 Graduate Seminar	First year graduate student
PHSX/CHEM 718 Mathematical Methods in Physical Sciences	2 semesters jr.-sr. MATH
PHSX 821 Classical Mechanics	12 hrs jr.-sr. PHSX

## Courses Normally Offered Each Spring Semester

<b>Course Number and Title</b>	<b>Prerequisites</b>
ASTR 391 Physical Astronomy	MATH 125 & honors or permission
ASTR 394 The Quest for Extraterrestrial Life	Intro GEOL, BIOL or ASTR course
PHSX/EPHX 511 Introductory Quantum Mechanics	PHSX 313, MATH 290
PHSX/EPHX 536 Electronic Circuits & Measurements	PHSX 212/214, MATH 127 and 290, PHSX 313 and 316 (rec.)
PHSX/EPHX 601 Design of Physical and Electronic Systems lab course	12 hrs jr./sr. PHSX/EPHX incl. one lab course
PHSX/EPHX 621 Mechanics II	PHSX 521
PHSX/EPHX 631 Electromagnetic Theory	PHSX 531
PHSX 811 Quantum Mechanics II	PHSX 711
PHSX/ASTR 815 Computational Physics & Astronomy	6 hrs jr.-sr. PHSX/ASTR
PHSX 831 Electrodynamics I	PHSX 718, PHSX 821

## Courses Normally Offered Every Other Fall Semester

<b>Course Number and Title</b>	<b>Prerequisites</b>
ASTR 591 <sup>+</sup> Stellar Astronomy	PHSX 212
ASTR 596 <sup>+</sup> Observational Astrophysics	ASTR 591 pre- or co-req.
ASTR/PHSX/EPHX 691 <sup>†</sup> Astrophysics I	PHSX 313 or consent
PHSX/EPHX 661 <sup>†</sup> Introduction to Elementary Particle Physics	PHSX 313
PHSX 761 <sup>†</sup> Elementary Particles I	PHSX 711
PHSX 781 <sup>+</sup> Solid State Physics I	PHSX 511, 671
PHSX792 <sup>+</sup> Topics in Advanced Astrophysics	ASTR 692 or consent
PHSX 911 <sup>+</sup> Quantum Mechanics III	PHSX 811
PHSX 931 <sup>†</sup> Electrodynamics II	PHSX 831

## Courses Normally Offered Every Other Spring Semester

<b>Course Number and Title</b>	<b>Prerequisites</b>
ASTR 592 <sup>†</sup> Galactic & Extragalactic Astronomy	ASTR 591 or consent
ASTR 692 <sup>+</sup> Astrophysics II	ASTR 691 or consent
PHSX/EPHX 641 <sup>†</sup> Introduction to Nuclear Physics	PHSX 313 and 511
PHSX/EPHX 693 <sup>†</sup> Gravitation & Cosmology	PHSX 313, MATH 320
PHSX731+ Molecular Biophysics	PHSX212, MATH 126 +CHEM188
PHSX 741 <sup>†</sup> Nuclear Physics I	PHSX 511
PHSX 793 <sup>†</sup> Physical Cosmology	MATH 718
PHSX/ASTR 795 <sup>+</sup> Space Plasma Physics	PHSX 621, 631 (coreq)
PHSX 871 <sup>†</sup> Statistical Physics I	PHSX 711, 821, 671 (rec.)

## Courses Offered Occasionally

<b>Course Number and Title</b>	<b>Prerequisites</b>
ASTR 293 Astronomy Bizarre	Previous ASTR course
PHSX 112 Concepts in Physics, Honors	Eligible for MATH 104
PHSX 502 Seminar in Physics & Astronomy Instruction	Permission
PHSX/EPHX 518 Mathematical Physics	PHSX 313, MATH 320
PHSX 594 Cosmology and Culture	None
PHSX/EPHX 600 Special Topics in Physics and Astrophysics	Permission
PHSX/EPHX 615 Numerical and Computational Methods in Physics	PHSX 313, MATH 320, EECS 138
PHSX/EPHX 623 Physics of Fluids	MATH 127&290,PHSX 212/214
PHSX/EPHX 655 Optics	PHSX 313 and 316
PHSX/EPHX 681 Concepts in Solids	PHSX 313 and 511
PHSX 721 <sup>+</sup> Chaotic Dynamics	MATH 320, PHSX 521
PHSX 801 Advanced Topics	Permission
PHSX 841 Nuclear Physics II	PHSX 741, 811
PHSX 861 Elementary Particles II	PHSX 761, 911 (Coreq)
PHSX 881 Solid State Physics II	PHSX 631, 711
PHSX 895 Plasma Physics	PHSX 795
PHSX 912 Quantum Field Theory	PHSX 911
PHSX 915 Relativity	10 hrs. jr./sr. PHSX/MATH
PHSX 971 Advanced Statistical Mechanics	PHSX 871 or CHEM 917

---

Several courses cross-listed with Geology are not included.

<sup>+</sup> These courses are taught in odd-numbered years.

<sup>†</sup> These courses are taught in even-numbered years.

## Course Numbering System

- Courses 000–099** do not count toward graduation.
- Courses 100–299** are designed for freshman and sophomores.
- Courses 300–499** are designed for juniors and seniors.
- Courses 500–699** are designed primarily for juniors and seniors but may be taken by graduate students for graduate credit.
- Courses 700–799** are designed primarily for graduate students who have less than 30 hours of graduate credit but may be taken by undergraduates for undergraduate credit.
- Courses 800–999** are open only to graduate students except by special permission.

**NOTE:** There are no sublevels within these six categories; *e.g.*, a 600–level course is not necessarily more advanced than a 500–level course. See the University Timetable of Classes and the Bulletin of the Graduate School for a complete description.

## Research and Graduate Programs

The Department offers graduate work leading to the Masters and Ph.D. degrees in Physics. It has ongoing experimental and theoretical programs of research in astrophysics, biophysics, chaos, condensed matter, cosmology, elementary particles, nuclear physics, and plasma and space physics. The directory, beginning on page 1, lists the faculty interests in these areas and their sub-field. These endeavors provide occasional opportunities for capable undergraduate students to become involved in research.