CALENDAR

SUMMER SESSION
Orientation for new undergraduate students
Registration for summer session, 8 a.m.
Opening of classes, 7 a.m.
University Holiday, offices closed
Close of session, 5 p.m.
University Commencement, 7:30 p.m.
Opening of Independent Study Unit for
Law and Graduate students
University Holiday, offices closed
Close of Independent Study Unit

1968
June 10, Monday
June 11, Tuesday
June 12, Wednesday
July 4, Thursday
August 7, Wednesday
August 8, Thursday
September 2, Monday
September 4, Wednesday

FIRST SEMESTER
Beginning of Registration, 1 p.m.
Opening of classes, 7:30 a.m.
University Induction Ceremony, 8:45 a.m.
Homecoming, classes suspended, except for
classes meeting on Saturdays only
Beginning of Thanksgiving recess, 10 p.m.
University Holiday, offices closed
Resumption of classes, 7:30 a.m.
Beginning of Holiday recess, 12:30 p.m.
University Holiday, offices closed (12 noon)
University Holiday, offices closed
University Holiday, offices closed
Resumption of classes, 7:30 a.m.
Close of First Semester classes
Beginning of Examination Week, 7:30 a.m.
Close of Examination Week
University Commencement, 10 a.m.

1968-69
September 18, Wednesday
September 21, Monday
September 22, Monday
October 12, Saturday
November 26, Tuesday
November 28, Thursday
December 2, Monday
December 21, Saturday
December 24, Tuesday
December 25, Wednesday
December 31, Tuesday
January 1, Wednesday
January 6, Monday
January 23, Wednesday
January 24, Friday
January 31, Friday
February 1, Saturday

SECOND SEMESTER
Beginning of Registration, 8 a.m.
Opening of classes, 7:30 a.m.
Foundation Day
Beginning of Easter recess, 10 p.m.
Resumption of classes, 7:30 a.m.
Beginning of Examination Week, 7:30 a.m.
University Holiday, offices closed
Close of Second Semester classes
University Commencement, 9:30 a.m.

1969-70
February 3, Monday
February 5, Wednesday
February 25, Tuesday
April 1, Tuesday
April 9, Wednesday
May 26, Monday
May 28, Monday
June 4, Wednesday
June 6, Friday

FIRST SEMESTER
Beginning of Registration, 1 p.m.
Opening of classes, 7:30 a.m.
University Induction Ceremony, 8:45 a.m.
Homecoming, classes suspended, except for
classes meeting on Saturdays only
Beginning of Thanksgiving recess, 10 p.m.
University Holiday, offices closed
Resumption of classes, 7:30 a.m.
Beginning of Holiday recess, 12:30 p.m.
University Holiday, offices closed
University Holiday, offices closed
University Holiday, offices closed
Resumption of classes, 7:30 a.m.
Close of First Semester classes
Beginning of Examination Week, 7:30 a.m.
Close of Examination Week
University Commencement, 10 a.m.

1969-70
September 10, Wednesday
September 15, Monday
September 15, Monday
October 25, Saturday
November 25, Tuesday
November 27, Thursday
December 1, Monday
December 10, Sunday
December 25, Thursday
December 26, Friday
January 1, Thursday
January 5, Monday
January 14, Wednesday
January 16, Friday
January 23, Friday
January 24, Saturday

PHYSICS AND ASTRONOMY

PHYSICS AND ASTRONOMY
Head of Department, James A. Van Allen
Office, 203 Physics Research Center
Associate Head of Department and
Undergraduate Adviser, Edward B. Nelson
Office, 211 Physics Research Center

The Department of Physics and Astronomy aims to pro-
vide opportunity for comprehensive study of all basic as-
pects of these subjects and for individual scholarly work at
an advanced level.

Career Opportunities
Persons possessing a mastery of physics and astronomy
are in great demand as teachers in universities and colleges
and as research workers in government and industrial labora-
tories. Those with a good working knowledge of these
subjects at the B.A. level find many opportunities in high
school teaching and in a variety of administrative and
technical pursuits.

Undergraduate Major in Physics
The following courses or their equivalents are required
for the Bachelor of Arts degree with a major in physics:

29:17, 18, 19 Introductory Physics I, II, III
29:118 Kinetic Theory and Thermodynamics (each) 5 s.h.
29:129, 130 Electricity and Magnetism 3 s.h.
29:132 Intermediate Laboratory 6 s.h.
29:191 Atomic Physics 3 s.h.
22M:19 Topics in Applied Mathematics 3 s.h.
22M:103, 104 Elementary Theoretical Mechanics 6 s.h.
22M:105 Advanced Calculus 3 s.h.

Undergraduate majors who plan to pursue graduate study
in physics are advised to
(1) take 29:171, 172 Methods of Theoretical Physics,
(2) acquire reading facility in either Russian or German,
and
(3) go beyond the minimum requirements listed above to
the greatest feasible extent.
Honors in Physics or Astronomy

Selected junior and senior majors take 6 to 8 semester hours of Honors Seminar, 29:92, as part of their program for the degree Bachelor of Arts with Honors in Physics or Astronomy.

For the general requirements of the College of Liberal Arts, see College of Liberal Arts.

Undergraduate Major in Astronomy

The following courses or their equivalents are required for the Bachelor of Arts degree with a major in astronomy:

- 29:01, 62 General Astronomy 8.0 s.h.
- 29:17, 18, 19 Introductory Physics I, II, III (each) 5.0 s.h.
- 29:120 Introductory Astrophysics I 3.0 s.h.
- 22M:103, 104 Elementary Theoretical Mechanics 6.0 s.h.
- 29:129, 130 Electricity and Magnetism 6.0 s.h.
- 29:132 Intermediate Laboratory 2.0 s.h.
- 29:137 Astronomical Laboratory 1.0 s.h.
- 22M:19 Topics in Applied Mathematics 3.0 s.h.

Undergraduate majors who plan to pursue graduate study in astronomy are advised to:

1. Take 29:118 Kinetic Theory and Thermodynamics, 29:171, 172 Methods of Theoretical Physics, and 29:191 Atomic Physics
2. Acquire reading facility in either Russian or German, and
3. Go beyond the minimum requirements listed above to the greatest feasible extent.

Graduate Program

Two advanced degrees are offered in physics, the Master of Science (with or without thesis) and the Doctor of Philosophy; and one in astronomy, the Master of Science (with or without thesis). A student who wishes to pursue a program in astronomy beyond the M.S. level may qualify for a Doctor of Philosophy degree in Physics with specialization and a dissertation in astronomy or astrophysics. An interdepartmental program leading to the M.S. and Ph.D. degrees in chemical physics is also available.

Each entering graduate student is assigned to a faculty adviser who will assist him in preparing a plan of study and in guiding his progress. A graduate student becomes a candidate for an advanced degree in physics or astronomy only after he has passed a general examination in all principal areas of the subject at the level of advanced undergraduate work. The examination is ordinarily given in February of each year and must be taken by all first-year graduate students. Ordinarily, a candidate for an advanced degree should begin research in his chosen specialty during his second year of residency. His thesis or essay adviser then becomes his general adviser and the chairman of his final examination committee.

For the general requirements for admission to the Graduate College and for advanced degrees, see Graduate College.

Master of Science Degree in Physics

The M.S. degree is offered with thesis or without thesis. Either degree may be an intermediate step toward a Ph.D. degree, or it may be a terminal degree. The final examination in either case is an oral one by a faculty committee appointed by the Dean of the Graduate College.

The program for the M.S. degree with thesis requires at least 24 semester hours of graduate course work and a thesis based on an original experimental or theoretical investigation by the candidate.

The program for the M.S. degree without thesis comprises a somewhat broader program of courses (total of 38 semester hours of graduate work), an independent study of the literature on a chosen topic, and the preparation of a critical essay on that topic (for which a maximum of 4 semester hours of credit is allowed). Up to one-third of the graduate program may be in related scientific fields other than physics and mathematics, e.g., chemistry, astronomy, engineering, etc.

The candidate for either of the M.S. degrees must have completed satisfactorily at least the following courses or their equivalents as an undergraduate or a graduate:

- 22M:101 Differential Equations 3.0 s.h.
- 29:117 Optics 4.0 s.h.
- 22M:118 Kinetic Theory and Thermodynamics 3.0 s.h.
- 22M:103, 104 Elementary Theoretical Mechanics 6.0 s.h.
- 22M:105 Advanced Calculus 3.0 s.h.
- 29:129, 130 Electricity and Magnetism 6.0 s.h.
- 29:133 Advanced Laboratory 4.0 s.h.
- 29:191 Atomic Physics 3.0 s.h.
- 29:192 Nuclear Physics 3.0 s.h.
- 29:193 Introductory Solid State Physics 3.0 s.h.

His plan of study should provide for as much advanced work as his aptitude and previous preparation permit. If he expects to continue toward a Ph.D. degree, he should take 29:171 and 172 during his first year of residency. Study of scientific Russian or German is recommended, but is not required of M.S. candidates.

Master of Science Degree in Astronomy

The M.S. degree is offered with thesis or without thesis. The general nature of the program of study for either degree is similar to that for the corresponding M.S. degree in physics (q.v.).

Specific departmental requirements for the M.S. degree in astronomy are:

The substantial equivalent of the undergraduate major program in astronomy listed in earlier paragraphs, and as many of the following courses as it is feasible to complete:

- 22M:115 Numerical Methods in Mathematics 3.0 s.h.
- 22M:116 Numerical Solution of Differential Equations 3.0 s.h.
- 29:117 Optics 3.0 s.h.
- 29:119 Stellar Dynamics and Galactic Structure 3.0 s.h.
- 29:121 Introduction to Astrophysics II 3.0 s.h.
- 29:131 Radio Astronomy 2.0 s.h.
- 29:171, 172 Methods of Theoretical Physics 6.0 s.h.
- 29:191 Atomic Physics 3.0 s.h.
- 29:192 Nuclear Physics 3.0 s.h.
- 29:194 Plasma Physics 3.0 s.h.
- 29:232, 233 Theoretical Astrophysics I, II 6.0 s.h.
- 29:234 Stellar Structure and Stellar Evolution 2.0 s.h.

An individual plan of study must be worked out by each candidate early in his graduate study.

Doctor of Philosophy Degree in Physics

The program of study for the Ph.D. degree with major in physics includes:
Thorough course work in both classical and modern theoretical physics for all candidates, whether their specialized research is to be in an experimental or a theoretical area. Comprehensive examinations.

Participation in advanced seminars.

Successful conduct of a major original research in experimental physics, theoretical physics, or astrophysics; and the preparation and defense of a written dissertation based on this work.

Emphasis is laid on the capabilities developed and the knowledge gained rather than on the particular courses taken, credits acquired, or other aspects of the means to the end. Although no specific courses are required, the following are recommended as preparation for the comprehensive examinations:

29:191, 192, 193 Atomic, Nuclear and Solid State Physics
29:205 Classical Mechanics
29:212 Statistical Mechanics
29:213, 214 Classical Electrodynamics
29:245, 246 Quantum Mechanics I, II

Advanced mathematics such as theory of functions of a complex variable and vector and tensor analysis are used freely in these courses. An introduction to these fields is given in Methods of Theoretical Physics 29:171, 172. The selection of some advanced courses will depend on the adequacy of the student's preparation for graduate work; his choice of more advanced and specialized courses will depend on the direction in which his interests develop.

Before a candidate is admitted to the comprehensive examinations, he must acquire and demonstrate to the appropriate foreign language department a reading competence in any two of the following three foreign languages: German, Russian, and French.

A candidate for the Ph.D. degree will not be recommended for the degree until he has written his dissertation in proper form for formal publication and has submitted it, with the approval of his research adviser, for publication to a standard scientific journal of wide distribution.

Research

The department has an excellent library and a number of well-equipped laboratories. An IBM 360/65 digital computer and the associated facilities of the University Computer Center are available for research by students and staff of the department. The central machine shop is fully equipped and staffed with skilled instrument makers and machinists, and there are several electronics and machine shops for the use of advanced students and the research staff.

Experimental research is conducted in the fields of nuclear structure physics, cosmic rays, atmospheric and space physics, astrophysics, chemical physics, and solid state physics.

Theoretical research is devoted to atomic and nuclear theory, quantum field theory, statistical mechanics, plasma physics, theory of solids, and theory of elementary particles, solar-terrestrial physics, and astrophysics.

Persons qualified for graduate study are invited to apply for fellowships and assistantships. Inquiries should be directed to the departmental office.

STAFF


Visiting Professor: J. H. Piddington.


*Not in residence 1967-68.

Physics

Prerequisites are specified as a guide and may be waived with the consent of the instructor.

Primarily for Undergraduates

29:1 College Physics 4 s.h.

Open to freshmen. For premedical, predental, and pharmacy students, and others interested in elementary physics. Descriptive lectures, laboratory and problem work in mechanics, heat and sound. Prerequisite or corequisite, Mathematics 22M-1. Both semesters and summer session. Instructors: Noordlinger, Nelson.

29:2 College Physics 4 s.h.

Continuation of 29:1, which is prerequisite. Electricity, magnetism, and light. Both semesters and summer session. Instructors: Nelson, Noordlinger.
29:7 General Physics 4 s.h.
For engineering students. Three lectures and one three-hour laboratory-recitation each week on mechanics, heat and sound. Prerequisite or corequisite, Mathematics 22M:6. Both semesters. Instructors: Carlson, Norbeck.

29:8 General Physics 4 s.h.
Continuation of 29:7, which is prerequisite. Electricity, magnetism, and light. Both semesters. Instructors: Krimigis, Carlson.

29:9 Introduction to Modern Physics 3 or 4 s.h.
Electronic, atomic, and nuclear phenomena from an experimental and interpretative point of view. Three lectures and one laboratory each week. Prerequisites, 29:1, 2 or 29:7, 8, and Mathematics 22M:7. Instructor: Payne.

29:17* Introductory Physics I 5 s.h.
Classical and modern physics for physics majors, honors students and others by permission of the instructor. Four lecture-discussion sections and one laboratory per week. Corequisite, Mathematics 22M:6. Instructor: Krimigis.

29:18* Introductory Physics II 5 s.h.

29:19* Introductory Physics III 5 s.h.
A continuation of 29:18, which is prerequisite. Instructor: Savage.

29:93 Reading in Physics cr.arr.
Consult head of department before registering. Staff.

29:99* Honors Seminar cr.arr.
For junior and senior honors candidates majoring in physics or astronomy. Guidance in conducting original scholarly investigations. Instructor: Savage.

For Undergraduates and Graduates
(These courses presuppose a working knowledge of differential and integral calculus, and completion of 29:17, 18, 19 or equivalents.)

29:103 Reading in Physics cr.arr.
Consult head of department before registering. Staff.

29:117 Optics 3 s.h.
Geometrical and physical optics. Lectures on the properties of lenses and simple optical instruments; phenomena of propagation of electromagnetic waves, interference, diffraction and polarization. Three lectures each week. Instructor: Norbeck.

29:118 Kinetic Theory and Thermodynamics 3 s.h.

29:127 Electricity and Electrical Measurements 3 s.h.
Electrical circuits, measurements, and electronics. Introduction to electromagnetic fields. Two lectures and one laboratory each week. Prerequisite, 29:3 or 29:8 and 22M:6. Staff.

29:128 Electronics 3 s.h.
Characteristics of vacuum tubes and transistors. Design and study of analog and digital circuits. Two lectures and one laboratory each week. Prerequisite, 29:127 or equivalent. Instructor: Enemark.

29:129 Electricity and Magnetism 3 s.h.
Fundamental principles including the phenomenological foundations of Maxwell's equations and their application. Three lectures each week. Instructor: Frank.

29:130 Electricity and Magnetism 3 s.h.
Continuation of 29:129, which is prerequisite. Instructor: Frank.

29:132 Intermediate Laboratory 2 s.h.
Laboratory work in electricity and magnetism and electronics, atomic, nuclear and solid state physics, optics, and spectroscopy. One laboratory period each week. May be repeated. Staff.

29:133 Advanced Laboratory 2 s.h.
Laboratory work in optical and X-ray spectroscopy, solid state, nuclear physics, and cosmic rays. One laboratory period each week. May be repeated. Instructor: Herskindowitz.

29:171 Methods of Theoretical Physics 3 s.h.
Linear algebra, integration methods, complex variables, transforms, special functions. Prerequisite, Mathematics 22M:100. Instructor: Payne.

29:172 Methods of Theoretical Physics 3 s.h.

29:191 Atomic Physics 3 s.h.

29:192 Nuclear Physics 3 s.h.
Nuclear masses, radioactivity, alpha, beta, and gamma ray spectra, nuclear energy levels and nuclear structure, nuclear reactions, the neutron, fission and fusion reactions, passage of radiations through matter, mesons and elementary particles, experimental techniques. Instructor: Waggoner.

29:193 Introductory Solid State Physics 3 s.h.
Phenomenological and theoretical properties of solids; classification of solids and crystal structures, electronic and vibrational processes in materials; thermal, optical, magnetic, and dielectric properties of solids. Instructor: Herskindowitz.

29:194 Plasma Physics 3 s.h.
Introduction to physics of ionized gases including: orbit theory, guiding center motion, adiabatic invariants; description of plasmas by fluid variables and distribution functions; linearized wave motions and instabilities; magnetohydrodynamics and MHD shock waves. Prerequisites, 29:130 and some knowledge of vector analysis. Instructor: Gurnett.
29:195 Plasma Physics 3 s.h.

Primarily for Graduates

29:205 Classical Mechanics 3 s.h.

29:211 Mechanics of Continua 3 s.h.
Hydrodynamics, dynamics of ideal fluids, both incompressible and compressible; viscous flow; the classical theory of elasticity. Prerequisites, Mathematics 22M:103, 104, and 29:171, 172, or the equivalent. Instructor: Montgomery.

29:212 Statistical Mechanics I 3 s.h.

29:213 Classical Electrodynamics 3 s.h.

29:214 Classical Electrodynamics 3 s.h.
Special relativity, motion of charges in fields, theories of radiation reaction, special topics. Prerequisite, 29:213. Instructor: Klink.

29:220 Individual Critical Study cr.arr.
An essay is to be written on a topic chosen in consultation with a member of the faculty. For candidates for the M.S. degree without thesis in physics or astronomy. Staff.

29:245 Quantum Mechanics I 3 s.h.
Nonrelativistic quantum mechanics; Schrödinger wave mechanics, Hilbert space methods, perturbation theory, scattering, spin and angular momentum, identical particles, selected applications; introduction to relativistic theory. Prerequisites, 29:191, 171, 172. Instructor: McCliment.

29:246 Quantum Mechanics II 3 s.h.
Continuation of 29:245. Instructor: McCliment.

29:249 Advanced Nuclear Physics 3 s.h.
The phenomena of nuclear physics and their interpretation. Static properties of nuclei, nuclear moments, shell model, collective model, y transitions, y decay, nuclear reaction mechanisms, and other topics. Prerequisites, 29:191, 192 and 245. May be repeated. Instructor: Carpenter.

29:250 Advanced Nuclear Physics 3 s.h.
Continuation of 29:249. Instructor: Carpenter.

Discussion of current research. Instructor: Savage.

29:265 Seminar: Theoretical Physics cr.arr.
Discussion of current research. Staff.

29:266 Seminar: Space Physics cr.arr.
Discussion of current research. Instructor: Van Allen.

29:267 Seminar: Nuclear Physics cr.arr.
Discussion of current research. Instructor: Carlson.

29:269 Special Topics in Nuclear Physics cr.arr.
Advanced lectures on one or more of the following topics: nuclear models and their relations, theory of nuclear reactions, weak interactions, heavy ion reactions. Prerequisites, 29:249, 250. May be repeated. Instructor: Carlson.

29:271 Theoretical Solid State Physics 3 s.h.

29:272 Theoretical Solid State Physics cr.arr.
Continuation of 29:271. May be repeated. Instructor: Herskindowitz.

29:273 Relativity 3 s.h.
Relativistic formulation of mechanics and electrodynamics; Einstein's theory of gravitation. Staff.

29:274 Statistical Mechanics II 3 s.h.
Advanced topics in statistical mechanics. Content may vary from year to year; e.g., foundations of kinetic theory and non-equilibrium statistical mechanics, or quantum statistical mechanics. Instructor: Schweitzer.

29:276 Special Topics in Quantum Mechanics 3 s.h.
Contemporary topics in quantum theory. Field theory, dispersion relations, group theoretic analysis of fundamental particle classification schemes, Regge poles, many-body problems. The topics discussed will vary from year to year as circumstances demand. Prerequisites, 29:245, 246. May be repeated. Staff.

29:278 Solar-Terrestrial Physics 2 s.h.
Phenomena in the solar atmosphere, corpuscular and electromagnetic radiation in interplanetary space, the geomagnetic field and interplanetary magnetic fields, magnetic storms, aurora and the geomagnetically trapped radiation. May be repeated. Instructors: Frank, Van Allen.

29:281 Research in Physics cr.arr.
Prerequisite, consent of head of department. Staff.

29:290 Physics and Chemistry of the Upper Atmosphere 2 s.h.
Physics of neutral and ionized gases. Absorption of solar radiation in relation to the ionosphere, the ozone layer, and chemical processes in the ionosphere. Electric currents associated with daily magnetic variations and magnetic storms. May be repeated. Staff.

29:294 Advanced Plasma Physics I 3 s.h.
Statistical mechanics of plasmas; Liouville equation.
29:295 Advanced Plasma Physics II 3 s.h.
Continuation of 29:294. May be repeated. Instructor: Montgomery.

Astronomy
Primarily for Undergraduates

29:61 General Astronomy 4 s.h.
Open to freshmen. Descriptive lectures and laboratory work in elementary astronomy. Study of the solar system and astronomical techniques. One laboratory per week for observation with the telescope and problem work. Prerequisite, at least one year each of high school algebra and geometry. Instructor: Neff.

29:62 General Astronomy 4 s.h.
Continuation of 29:61. Stellar astronomy, motions and physics of the stars; systems of stars; interstellar matter; galaxies. Prerequisite, same as 29:61. Instructor: Neff.

29:94 Reading in Astronomy cr.arr.
Consult head of department before registering. Staff.

29:99 Honors Seminar cr.arr.
See Physics.

For Undergraduates and Graduates

29:104 Reading in Astronomy cr.arr.
Consult head of department before registering. Staff.

29:105 General Astronomy 4 s.h.
Accelerated course offered only in the summer. Prerequisite, same as 29:61. Staff.

29:119 Stellar Dynamics and Galactic Structure 3 s.h.
Fundamentals of astrometry and stellar spectroscopy. Properties of visual, spectroscopic, and eclipsing binary stars. Stellar kinematics and dynamics. Distance indicators, their application to the investigation of the structure of the galaxy and extragalactic systems. Prerequisites, 29:18 and 22:M.7 or equivalent. Offered alternate years starting 1968. Instructor: Neff.

29:120 Stellar and Galactic Astrophysics 3 s.h.
Basic problems and methods of astrophysics. Radiation and spectra of the sun, stars, nebulae, and interstellar matter. Prerequisites, 29:10 and 22:M.7 or equivalent. Instructor: Neff.

29:121 Solar System Astrophysics 3 s.h.
Astronomical coordinates, celestial dynamics, the two and N body problems, planetary properties, planetary atmospheres. The sun and interplanetary space. Prerequisites, 29:19 and 22:M.7 or equivalent. Alternate years starting 1967-68. Instructor: Neff.