PHYSICS (PHY)

Program Director: Sam J. Cipolla
Program Office: Hixson-Lied Science Building, Room G81

GRADUATE STUDY IN PHYSICS

At Creighton University the graduate program in Physics is flexible and designed to combine a solid grounding in Physics with adaptability to a wide range of student interests and career objectives. There is a close association of students and faculty that facilitates responsiveness to the needs of each student. Graduates of four-year liberal arts colleges are of special interest to the Physics faculty, as are secondary-school and junior-college teachers who wish to enrich their background in physics. Most classes can be scheduled to accommodate working students in progressing toward the M.S. degree on a part-time basis.

Program Goals

In addition to the general learning goals of the Graduate School, at the completion of the physics graduate program, the student will:

1. Demonstrate advanced knowledge in graduate level physics and in their field of thesis research.
2. Demonstrate independent critical and analytical thinking, both within their field of study and beyond, for use in the service to others
3. Identify and suggest possible solutions to ethical dilemmas that occur in their work and field of study, and understand the importance of professional ethics in all aspects of scientific communication and laboratory work.
4. Demonstrate competence in their laboratory or computational work, including application of the scientific method and appropriate use of basic and state of the art tools and techniques.
5. Demonstrate written and oral skills necessary for communication of research, knowledge, and ideas to scientists and non-scientists.

Faculty

Professors: M. Cherney, S. Cipolla J. Seger; Professor Emeritus: R. Kennedy, T. Zepf;
Associate Professor: G. Duda, M. Nichols, D. Sidebottom;
Assistant Professors: J. Gabel, T. McShane, P. Soto.

Admission Requirements

In general, properly prepared students will have undergraduate preparation in physics comparable to the present minimum Physics degree requirements at Creighton University. This must include upper-division course work covering each of the following categories: mechanics, electromagnetics, and modern physics. Additional work in physics to bring the total to 24 semester hours, plus support from mathematics, is needed.

The Graduate School requires all students from countries in which English is not the native language to demonstrate competence in English by a score of 550 in the TOEFL (Test of English as a Foreign Language) examination or 80 on the Internet-based Test (iBT) at the graduate level.

Master of Science (M.S.) Program

Flexibility is achieved within the Graduate Division of the University through two types of master's programs — Plan A (with thesis) and Plan B (without thesis) — and within the Physics Department through the further tailoring of these programs to the needs of the individual student. **All Physics graduate students at Creighton, whether in a Plan A or a Plan B program, take the following four courses:**

PHY 611	Classical Mechanics	3 credits
PHY 621	Electromagnetic Theory	3 credits
PHY 631	Quantum Mechanics I	3 credits
PHY 641	Statistical Mechanics	3 credits

These "core courses" are designed to provide an advanced understanding of concepts, principles, and methods in the fundamental areas of Physics. In building around this core, there is considerable latitude in the choice of course work to complete the Master's degree program. The Master's program is designed to be completed by full-time students in two academic years.

Special Requirements

Physics graduate students individually arrange their graduate programs in consultation with their advisor. Course electives may be selected with the consent of the advisor. These courses normally come from the areas of atmospheric sciences, mathematics/computer science, chemistry, or biology.

Teaching Certification

Teaching certification and a M.S. degree in Physics can be earned in two years (4 semesters, 2 summers). Graduate courses are taken in both the Education and Physics departments. The program includes financial support and tuition remission for three semesters of work as a teaching assistant. A 50 percent reduction in tuition is available for the remaining credits.

Consult with Graduate Physics Advisor and Secondary Education Advisor

Summer I (50 percent tuition)

EDU 503	Foundations of Education	3 credits
EDU 510	Growth and Develop. of Children and Adolescents	3 credits
EDU 583	Management Practices for Classroom Teachers	3 credits

Fall I (tuition remission)

EDU 551	Methods of Instruction for Secondary Teaching	3 credits
EDU 552	Technology Instruction for Secondary Teaching	1 credit
PHY 585	Teaching of Physics (EDU 665)	3 credits
PHY 621	Electromagnetic Theory	3 credits

(Teaching Assistant in Creighton Physics Department - 20 hrs./week)

Spring I (tuition remission)

EDU 525	Procedures for Including Students with Mild/Moderate Disabilities in the Regular Classroom	3 credits
PHY 641	Statistical Mechanics	3 credits
PHY 791	Graduate Seminar	1 credit
PHY 797	Directed Independent Research	1 credit

Summer II (50 percent tuition)

Students who do not have a background in science other than physics will be required to take up to 12 additional hours of undergraduate courses to meet Nebraska requirements for the Physics endorsement.* (Student may work as a Teaching Assistant.)

Fall II

EDU 548	Teaching Reading in Content Areas in Middle and Secondary Schools	3 credits
PHY 631	Quantum Mechanics (meets with PHY 531)	3 credits
PHY 611	Classical Mechanics	3 credits

(Teaching Assistant in Creighton Physics Department - 20 hrs./week)

Spring II (50 percent tuition)

PHY 785	Practicum in Teaching (EDU 591)	3 credits
EDU 592	Advanced Secondary School Observation and Student Teaching	3 credits
EDU 593	Seminar in Secondary School Observation and Student Teaching	3 credits

*Specified Support Courses

CHM 203	General Chemistry I	3 credits
CHM 204	General Chemistry Laboratory I	1 credit

(One of the following:)

BIO 211	General Biology: Molecular and Cellular	4 credits
BIO 212	General Biology: Organismal and Population	4 credits

(One of the following:)

ATS/EVS 113/114	Intro to Atmospheric Sciences and Laboratory	4 credits
ATS/EVS 443	Environmental Geology	4 credits
PHY 107/108	Introductory Astronomy and Laboratory	4 credits

PHY 521 **Electronics for Scientists** (3) I
Basic course in electronics. Laboratory experiments include an introduction to measuring instruments, solid state components, and digital and logic circuits. Lecture closely follows the experiments. 1R, 5L.

PHY 522 **Electric Circuits** (3)
Kirchoff's Laws. Solutions to homogeneous and non-homogeneous linear systems in electronics. AC and DC circuit response. Computer-assisted modeling of circuits. **P: IC.**

PHY 531 **Quantum Mechanics** (3) I
Wave-packet representation of particles; development of the formalism of quantum mechanics; applications to the harmonic oscillator, the hydrogen atom, square-well potential, and scattering.

PHY 541 **Thermodynamics and Statistical Mechanics** (3) II
Laws of thermodynamics, thermodynamic variables, thermodynamic potentials; kinetic theory, distribution functions, classical and quantum statistics.

PHY 551 **Mathematical Physics** (3) OD
Mathematical methods for the representation of physical processes in space and time. Fourier and other complete representations; vector calculus; tensors and matrices. Selection and emphasis on topics keyed to needs of students enrolled. **P: PHY 212; MTH 347.**

PHY 553 **Computational Physics** (3) OD
An introduction to the computational methods most often employed within applied and theoretical physics. Each computational method is introduced in the context of a specific type of physics problem. Examples are drawn from a variety of subfields of physics including; classical, atomic, nuclear and thermodynamics. Topics include: Taylor series expansions and error estimation, numerical solutions of differential equations, solving systems of linear and/or non-linear equations, numerical solutions to partial differential equations, numerical integration techniques, Monte Carlo methods, and the Metropolis algoritm.

PHY 559 **Gravitation and Cosmology** (3) OD
This course will be an introduction to Standard Big Bang Cosmology utilizing Einstein's General Theory of Relativity. Topics in relativity will include tensor analysis, Reimannian geometry, and the Einstein Equation. Topics in cosmology will include the Friedman-Robertson-Walker metric, the age of the Universe, Dark Matter and Dark Energy, and early Universe thermodynamics.

PHY 561 **Nuclear Physics** (3) II
Application of elementary quantum mechanical theory and relativity to the study of nuclear structure, radioactive decay, and nuclear models. **P: PHY 531.**

PHY 562 **Nuclear Instruments and Methods** (2) I
Laboratory work in nuclear physics designed to teach the methods and procedures of experimental nuclear physics at an advanced level and to familiarize the student with modern research equipment and its use. 3L.

PHY 563 **High Energy Nuclear Physics** (1) OD
Students will read and discuss original journal articles related to the historical development of high energy physics.

PHY 571 **Solid State Physics** (3) II
Introduction to the theory of the solid state based on quantum mechanics. Crystal structure and symmetry, lattice dynamics, free electron model, and band theory of solids. **P: PHY 531.**

PHY 572 **Solid State Laboratory** (1) II
Laboratory work in solid state physics including x-ray crystallography. 3L. **CO: PHY 571.**

PHY 585 **Teaching of Physics** (3) I
Objectives and functions of the teaching of science in terms of secondary-school learning experiences. Attention is directed to the selection, organization, and presentation of meaningful materials; selection, use and evaluation of textbooks and related aids. Specific application of course material to physics through independent projects. Meets concurrently with EDU 445. Students are expected to complete all of the course work of EDU 445 and complete an additional independent project. **CO: EDU 341 and 342.**

PHY 587 **Laser Physics** (3) OD
A thorough review of the essential optical and physical principles needed for understanding laser characteristics, operation and design. Topics include the principle of detailed balance, absorption, stimulated emission, gain, obtaining population inversions, pumping requirements, laser cavity modes, Gaussian beams, laser resonators, Q-switching, mode-locking, and an overview of specific laser systems including gas-tube and solid-state lasers.

PHY 591 **Seminar in Engineering** (3)
A series of lectures, dicussions and engineering speakers to assist pre-engineers to define more clearly their professional goals by acquainting them with diversified career options available to engineers. Topics include: engineering career exploration and development; cooperative education and internships; and job search, resume writing and interviewing techniques. **P: IC.**

PHY 595 **Special Topics** (1-3) I, II
A course treating physics topics of special interest. The course will be subtitled in the Schedule of Classes and may be repeated under different subtitles. **P: IC.**

PHY 611 **Classical Mechanics** (Core Course) (3) I
Variational principles, Lagrange's equations, two-body central force motion, rigid-body motion, transformations, small oscillations.

PHY 621 **Electromagnetic Theory** (Core Course) (3) I
Electromagnetic fields, application of Maxwell's equations to electromagnetic waves and their interaction with matter.

PHY 631 **Quantum Mechanics I** (Core Course) (3) II
Development of the formalism of quantum mechanics with applications to simple systems.

PHY 632 **Quantum Mechanics II** (3) OD
Applications of quantum mechanics to current fields of interest. **P: PHY 631.**

PHY 641 **Statistical Mechanics** (Core Course) (3) II
Review of thermodynamics, classical and quantum statistical theory, applications to current fields of interest.

PHY 652 **Advanced Mechanical Methods** (3) OD
Small oscillations, transformations, special functions, boundary value problems.

PHY 785 **Practicum in College Teaching** (1-4) OD
Practical experience in the observation and conduct of classroom and laboratory teaching on the college level. Experience obtained under the immediate supervision of senior members of the Department of Physics. Required of all teaching assistants in the department. 9L, 1C.

PHY 790 **Research Methods** (2) OD
Introduction to current research in Physics.

PHY 791 **Graduate Seminar** (1-3) I, II
Oral presentation and critical discussion of subjects in physics or related fields by invited speakers, faculty, and students.

PHY 793 **Directed Independent Readings** (1-3) I, II, S
Advanced instruction in areas of special interest to the faculty, such as the following: atomic physics, nuclear physics, particle physics, solid state physics, surface physics, statistical mechanics, foundations of physics; biophysics. **P: IC.**

PHY 795 **Directed Independent Study** (1-3) I, II, S
Advanced study in a specific area of interest to the faculty. **P: IC.**

PHY 797 **Directed Independent Research** (1-3) I, II, S
An independent research project under the guidance of a member of the faculty. Weekly conferences. Written report of work required at the end of each semester. **P: IC.**

PHY 799 **Master's Thesis** (1-3) I, II, S
Research in connection with the preparation of the Master's thesis. Students must register for this course in any term when engaged in formal preparation of the master's thesis; however, six credit hours are the maximum applicable toward the degree. **P: DC.**