PHYSICS

Chair: Michael "Bodhi" Rogers
Department Administrator: JoAnna Ramirez-Darnell
Lower Division Laboratory Coordinator: Sami Pettus
Upper Division Laboratory Coordinator: Evan Privet
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Graduate Information

Physics, as the most fundamental of the sciences, is the foundation upon which many other disciplines are built. Therefore, other programs often require knowledge of the fundamentals of physics, and a physics degree is an outstanding platform for employment and advanced study in many technical disciplines. The Department of Physics offers an undergraduate degree in physics, has a 4+1 program between the Physics BS and the Master of Integrated Sciences (https://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-liberal-arts-sciences/integrated-sciences/), and undergraduate and graduate certificates in Quantum Information Technology and Scientific Foundations of Technical Innovation. The department also offers undergraduate minors in Astrophysics, Biophysics, and Physics.

Programs Offered

- Quantum Information Technology Graduate Certificate (http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-liberal-arts-sciences/physics/quantum-information-technology-certificate/)

Faculty

Professors:

Martin E. Huber, PhD, Stanford University
Michael "Bodhi" Rogers, PhD, RPA, Oregon State University
Alberto C. Sadun, PhD, Massachusetts Institute of Technology

Associate Professor:

Randall P. Tagg, PhD, Massachusetts Institute of Technology

Assistant Professors:

Amy L. Roberts, PhD, University of Notre Dame
Anthony N. Villano, PhD, Rensselaer Polytechnic Institute
Kathryn Hamilton, PhD, Queen's University Belfast

Teaching Professor:

Masoud Asadi-Zeydabadi, PhD, University of Colorado Boulder

Assistant Teaching Professor:

Ramesh Dhungana, PhD, University of North Dakota, Grand Forks

Research Professor:

Glen S. Mattioli, PhD, Northwestern University

Research Associate Professor:

Michael J. Friedel, PhD, University of Minnesota

Senior Instructors:

John Carlson, PhD, University of Michigan, Ann Arbor
Julian Gifford, PhD, University of Colorado Boulder

Emeritus Professors:

Martin M. Maltempo, PhD, Columbia University
Clyde S. Zaidins, PhD, California Institute of Technology

Physics (PHYS)

PHYS 5211 - Quantum Mechanics (3 Credits)
A course in which both wave and matrix mechanics are developed and applied to selected problems in atomic physics. Restriction: Restricted to Graduate and Graduate Non-Degree majors Term Typically Offered: Fall. Cross-listed with PHYS 4211. Max hours: 3 credits
Grading Basis: Letter Grade
Restriction: Restricted to Graduate and Graduate Non-Degree Majors
Typically Offered: Fall.

PHYS 5311 - Electricity & Magnetism (3 Credits)
Elements of mathematical theory of electricity and magnetism, including electrostatics, magnetostatics, polarized media, direct and alternating current theory, and introduction to electromagnetic fields and waves. Restriction: Restricted to Graduate and Graduate Non-Degree Majors. Term Typically Offered: Spring. Cross-listed with PHYS 4311. Max hours: 3 credits.
Grading Basis: Letter Grade
Restriction: Restricted to Graduate and Graduate Non-Degree Majors
Typically Offered: Spring.

PHYS 5351 - Bioelectromagnetism (4 Credits)
The fundamental theory of electric and magnetic fields is developed and applied to problems in biology and medicine. Examples in medical diagnostics and treatment are built upon rigorous application of Maxwell's equations and constitutive models of electromagnetic properties of biomaterials. Restriction: Restricted to Graduate and Graduate Non-Degree Majors. Cross-listed with PHYS 4351. Term offered: spring, infrequent. Max hours: 4 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to Graduate and Graduate Non-Degree Majors
Typically Offered: Spring.

PHYS 5352 - Bioelectromagnetism NM (4 Credits)
This course is the non-majors' companion to PHYS 4351/5351 (taught simultaneously) using modeling approaches accessible to the general science student. Restriction: Restricted to Graduate and Graduate Non-Degree Majors. Cross-listed with PHYS 4352. Term offered: spring, infrequent. Max Hours: 4 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to Graduate and Graduate Non-Degree Majors
Typically Offered: Spring.

PHYS 5400 - Scientific Instrumentation (3 Credits)
Conceptual and practical knowledge needed to design scientific instruments, develop technical products, and use special laboratory procedures to research. Topics include materials, mechanisms, electronics, and optics. Cross-listed with PHYS 4400. Repeatable. Infrequently Offered. Max hours: 6 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 6.

PHYS 5401 - Special Topics (1-3 Credits)
Repeatable. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 3.

PHYS 5678 - Quantum Computing (3 Credits)
The course teaches students the principles, the algorithms and the programming methods of quantum computing, and also discusses the associated physics and mathematics background required. Other related topics such as quantum communication and quantum entanglement will also be discussed. Prereq: PHYS 2811 with a C- or higher or Permission of Instructor. Cross-listed with PHYS 4678, ELEC 4678, and ELEC 5678. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: PHYS 2811 with a C- or higher.
Typically Offered: Spring.

PHYS 5679 - Quantum Computing Algorithms (3 Credits)
The course discusses several seminal quantum algorithms, including the quantum Fourier transforms, Grover's and Shor's algorithms, followed by explaining several advanced quantum computing algorithms, including quantum error correction, sparse linear systems , and variational eigensolver. Google Cirq quantum programming library will be used for actual quantum programming implementations of the algorithms discussed. Instructor permission required. Cross-listed with PHYS 4679, ELEC 4679, and ELEC 5679. Max hours: 3 Credits.
Grading Basis: Letter Grade

PHYS 5680 - Quantum Computing Technology (3 Credits)
Students will explore some of the concepts and experimental practices for realizing quantum computers. They will engage in laboratory practice of relevant skills including high-performance analog electronics; optics-based quantum encryption and eraser implementations; RF electronics; and vacuum and cryogenic techniques. Instructor permission required. Pre-req: PHYS 3711 with a C- or higher or Permission of Instructor. Cross-listed with PHYS 4680, ELEC 4680, and ELEC 5680. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: PHYS 3711 with a C- or higher.
Typically Offered: Fall.

PHYS 5681 - Quantum Technology Systems (3 Credits)
Students will explore a systems approach toward experimental practices for realizing quantum information science and engineering (QISE), with a focus on vacuum and cryogenic techniques and integration of electronics subsystems into a "dry" cryostat. They will engage in laboratory practice of relevant skills including creation and measurement of high vacuum, methods for reaching ultra-low temperatures, concerns in the design and construction of cryogenic apparatuses, and operation of a "dry" cryogenic system at 4 K, including measurements on superconducting quantum interference devices. Prereq: PHYS 4680 OR PHYS 5680 OR ELEC 4680 OR ELEC 5680 with a C- or higher. Cross-listed with ELEC 4681, ELEC 5681 and PHYS 4681. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: PHYS 4680 OR PHYS 5680 OR ELEC 4680 OR ELEC 5680 with a C- or higher.

PHYS 5840 - Independent Study: PHYS (1-3 Credits)
Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Term offered: spring, summer, fall infrequently. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 3.
Typically Offered: Fall, Spring, Summer.

PHYS 5850 - Physics for Design and Innovation I (3 Credits)
A service-learning project using fundamental physical principles to design a prototype scientific instrument, technical device, or technical process for a real-world client. Includes instruction on project management, intellectual property, and market analysis. Cross-listed with PHYS 4850. Repeatable. Term offered: infrequent. Max Hours: 6 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 6.

PHYS 5852 - Physics for Design and Innovation II (3 Credits)
A capstone project using fundamental physical principles to prototype a scientific instrument, technical device or technical process. The focus is on the student's own product idea. Includes online guided readings on the wider context of product development. Students should consult with instructor on necessary physics and mathematics preparation for the project. Prereq: PHYS 4850 or 5850 with a C- or higher. Cross-listed with PHYS 5852. Repeatable. Term offered: infrequent. Max hours: 6 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 6.
Prereq: PHYS 4850 or 5850 with a C- or higher.

PHYS 5880 - Directed Research (1-6 Credits)
Students will engage in original research projects supervised and mentored by faculty. Students must work with faculty prior to registration to develop a proposal for their project and receive permission to take this course. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Max Hours: 6 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 6.

PHYS 5939 - Internship (1-6 Credits)
Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Note: Students must check with a faculty member before taking this course. Repeatable. Term offered: spring, summer, fall infrequently. Max hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.
Typically Offered: Fall, Spring, Summer.

PHYS 5950 - Master's Thesis (1-8 Credits)
Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Max hours: 8 Credits.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 8.
Additional Information: Report as Full Time.

PHYS 5960 - Master's Project (1-8 Credits)
Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Department consent required. Repeatable. Max hours: 8 Credits.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 8.
Additional Information: Report as Full Time.

PHYS 5980 - Advanced Physics Topics (1-3 Credits)
Covers a particular topic as announced in the 'Schedule Planner.' Note: May be taken more than once for credit in different topics. Note: this course assumes that students have completed PHYS 2811 or equivalent. Prereq: Graduate standing. Repeatable. Max hours: 12 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 12.
Restriction: Restricted to Graduate and Graduate Non-Degree Majors

PHYS 6840 - Independent Study: PHYS (1-3 Credits)
Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 3.