PHYSICS

Undergraduate Program Information
A bachelor’s degree in physics provides the basis for careers in industry, teaching, the military, government or for study toward advanced degrees in physics or engineering. It should also provide the skills that recipients of physics degrees have listed as among the most important in obtaining their current positions, including problem solving ability, computer skills, mathematical skills, and laboratory skills, as well as knowledge of physics.

Further information about the department may be found on the web at www.physics.nmsu.edu (http://www.physics.nmsu.edu). All incoming (new or transfer) students must schedule an orientation meeting with the department head and/or the undergraduate program head before their first semester at NMSU. All students will be assigned a faculty advisor in the physics department to discuss course selection, career resources, internships and coops, and other topics.

Graduate Program Information
The Department of Physics offers programs in many areas of emphasis leading to the MS and Ph.D. degrees. Admission to these programs is competitive and selection of applicants is based on undergraduate and/or previous graduate grade-point averages, performance on the general and subject Graduate Record Examination, other evidence of prior academic and research accomplishments submitted by the applicant, and references, as well as, in the case of applicants for the doctoral program, matching of the applicant’s research interests, as described by the student’s statement of purpose, to the Department’s research activities.

All degree-seeking graduate students must satisfy the relevant Graduate School requirements, pass a qualifying examination based on undergraduate physics courses at the 400 level, successfully complete a 3-credit, 500-level laboratory, and demonstrate or develop knowledge of computer programming. Additional course requirements are described below; courses taken S/U may not be used to satisfy any of the degree requirements, including the lab requirement for Master’s and Ph.D. students.

The qualifying and comprehensive examination outcomes are decided by vote of the entire faculty, based on the recommendations of the corresponding examination committees. For the qualifying examination, the faculty may decide that

- a student pass at the doctoral level;
- pass at the master’s level;
- be requested to retake the exam at the next available opportunity; or
- terminate graduate study.

For the written part of the comprehensive examination, the faculty may decide that

- a student be given an unconditional pass;
- be given a conditional pass, with the requirement that the student produce additional evidence of research accomplishments during the oral part of the exam before being granted admission to candidacy;
- repeat the written part the next time it is offered; or
- terminate graduate study.

In addition, the faculty may decide to discontinue financial support to a student based on the student’s performance on the qualifying or comprehensive examination. Students will receive written notification of the exam’s outcome from the Graduate Physics Program Head within 30 days of the exam. Appeals must be addressed to the Physics Department Head within 30 days of receiving written notification of the exam’s outcome and will be decided by the physics faculty.

A student granted an unconditional or conditional pass on the written part of the comprehensive examination must take the oral part in the same semester that the written part was taken; the student’s Ph.D. committee makes the final decision, following the oral part of the comprehensive examination, on admission of the student to the candidacy to the doctoral degree.

Students may choose areas of emphasis from a variety of experimental, theoretical and computational research programs in the department. The current major research areas of the department include atmospheric physics, condensed matter physics/materials science, geophysics, optics, particle and nuclear physics, physics education, and others. These research projects are supported by multimillion-dollar funding by various federal agencies and two national laboratories within the state of New Mexico: Los Alamos National Laboratory and Sandia National Laboratories. In addition to the in-house research, the department conducts collaborative research programs with

- The Brookhaven National Laboratory,
- The Center for Integrated NanoTechnologies,
- Los Alamos National Laboratory,
- Sandia National Laboratories,
- The Thomas Jefferson Laboratory,
- Fermilab,
- Air Force Research Laboratory and
- other national and international laboratories.

The MS in Physics with a concentration in Space Physics program provides students with a strong foundation in physics with an intensive focus on space physics. Graduate study in space physics at the master’s level prepares graduates for continued and specialized study toward the doctorate program in space-related fields as well as for challenges they will confront in space industrial and government settings.

The department is housed in a newly-renovated building which contains research laboratories, classrooms, offices and a computational laboratory.

Degrees for the Department
Physics - Bachelor of Arts (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-bachelor-arts)

Physics - Bachelor of Science (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-bachelor-science)

Engineering Physics - Bachelor of Science in Engineering Physics (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/engineering-physics-bachelor-science-engineering-physics)

Physics - Master of Science (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-master-science)

Physics - Doctor of Philosophy (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-doctor-philosophy)
Dual Degree
Physics - Bachelor of Science/Master of Science (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-bachelor-science) (scroll to bottom of the B.S. Page for more information)

Minors for the Department
Physics - Undergraduate Minor (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-undergraduate-minor)

Physics - Graduate Minor (http://catalogs.nmsu.edu/nmsu/arts-sciences/physics/physics-graduate-minor)

Professor, Stefan Zollner, Department Head

Professor, Stephen Pate, Undergraduate Program Head

Associate Professor, Vassilios Papavassiliou, Graduate Program Head

Professor, Heinz Nakotte, Engineering Physics Program Head

Professors Ma. Burkardt, Kiefer, Nakotte, Pate, Vasilyiev, Zollner; Associate Professors Engelhardt, Hearn, Papavassiliou, Urquidi; Assistant Professors Cooper, Fohtung, Schlegel, Waszek; College Professors Mi. Burkardt, DeAntonio; Emeritus Faculty Burleson, Gibbs, Goedcke, Kanim, Kyle, Liefield, Ni.


Geophysics Courses
GPHY 340V. Planet Earth
3 Credits

GPHY 450. Selected Topics
1-3 Credits
Readings, discussions, lectures or laboratory studies of selected areas of geophysics. May be repeated for a maximum of 12 credits.

GPHY 501. Geophysical Field Methods
1-3 Credits (3-9P)
Field collection, reduction, and interpretation of geophysical data; equipment operation.

GPHY 520. Selected Topics
1-3 Credits
Formal treatment of graduate topics not covered in regular courses. May be repeated for unlimited credit.

GPHY 530. Seismology
3 Credits
Seismic wave propagation in a layered earth, ray theory, exploration techniques, earth structure, and seismicity. May be repeated up to 3 credits.

GPHY 540. Physics of the Earth and Planetary Interiors
3 Credits

GPHY 550. Applied Inverse Theory
3 Credits
Inversion of data with an emphasis on geophysical problems. Curve fitting, tomography, earthquake location, over determined and under determined problems, linear and nonlinear problems. Computing experience desirable. May be repeated up to 3 credits. Consent of Instructor required.

GPHY 598. Special Research Problems
1-3 Credits
Individual investigations, either analytical or experimental. May be repeated for unlimited credit.

GPHY 599. Master’s Thesis
1-15 Credits (1-15)
Thesis.

GPHY 620. Advanced Topics in Geophysics
3 Credits
Advanced formal treatment of a topic or topics not covered in regular courses. May be repeated for unlimited credit.

GPHY 630. Theoretical Seismology
3 Credits
Advanced treatment of wave propagation, ray theory, inversion methods, extension to heterogeneous media, and free oscillations.

GPHY 640. Physics of the Earth and Planetary Interiors
3 Credits
Dissertation.

GPHY 700. Doctoral Dissertation
1-15 Credits (1-15)
Dissertation.

Physics Courses
PHYS 110G. The Great Ideas of Physics
4 Credits (3+3P)
Conceptual, quantitative, and laboratory treatments of the great ideas and discoveries that have influenced lives and changed perceptions of nature, from Johannes Kepler’s laws of planetary motion and Isaac Newton’s and Albert Einstein’s laws of motion and gravity to the modern concepts of the quantal structure of nature and the big bang universe.
PHYS 120G. Introduction to Acoustics  
4 Credits (3+2P)  
Lecture, demonstration, and laboratory treatment of the general properties of waves, the production, transmission, and reception of sound waves, including musical and vocal sounds, and characteristics of the human ear and several kinds of sources.  

PHYS 150. Elementary Computational Physics  
3 Credits (2+2P)  
Introduction to computational techniques for the solution of physics-related problems. May be repeated up to 3 credits.  
Prerequisite(s): a C- or better in MATH 121G or MATH 190G or MATH 191G.

PHYS 203. Supplemental Instruction to PHYS 213  
0.5-1 Credits (.5-1)  
Optional workshop as a supplement to PHYS 213. The tutorial sessions focus on reasoning and hands-on problem solving. May be repeated up to 1 credits.  
Corequisite(s): PHYS 213.

PHYS 204. Supplemental Instruction to PHYS 214  
0.5-1 Credits (.5-1)  
Optional workshop as a supplement to PHYS 214. The tutorial sessions focus on reasoning and hands-on problem solving. May be repeated up to 1 credits.  
Corequisite(s): PHYS 214.

PHYS 205. Supplemental Instruction to PHYS 215G  
0.5-1 Credits (.5-1)  
Optional workshop as a supplement to PHYS 215G. The tutorial sessions focus on reasoning and hands-on problem solving. May be repeated up to 1 credits.  
Corequisite(s): PHYS 215G.

PHYS 206. Supplemental Instruction to PHYS 216G  
0.5-1 Credits (.5-1)  
Optional workshop as a supplement to PHYS 216G. The tutorial sessions focus on reasoning and hands-on problem solving. May be repeated up to 1 credits.  
Corequisite(s): PHYS 216G.

PHYS 210. Introductory Physics for the Health Sciences  
3 Credits  
Algebra-level introduction to topics required for the Health Sciences including basic mechanics (including sound, mechanical waves and fluids), heat and thermodynamics, electricity and magnetism, optics and electromagnetic waves, atomic and nuclear physics and applications to medical imaging. Restricted to Community Colleges campuses only.  
Prerequisite(s): MATH 120 or Equivalent.

PHYS 211G. General Physics I  
3 Credits  
Non-calculus treatment of mechanics, waves, sound, and heat. Knowledge of simple algebra and trigonometry is required.

PHYS 211GL. General Physics I Laboratory  
1 Credit  
Laboratory experiments in topics associated with material presented in PHYS 211G.  
Prerequisite(s)/Corequisite(s): PHYS 211G.

PHYS 212G. General Physics II  
3 Credits  
Non-calculus treatment of electricity, magnetism, and light. May be repeated up to 3 credits.  
Prerequisite(s): a C- or better in PHYS 211G or PHYS 221G.

PHYS 212GL. General Physics II Laboratory  
1 Credit  
Laboratory experiments in topics associated with material presented in PHYS 212G.  
Prerequisite(s)/Corequisite(s): PHYS 212G.

PHYS 213. Mechanics  
3 Credits  
Newtonian mechanics. Pre/ 
Corequisite(s): MATH 191G.

PHYS 213 L. Experimental Mechanics  
1 Credit  
Laboratory experiments associated with the material presented in PHYS 213. Science majors. Pre/ 
Corequisite(s): PHYS 213.

PHYS 214. Electricity and Magnetism  
3 Credits  
Charges and matter, the electric field, Gauss law, the electric potential, the magnetic field, Ampere’s law, Faraday’s law, electric circuits, alternating currents, Maxwell’s equations, and electromagnetic waves. May be repeated up to 3 credits.  
Prerequisite(s)/Corequisite(s): MATH 192G. Prerequisite(s): a C- or better in PHYS 213 or PHYS 215G, and MATH 191G.

PHYS 214 L. Electricity and Magnetism Laboratory  
1 Credit  
Laboratory experiments associated with the material presented in PHYS 214.  
Prerequisite(s)/Corequisite(s): PHYS 214. Prerequisite(s): a C- or better in PHYS 213L or PHYS 215GL.

PHYS 215G. Engineering Physics I  
3 Credits  
A calculus-level treatment of kinematics, work and energy, particle dynamics, conservation principles, simple harmonic motion. May be repeated up to 3 credits.  
Prerequisite(s): a C- or better in MATH 191G.

PHYS 215GL. Engineering Physics I Laboratory  
1 Credit  
Laboratory experiments associated with the material presented in PHYS 215G. Students wishing to use the PHYS 215G-216G sequence to satisfy the basic natural science general education requirement must register for either PHYS 215GL or PHYS 216GL. Pre/ 
Corequisite(s): PHYS 215G.

PHYS 216G. Engineering Physics II  
3 Credits  
A calculus-level treatment of topics in electricity, magnetism, and optics. May be repeated up to 3 credits.  
Prerequisite(s): a C- or better in PHYS 213 or PHYS 215G and MATH 192G.

PHYS 216GL. Engineering Physics II Laboratory  
1 Credit  
Laboratory experiments associated with the material presented in PHYS 216G.  
Prerequisite(s)/Corequisite(s): PHYS 216G. Prerequisite(s): A C- or better in PHYS 213L or PHYS 215GL.
PHYS 217. Heat, Light, and Sound
3 Credits
Calculus-level treatment of thermodynamics, geometrical and physical optics, and sound. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 213 or PHYS 215G, and MATH 191G.

PHYS 217 L. Experimental Heat, Light and Sound
1 Credit
Laboratory experiments associated with the material presented in PHYS 217. Science majors.
Prerequisite(s)/Corequisite(s): PHYS 217. Prerequisite(s): a C- or better in PHYS 213L or PHYS 215GL.

PHYS 218. Supplemental Instruction to PHYS 217
0.5-1 Credits (.5-1)
This optional workshop supplements PHYS 217 "Heat, Light, and Sound". Students actively apply concepts and methods introduced in PHYS 217 to problem solving and quantitative analysis. May be repeated up to 1 credits.
Corequisite(s): PHYS 217.

PHYS 221G. General Physics for Life Sciences I
3 Credits
This algebra-based introduction to general physics covers mechanics, waves, sound, and heat. Special emphasis is given to applications in the life sciences. This course is recommended for students in the life sciences and those preparing for the physics part of the MCAT.
Prerequisites: a C or better in MATH 120 or higher.

PHYS 221GL. Laboratory to General Physics for Life Science I
1 Credit
Laboratory experiments in topics associated with material presented in PHYS 221G.
Prerequisite(s)/Corequisite(s): PHYS 221G. Restricted to Las Cruces campus only.

PHYS 222G. General Physics for Life Sciences II
3 Credits
This algebra-based course covers electricity, magnetism, light, atomic physics, and radioactivity. Special emphasis is given to applications in the life sciences. This course is recommended for students in the life sciences and those preparing for the physics part of the MCAT. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 211G or PHYS 221G, and MATH 121G.

PHYS 222GL. Laboratory to General Physics for Life Sciences II
1 Credit
Laboratory experiments in topics associated with material presented in PHYS 222G.
Prerequisite(s)/Corequisite(s): PHYS 222G. Restricted to Las Cruces campus only.

PHYS 223. Supplemental Instruction to PHYS 221
1 Credit
This optional workshop supplements Physics for Life Sciences I. The tutorial sessions focus on reasoning and hands-on problem solving.
Corequisite(s): PHYS 221G.

PHYS 224. Supplemental Instruction to PHYS 222
1 Credit
This optional workshop is a supplement to Physics for Life Science II. The tutorial sessions focus on reasoning and hands-on problem solving.
Corequisite(s): PHYS 222G.

PHYS 280. Independent Study
1-3 Credits
Individual analytical or laboratory studies directed by a faculty member. May be repeated for a maximum of 6 credits.
Prerequisite: consent of instructor.

PHYS 290. Special Topics
1-3 Credits
Topics to be announced in the Schedule of Classes. May be repeated for a maximum of 12 credits.

PHYS 303V. Energy and Society in the New Millennium
3 Credits
Traditional and alternative sources of energy. Contemporary areas of concern such as the state of depletion of fossil fuels; nuclear energy, solar energy, and other energy sources; environmental effects; nuclear weapons; and health effects of radiation. Discussion of physical principles and impact on society. Focus on scientific questions involved in making decisions in these areas. No physics background required.

PHYS 304. Forensic Physics
4 Credits (3+3P)
Theories, laboratory, and field techniques in the area of forensic physics.

PHYS 305V. The Search for Water in the Solar System
3 Credits
Examines the formation, abundance and ubiquity of water in our Solar System stemming from comets, Martian and Lunar poles, Earth’s interior and into the outer reaches of the Solar System. Topics will include nuclear synthesis, Solar System formation, remote sensing, as well as past, present and future NASA missions for water.

PHYS 315. Modern Physics
3 Credits
An introduction to relativity and quantum mechanics, with applications to atoms, molecules, solids, nuclei, and elementary particles. May be repeated up to 3 credits.
Prerequisite(s): a C - or better in MATH 291G and PHYS 214 or PHYS 216G.

PHYS 315 L. Experimental Modern Physics
3 Credits (1+6P)
Elementary laboratory in modern physics which supports the subject matter in PHYS 315. Required for physics majors. May be repeated up to 3 credits.
Prerequisite(s)/Corequisite(s): PHYS 315. Prerequisite(s): a C- or better in PHYS 214L or 216GL.

PHYS 316. Supplemental Instructions to PHYS 315
1 Credit
This optional workshop supplements PHYS 315 “Modern Physics”. Students actively apply concepts and methods introduced in PHYS 315 to problem solving and quantitative analysis.
Corequisite(s): PHYS 315.

PHYS 350. Special Topics
1-3 Credits
Lectures, demonstrations, and discussions on such topics as lasers and holography, energy sources, clouds, and biophysics. May be repeated for a maximum of 12 credits under different subtitles.

PHYS 380. Individual Study
1-3 Credits
Individual analytical or laboratory studies directed by a faculty member. May be repeated for a maximum of 6 credits.
Prerequisite: consent of instructor.
PHYS 395. Intermediate Mathematical Methods of Physics 3 Credits
Introduction to the mathematics used in intermediate-level physics courses. Topics include vector calculus, curvilinear coordinates, matrices, linear algebra, function spaces, partial differential equations, and special functions. May be repeated up to 3 credits.
Prerequisite(s)/Corequisite(s): MATH 392. Prerequisite(s): a C- or better in MATH 291G.

PHYS 400. Undergraduate Research 1-3 Credits
May be repeated for a maximum of 6 credits.
Prerequisite: consent of instructor.

PHYS 420. Capstone Project I 3 Credits
Application of engineering physics principles to a significant design project. Includes teamwork, written and oral communication and realistic technical, economic and public safety requirements.

PHYS 421. Capstone Project II 3 Credits
Continuation of PHYS 420.

PHYS 450. Selected Topics 1-3 Credits
Readings, lectures or laboratory studies in selected areas of physics. May be repeated for a maximum of 12 credits.

PHYS 451. Intermediate Mechanics I 3 Credits
Vector calculus, Lagrangian and Hamiltonian formulations of Newtonian mechanics. Topics include central force motion, dynamics of rockets and space vehicles, rigid body motion, noninertial reference frames, oscillating systems, relativistic mechanics, classical scattering, and fluid mechanics. May be repeated up to 3 credits.
Prerequisite(s)/Corequisite(s): MATH 392. Prerequisite(s): a C- or better in PHYS 213 or PHYS 215G, and MATH 291G.

PHYS 454. Intermediate Modern Physics I 3 Credits
Introduction to quantum mechanics, focusing on the role of angular momentum and symmetries, with application to many atomic and subatomic systems. Specific topics include intrinsic spin, matrix representation of wave functions and observables, time evolution, and motion in one dimension. May be repeated up to 3 credits.
Prerequisite(s)/Corequisite(s): MATH 392 and PHYS 395. Prerequisite(s): a C- or better in PHYS 315.

PHYS 455. Intermediate Modern Physics II 3 Credits
Continuation of subject matter of PHYS 454. Specific topics include rotation and translation in three dimensions, solution of central potential problems, perturbation theory, physics of identical particles, scattering theory, and the interaction between photons and atoms. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 454, MATH 392, and PHYS 395.

PHYS 461. Intermediate Electricity and Magnetism I 3 Credits
The first part of a two-course sequence in classical electrodynamics. Covered topics include static electric and magnetic fields, Laplace's and Poisson's equations, electromagnetic work and energy, Lorentz force, Gauss's, Biot-Savart, and Ampere's laws, Maxwell's equations, as well as electric and magnetic fields in matter. May be repeated up to 3 credits.
Prerequisite(s)/Corequisite(s): MATH 392 and PHYS 395. Prerequisite(s): a C- or better in PHYS 214 or PHYS 216G or equivalent and a C- or better in MATH 291G.

PHYS 462. Intermediate Electricity and Magnetism II 3 Credits
Continuation of subject matter of PHYS 461. Covered topics include Maxwell's equations and their applications, electromagnetic waves, reflection, refraction, dispersion, radiating systems, interference and diffraction, as well as Lorentz transformations and relativistic electrodynamics. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 461, MATH 392, and PHYS 395.

PHYS 467. Nanoscience and Nanotechnology 3 Credits
See CHME 467. Crosslisted with: CHME 467.
Prerequisite(s): CHEM 112 and (PHYS 211 or PHYS 215) and (EH&S Safety training to include the courses: (1) Employee & Hazard Communication Safety (HazCom); (2) Hazardous Waste Management; and (3) Laboratory Standard.

PHYS 468. Intermediate X-ray Diffraction 3 Credits
Introduction to x-ray diffraction and reflectivity spectra. Topics include X-ray sources and detectors, atomic spectra, characteristic x-rays, thermionic emission, synchrotron radiation, instrument components, and beam conditioners. Crosslisted with: CHME 488.
Prerequisite(s): a C- or better in PHYS 315 and PHYS 315L.

PHYS 471. Modern Experimental Optics 3 Credits (1+6P)
Advanced laboratory experiments in optics related to the material presented in PHYS 473.
Prerequisite(s): PHYS 315 and PHYS 315L.

PHYS 473. Introduction to Optics 4 Credits
The nature of light, Geometrical optics, basic optical instruments, wave optics, aberrations, polarization, and diffraction. Elements of optical radiometry, lasers and fiber optics. May be repeated up to 4 credits. Crosslisted with: E E 473.
Prerequisite(s): PHYS 216G or PHYS 217.

PHYS 475. Advanced Physics Laboratory 1-3 Credits (1+6P)
Advanced undergraduate laboratory involving experiments in atomic, molecular, nuclear, and condensed-matter physics. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 315 and PHYS 315L.

PHYS 476. Computational Physics 3 Credits
An introduction to finite difference methods, Fourier expansions, Fourier integrals, solution of differential equations, Monte Carlo calculations, and application to advanced physics problems. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 150 or equivalent and MATH 392.
PHYS 478. Fundamentals of Photonics
4 Credits (3+3P)
Prerequisite(s): PHYS 216G or PHYS 217.

PHYS 479. Lasers and Applications
4 Credits (3+3P)
See E E479 Crosslisted with: E E479.
Prerequisite(s): C- or better in E E 315 or PHYS 461.

PHYS 480. Thermodynamics
3 Credits
Thermodynamics and statistical mechanics. Basic concepts of temperature, heat, entropy, equilibrium, reversible and irreversible processes. Applications to solids, liquids, and gases. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 217, PHYS 315, and MATH 291G.

PHYS 485. Independent Study
1-3 Credits
Individual analytical or laboratory studies directed by a faculty member. May be repeated for a maximum of 6 credits.
Prerequisite: consent of instructor.

PHYS 488. Introduction to Condensed Matter Physics
3 Credits
Crystal structure, X-ray diffraction, energy band theory, phonons, cohesive energy, conductivities, specific heats, p-n junctions, defects, surfaces, and magnetic, optical, and low-temperature properties. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 315.

PHYS 489. Introduction to Modern Materials
3 Credits
Structure and mechanical, thermal, electric, and magnetic properties of materials. Modern experimental techniques for the study of material properties. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 315.

PHYS 491. High Energy Physics I
3 Credits
Prerequisite(s): a C- or better in PHYS 455.

PHYS 493. Experimental Nuclear Physics
3 Credits (1+6P)
Selected experimental investigations in nuclear physics such as measurement of radioactivity, absorption of radiation, nuclear spectrometry. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in PHYS 315 and PHYS 315L.

PHYS 495. Mathematical Methods of Physics I
3 Credits
Applications of mathematics to experimental and theoretical physics. Topics selected from: complex variables; special functions; numerical analysis; Fourier series and transforms, Laplace transforms. May be repeated up to 3 credits.
Prerequisite(s): a C- or better in MATH 392 and PHYS 395.

PHYS 500. Special Topics Seminar
1-2 Credits
Treatment of topics not covered by regular courses. Graded S/U. May be repeated.

PHYS 501. Mathematical Methods of Physics I
3 Credits
Same as PHYS 495. Additional work required at a more advanced level.

PHYS 511. Mathematical Methods of Physics I
3 Credits
Same as PHYS 495. Additional work required at a more advanced level.

PHYS 511. Mathematical Methods of Physics I
3 Credits
Same as PHYS 495. Additional work required at a more advanced level.

PHYS 520. Selected Topics
1-3 Credits
Formal treatment of graduate-level topics not covered in regular courses. May be repeated for a maximum of 9 credits.
Prerequisites: graduate standing, consent of instructor, and selection of a specific topic prior to registration.

PHYS 521. Individual Study
1-3 Credits
Individual analytical or laboratory studies directed by a faculty member. May be repeated for a maximum of 6 credits.
Prerequisites: graduate standing, consent of instructor, and selection of a specific topic prior to registration.

PHYS 528. Fundamentals of Photonics
4 Credits (3+3P)
Same as E E 528. Crosslisted with: E E528.

PHYS 551. Classical Mechanics
3 Credits
Lagrangian and Hamiltonian formulation of dynamics. Advanced treatments of most topics listed under PHYS 451, plus canonical transformations and Hamilton-Jacobi theory. PHYS 451 strongly recommended.

PHYS 554. Quantum Mechanics I
3 Credits

PHYS 555. Quantum Mechanics II
3 Credits
Continuation of topics in PHYS 554.
Prerequisites: PHYS 554 or consent of instructor.

PHYS 561. Electromagnetic Theory I
3 Credits
Detailed advanced treatments of most topics listed under PHYS 461, PHYS 462, plus multipole radiation, collisions of charged particles and bremsstrahlung, scattering, and radiation reaction. PHYS 461 and PHYS 462 strongly recommended.

PHYS 562. Electromagnetic Theory II
3 Credits
Continuation of topics in PHYS 561.
Prerequisites: PHYS 561 or consent of instructor.

PHYS 564. Quantum Mechanics I
3 Credits

PHYS 565. Quantum Mechanics II
3 Credits
Continuation of topics in PHYS 564.
Prerequisites: PHYS 554 or consent of instructor.

PHYS 567. Nanoscience and Nanotechnology
3 Credits
See CHME 567. Crosslisted with: CHME 567.

PHYS 568. Elements of X-ray Diffraction
3 Credits
Same as PHYS 468, but additional work required. Crosslisted with: CHME 588.

PHYS 571. Advanced Experimental Optics
3 Credits
Taught with PHYS 471 with additional work required at the graduate level. Consent of Instructor required.
Prerequisite(s): PHYS 473 or PHYS 562.
PHYS 575. Advanced Physics Laboratory  
1-3 Credits (1+6P)  
Selected experiments in atomic, molecular, nuclear and condensed-matter physics.

PHYS 576. Advanced Computational Physics I  
3 Credits  
Advanced treatment of topics listed under PHYS 476, plus additional required work. Applications of numerical methods to complex physical systems. Recommended knowledge of Fortran or C, and MATH 377 or MATH 392. Same as PHYS 476, but additional work required.

PHYS 577. Fourier Methods in Electro-Optics  
3 Credits  
Same as E E 577 Crosslisted with: E E 577

PHYS 584. Statistical Mechanics  
3 Credits  

PHYS 588. Condensed Matter Physics  
3 Credits  
Same as PHYS 488, but additional work required.  
Prerequisite(s): PHYS 554 or consent of instructor.

PHYS 589. Modern Materials  
3 Credits  
Same as PHYS 489 with differentiated assignments for graduate students.  
Prerequisite: PHYS 554 or consent of instructor.

PHYS 591. Advanced High-Energy Physics I  
3 Credits  
Taught with PHYS 491 with additional work required at the graduate level.  
Prerequisite(s): PHYS 555 or consent of instructor.

PHYS 592. Advanced High-Energy Physics II  
3 Credits  
Continuation of topics in PHYS 591  
Prerequisite(s): PHYS 591.

PHYS 593. Advanced Experimental Nuclear Physics  
3 Credits (1+6P)  
Advanced experimental investigation of topics such as measurement of radioactivity, absorption of radiation, and nuclear spectrometry.

PHYS 597. Space Plasma Physics  
3 Credits  
Same as PHYS 497 but with added requirements.

PHYS 599. Master’s Thesis  
1-15 Credits (1-15)  
Thesis.

PHYS 600. Research  
1-15 Credits  
Doctoral research. May be repeated.

PHYS 620. Advanced Topics in Physics  
1-3 Credits  
Advanced formal treatment of topics not covered in regular courses. May be repeated for a maximum of 9 credits.  
Prerequisite: consent of instructor.

PHYS 650. General Relativity I  
3 Credits  
Basic foundations and principles of general relativity, derivation of the Einstein field equations and their consequences, the linearized theory, the Bel-Petrov classification of the curvature tensor, derivation of the Schwarzschild solution and the four basic tests of general relativity.  
Prerequisite(s): PHYS 511 or PHYS 561 or consent of instructor.

PHYS 680. Independent Study  
1-3 Credits  
Individual analytical or laboratory studies directed by a faculty member. May be repeated for a maximum of 6 credits.  
Prerequisite: graduate standing or consent of instructor.

PHYS 688. Advanced Condensed Matter Physics  
3 Credits  
Continuation of the advanced condensed matter physics presented in PHYS 588. Topics include electronic structure methods, optical, magnetic, and transport properties of solids, semiconductors, crystalline defects, nanostructures, and noncrystalline solids. PHYS 588 strongly recommended.

PHYS 689. Advanced Modern Materials  
3 Credits  
Advanced topics in the physics of modern materials, such as crystalline, amorphous, polymeric, nanocrystalline, layered, and composite materials and their surfaces and interfaces.  
Prerequisites: PHYS 555, PHYS 588, or consent of instructor.

PHYS 691. Quantum Field Theory I  
3 Credits  
Path integrals, gauge invariance, relativistic quantum mechanics, canonical quantization, relativistic quantum field theory, introduction to QED.  
Prerequisites: PHYS 555 and PHYS 562, or consent of instructor.

PHYS 692. Quantum Field Theory II  
3 Credits  
QED, running coupling constant, QCD, electroweak theory, asymptotic freedom, deep inelastic scattering, basic QCD phenomenology, path integrals in quantum field theory, lattice QCD.  
Prerequisite: PHYS 691 or consent of instructor.

PHYS 700. Doctoral Dissertation  
1-15 Credits (1-15)  
Dissertation.

Phone: (575) 646-3831  
Website: http://physics.nmsu.edu/