DEPARTMENTS OF CHEMISTRY AND PHYSICS

Programs

Master

- Chemical Physics / Master of Science (https://catalog.lewisu.edu/graduate/aviation-science-technology/chemistry-physics/chemical-physics-master-science/)
- Chemistry / Master of Science (https://catalog.lewisu.edu/graduate/aviation-science-technology/chemistry-physics/chemistry-master-science/)
- Physics / Master of Science (https://catalog.lewisu.edu/graduate/aviation-science-technology/chemistry-physics/physics-master-science/)

Courses

Chemistry

CHEM 50100 - Chemical Thermodynamics (3)
This course provides instruction in thermochemistry and examines models and systems used to study chemical reactions under extreme thermodynamic conditions (e.g., pressure). Students will review and develop an understanding of the changes in equilibrium and reaction kinetics that occur under non-standard and non-ideal conditions.

CHEM 50200 - Strategic Organic Chemistry (3)
This course explores the basic principles of synthetic methodology, retrosynthesis, and the tactics and strategies for the total synthesis of complex organic molecules.

CHEM 52000 - Advanced Analytical Chemistry (3)
This course explores advanced applications of equilibrium, instrumental techniques, and analytical method development. Topics include the statistical treatment of data, signal-to-noise theory and optimization of S/N ratio, separations, and instrumental sensitivity and detection limits.

CHEM 59600 - Introduction to Research (1)
Topics include research ethics and laboratory conduct, literature searches, proposal writing, and scientific communication. Students learn about current research ongoing at Lewis and begin writing a proposal for their thesis research.

CHEM 59700 - Applied Data Analysis and Visualization in the Physical Sciences (1)
This course provides an introduction to common techniques for analyzing and visualizing data in the physical sciences using available software tools. Students will use methods from probability and statistics to interpret experimental data, to test hypotheses, to analyze statistical and systematic uncertainties, to do design of experiments, and to visualize data and results. Students will also identify, explain, and evaluate the analysis and visualization methods used in research papers and/or scientific presentations.

CHEM 59800 - Topical Seminar in Experimental Techniques (1)
This course provides an introduction to common techniques used in the experimental laboratory. The seminar will focus on a set of related experimental techniques such as electronics techniques, optical measurement techniques, material characterization techniques, or other topics of current interest. This course may be repeated for credit for different topical coverage. Topics will vary. There is a laboratory fee with this course.

CHEM 60000 - Physical Inorganic Chemistry (3)
This course synthesizes concepts from quantum mechanics, statistical thermodynamics and fundamental inorganic chemistry to explore advanced topics in transition-metal ion and complex chemistry and spectroscopy. The purity of materials, dynamic effects, crystallographic features, and surface adsorption phenomena will be discussed.

CHEM 60100 - Kinetics and Reaction Mechanisms (3)
This course explains the mechanisms of chemical reactions based on kinetic and thermodynamic principles to evaluate mechanistic arguments that govern the pathway from reactant to product. The course is meant to be broadly applicable to many types of chemistry- organic, physical, materials, etc., and will focus on basic principles of reaction mechanisms and the subsequent energetics and dynamics present in the systems.

CHEM 60200 - Advanced Biophysical Chemistry (3)
This course synthesizes concepts from Biochemistry and Physical Chemistry to describe quantum mechanically the behavior of biomolecules and polymers and study the behavior of proteins and protein function. Physical principles and mathematical models will be used to describe protein behavior.

CHEM 60500 - Applied Spectroscopy (3)
This course applies a rigorous mathematical construct to fundamentals discussed in Spectroscopy and Physical Chemistry. The interaction of light and matter is developed with descriptions of the quantum mechanical aspects of light, the electric and magnetic properties of matter, group theory, perturbation theory and the time-dependent approach.

CHEM 62100 - Materials Chemistry (3)
This course discusses the design and characterization of materials that are the foundation for advanced technologies. The course covers the synthesis, structures, and properties of advanced materials, focusing on a range of topics with current societal importance (e.g. energy, computers, nanoscience, etc.). Specific topics may include batteries, fuel cells, catalysts, metals, semiconductors, superconductors, magnetism, and polymers.

CHEM 62300 - Supramolecular Chemistry (3)
Supramolecular chemistry can be broadly defined as chemistry of the non-covalent bond. This course explores the field of supramolecular chemistry in the context of photochemistry and photophysics. More specifically, the control of photochemical reactions through the use of supramolecular structures will be studied. Furthermore, the strategy for the synthesis of supramolecular systems and the reaction dynamics will be explored.

CHEM 65200 - Computational Chemistry (3)
Computational chemistry is the development and practical application - through high-performance computing - of quantum and classical mechanics (and informatics) to the study of chemical processes ranging from fundamental spectroscopic events in the gas phase to the nature of protein-drug interactions to the development of novel conducting materials.

CHEM 68000 - Special Topics in Chemistry (1-3)
This special topics course will be offered in either a lecture and/or lab format presenting topics of current interest in Chemistry. Course may be repeated for credit. Topics selected to enhance student learning and complement, not duplicate, material used in Readings, Seminar, and Thesis. Topics will vary.

CHEM 68014 - ST: Environmental Chemodynamics (3)

CHEM 68500 - Readings in Chemistry (1-3)
Special topics in specific areas of chemistry tailored to meet the needs of individual students.Readings selected to enhance student learning and complement, not duplicate, readings designed to meet Seminar and Thesis requirements.

CHEM 69500 - Graduate Capstone (1-3)
Students will conduct a Capstone Experience in which they complete a research project or some other kind of approved high impact experience like a significant community service or outreach project, an interdisciplinary project, or an approved internship. This Capstone project may be completed in a single semester or over multiple semesters. During this course, students will be engaged in formal preparation of the Capstone Presentation and Capstone Paper, or other approved mechanism of dissemination. Only 3 hours of Graduate Capstone may be applied to the masters degree.

CHEM 69600 - Graduate Seminar (1)
Students engage in journal reading, oral presentations, and critical discussions of topics in physics or related fields by invited speakers, faculty, and graduate students. Students must take this course for at least two semesters; however, only two credit hours can be applied toward the 30 credit hour degree requirement. Seminar will not replicate content of Readings or Thesis.

CHEM 69800 - Masters Thesis (1-6)
Students conduct research leading toward preparation of the Master's thesis. Students are required to register for this course during any term in which they are engaged in formal preparation of the master's thesis; however, the required six credit hours are the maximum number of credit hours applicable toward the 30 credit hour degree requirement.

Physics

PHYS 50500 - Classical Mechanics (3)
Topics include variational principles, Lagrangian and Hamiltonian formulations of mechanics; central force motion, small oscillations, and canonical transformations. Time permitting, the instructor may cover additional topics including non-linear dynamics and chaos, Hamilton-Jacobi Theory, the mechanics of continuous media, or other relevant topics.

PHYS 50600 - Mathematical Methods for the Physical Sciences (3)
This course provides instruction in common theoretical methods applied to the physical sciences. Topics may include linear and matrix algebra, tensors, ordinary and partial differential equations, complex variables, group theory and symmetries, and special functions. In addition to covering the theory, students are introduced to computational methods for solving problems.

PHYS 51000 - Electromagnetic Theory and Applications (3)
Maxwell's equations will be used to describe electrostatics, magnetostatics, multipole expansion, electromagnetic waves, and radiating charges. Topics like waveguides; absorption, reflection, and transmission of radiation; and/or relativistic electrodynamics will be explored using theoretical and computational methods. Other topics may be covered as time permits.

PHYS 51800 - Applied Modern Optics (3)
Topics covered include geometrical optics, diffraction, interferometry, polarization, laser construction, and optical materials. Applications such as holography or spectroscopy will be introduced as time permits at the discretion of the instructor. Modern optical techniques and instrumentation are emphasized. This is a lecture/lab course.

PHYS 53000 - Statistical Mechanics and Thermodynamics (3)
Topics covered include the laws of thermodynamics, kinetic theory, statistical distributions of particles, fundamental postulates of classical and quantum statistical mechanics, ensemble theory, and Maxwell-Bolzmann, Fermi-Dirac, and Bose-Einstein statistics. Applications may include electron and photon gases, liquid helium, phase changes, and behavior of metals.

PHYS 54100 - Quantum Mechanics (3)
This course includes wave-particle duality, Heisenberg uncertainty principle, wave equations and principles of wave mechanics, applications of the time-independent Schrodinger equation in 1 and 3 dimensions, operator methods and approximation techniques, and angular momentum.

PHYS 54200 - Condensed Matter Physics (3)
This course covers the structure and properties of crystals, lattice vibrations, waves in crystals, specific heat and thermal conduction, electron theory of metals and semi-conductors, superconductivity and magnetism. Other contemporary topics and applications to materials science and optics may also be discussed if time permits.
Prerequisite: PHYS 44100 or PHYS 54100

PHYS 54300 - Nuclear and Particle Physics (3)
Topics include nuclear structure models, nuclear decay, Standard Model particles and interactions, conservation laws, angular momentum and isospin, Feynman diagrams, boson and fermion properties, and fundamentals of experimental nuclear and particle physics. Physics beyond the Standard Model, nuclear and particle astrophysics, or other contemporary topics may be discussed at the instructor's discretion.

PHYS 59600 - Introduction to Research (1)
Topics include research ethics and laboratory conduct, literature searches, proposal writing, and scientific communication. Students learn about current research ongoing at Lewis and begin writing a proposal for their thesis research.

PHYS 59700 - Applied Data Analysis and Visualization in the Physical Sciences (1)
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PHYS 59800 - Topical Seminar in Experimental Techniques (1)
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PHYS 61800 - Advanced Modern Optics (3)
Topics include electromagnetic wave optics, Fourier optics, wave guides and fiber optics, and an introduction to photon/quantum optics. Additional advanced topics will be chosen at the discretion of the instructor and may include quantum optics, lasers, semiconductor optics and optical devices, electro-optical devices, or non-linear optics.

PHYS 64000 - Advanced Quantum Mechanics (3)
Topics include operator formalism, group-representations, time dependent Schrodinger equation, time-independent and time-dependent perturbation theory, scattering theory, spin, many particle systems, and identical particle systems. Applications to atomic, molecular, condensed matter, and/or nuclear/particle physics will be introduced at the instructor's discretion.
Prerequisite: PHYS 44100 or PHYS 54100

PHYS 64200 - Semiconductor Physics and Devices (3)
Topics include semiconductor structure and properties, band structure, electron transport, pn-junctions, and semiconductor devices. Additional topics may include optical properties of semiconductors and quantum confinement.

PHYS 68000 - Special Topics in Physics (1-3)
This course will provide students with lecture and/or lab experiences presenting topics of current interest in Physics. The course may be repeated for credit. Topics will vary. Topics are selected to enhance student learning and complement, not duplicate, material used in Readings, Seminar, and Thesis.

PHYS 68500 - Readings in Physics (1-3)
Special topics in specific areas of physics tailored to needs of individual students. Readings selected to enhance student learning and complement, not duplicate, readings designed to meet Seminar and Thesis requirements.

PHYS 69500 - Graduate Capstone (1-3)
Students will conduct a Capstone Experience in which they complete a research project or some other kind of approved high impact experience like a significant community service or outreach project, an interdisciplinary project, or an approved internship. This Capstone project may be completed in a single semester or over multiple semesters. During this course, students will be engaged in formal preparation of the Capstone Presentation and Capstone Paper, or other approved mechanism of dissemination. Only 3 hours of Graduate Capstone may be applied to the masters degree.

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PHYS 69800 - Masters Thesis (1-6)
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