

PHYSICS (PHYSICS)

PHYSICS 103 – GENERAL PHYSICS

4 credits.

Introduction to physics at the non-calculus level. Principles of mechanics, heat, and waves, with applications to a number of different fields. Not recommended for students in the physical sciences and engineering.

Requisites: MATH 112, 113, 114, 171, placement into MATH 211 or 221, or special student standing. Not open to students with credit for PHYSICS 201, 207, or 247.

Course Designation: Gen Ed - Quantitative Reasoning Part B Breadth - Physical Sci. Counts toward the Natural Sci req Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 104 – GENERAL PHYSICS

4 credits.

Continuation of PHYSICS 103. Principles of electricity and magnetism, light, optics, and modern physics, with applications to a number of different fields. Not recommended for students in the physical sciences and engineering.

Requisites: PHYSICS 103, 201, 207, 247, E M A 201 or special student standing. Not open to students with credit for PHYSICS 202, 208, or 248.

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 106 – PHYSICS OF SPORTS

3 credits.

A tenth of a second, a single inch, or a slightly different angle can make all the difference in a sporting event. Application of physical principles to competitive sport, leading to a better understanding of performances in such sports as track and field, cycling, archery, golf, football and basketball.

Requisites: Satisfied Quantitative Reasoning (QR) A requirement. Not open to students with credit for PHYSICS 103, 201, 207, or 247.

Course Designation: Gen Ed - Quantitative Reasoning Part B Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 107 – THE IDEAS OF MODERN PHYSICS

3 credits.

The twentieth-century physical world picture and its origins. Selected topics in classical physics, relativity, and the quantum theory with emphasis on the meaning of basic concepts and their broader implications, rather than practical applications.

Requisites: Satisfied Quantitative Reasoning (QR) A requirement or special student standing

Course Designation: Gen Ed - Quantitative Reasoning Part B Breadth - Physical Sci. Counts toward the Natural Sci req Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 109 – PHYSICS IN THE ARTS

3 credits.

The nature of sound and sound perception; fundamentals of harmony, musical scales, and musical instruments. Studies of light including lenses, photography, color perception, and color mixing.

Requisites: Satisfied Quantitative Reasoning (QR) A requirement or special student standing. Not open to students with credit for PHYSICS 371.

Course Designation: Gen Ed - Quantitative Reasoning Part B Breadth - Physical Sci. Counts toward the Natural Sci req Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 115 – ENERGY AND CLIMATE

3 credits.

Introduction to energy, focusing on energy sources and their impacts on humans and the environment, particularly through climate change. Develop basic physics skills to form opinions on energy-related issues affecting the world as well as your own use of energy. Apply the physical principles of mechanics, heat, electricity, and atomic nuclei to various energy sources (fossil fuels, renewables, and nuclear) and their impacts.

Requisites: Satisfied Quantitative Reasoning (QR) A requirement. Not open to students with credit for PHYSICS 103, 201, 207, or 247.

Course Designation: Gen Ed - Quantitative Reasoning Part B Breadth - Physical Sci. Counts toward the Natural Sci req Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 198 – DIRECTED STUDY

1-3 credits.

Introductory-level mentored research project in physics.

Requisites: Consent of instructor

Course Designation: Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2022

PHYSICS 199 – DIRECTED STUDY

1-3 credits.

Introductory-level mentored research project in physics.

Requisites: Consent of instructor**Course Designation:** Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions**Last Taught:** Fall 2022**PHYSICS 201 – GENERAL PHYSICS**

5 credits.

Calculus-based introduction to physics intended for engineering students. Mechanics: kinematics, statics, dynamics; energy and momentum.

Requisites: MATH 217, 221, or 275. Not open to students with credit for PHYSICS 207 or 247.**Course Designation:** Gen Ed - Quantitative Reasoning Part B

Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 202 – GENERAL PHYSICS**

5 credits.

Calculus-based introduction to physics intended for engineering students. Electricity, magnetism, light, and sound.

Requisites: (PHYSICS 103, 201, 207, 247, or E M A 201) and (MATH 217, 221, or 275). Not open to students with credit for PHYSICS 208 or 248.**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 205 – MODERN PHYSICS FOR ENGINEERS**

3 credits.

Introduction to atomic, solid state, and nuclear physics.

Requisites: PHYSICS 202, 208 or 248. Not open to students with credit for PHYSICS 241, 244, or 249.**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2021**PHYSICS 206 – SPECIAL TOPICS IN PHYSICS**

1-5 credits.

Special topics in physics at the intermediate undergraduate level.

Requisites: (PHYSICS 103, 201, 207 or 247) and (MATH 217, 221, or 275)**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions**Last Taught:** Fall 2022**PHYSICS 207 – GENERAL PHYSICS**

5 credits.

Calculus-based introduction to physics intended for students majoring in biological sciences. Mechanics: kinematics, statics, dynamics; energy and momentum. Heat and sound.

Requisites: MATH 217, 221, or 275. Not open to students with credit for PHYSICS 201 or 247.**Course Designation:** Gen Ed - Quantitative Reasoning Part B

Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 208 – GENERAL PHYSICS**

5 credits.

Continuation of PHYSICS 207: calculus-based introduction to physics intended for students majoring in biological sciences. Electricity, magnetism, light, and modern physics.

Requisites: PHYSICS 201, 207, 247, E M A 201, or (PHYSICS 103 and MATH 217, 221, or 275). Not open to students with credit for PHYSICS 202 or 248.**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS/E C E 235 – INTRODUCTION TO SOLID STATE ELECTRONICS**

3 credits.

An introduction to the physical principles underlying solid-state electronic and photonic devices, including elements of quantum mechanics, crystal structure, semiconductor band theory, carrier statistics, and band diagrams. Offers examples of modern semiconductor structures. Prior experience with MATLAB [such as E C E 203] is strongly encouraged but not required.

Requisites: (MATH 222 or 276) and (PHYSICS 202, 208, or 248), or member of Engineering Guest Students**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 241 – INTRODUCTION TO MODERN PHYSICS**

3 credits.

Kinetic theory; relativity; experimental origin of quantum theory; atomic structure and spectral lines; topics in solid state, nuclear and particle physics.

Requisites: (PHYSICS 202, 208, or 248) and (MATH 222 or 276). Not open to students with credit for PHYSICS 205, 244, or 249.**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024

PHYSICS 247 – A MODERN INTRODUCTION TO PHYSICS

5 credits.

Calculus-based introduction to physics intended for Physics, AMEP, and Astronomy-Physics majors. Mechanics, waves, thermodynamics and statistical mechanics, topics in modern physics; with computation. A more mathematically rigorous and in-depth introduction to physics than the other introductory physics sequences.

Requisites: MATH 222 or concurrent enrollment or MATH 276 or concurrent enrollment.

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 248 – A MODERN INTRODUCTION TO PHYSICS

5 credits.

Continuation of PHYSICS 247. Electromagnetism, circuits, optics, additional topics in modern physics; with computation.

Requisites: PHYSICS 247 and (MATH 234 or concurrent enrollment or MATH 376 or concurrent enrollment)

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 249 – A MODERN INTRODUCTION TO PHYSICS

4 credits.

Continuation of Physics 248. Modern physics: introduction to quantum mechanics, topics from nuclear and particle physics, condensed matter physics, and atomic physics. Three lectures and one discussion per week.

Requisites: PHYSICS 248

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS/MED PHYS 265 – INTRODUCTION TO MEDICAL PHYSICS

2 credits.

A general interest survey that introduces the principles and applications of medical physics. Topics include biomechanics, energy usage and temperature regulation, pressure, sound and hearing, ultrasound, electricity in the body, optics and the eye, ionizing radiation in diagnosis and therapy, radiobiology, and nuclear medicine.

Requisites: PHYSICS 104, 202, 208, or 248

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 298 – DIRECTED STUDY

1-3 credits.

Intermediate-level mentored research project in physics.

Requisites: Consent of instructor

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2021

PHYSICS 299 – DIRECTED STUDY

1-3 credits.

Intermediate-level mentored research project in physics.

Requisites: Consent of instructor

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

PHYSICS 301 – PHYSICS TODAY

1 credit.

A series of weekly presentations and discussions of current research topics in physics, by scientists directly involved in those studies. Provides undergraduates with access to the topics and excitement of the research frontier in a manner not possible in normal subject courses.

Requisites: PHYSICS 202 or concurrent enrollment, PHYSICS 208 or concurrent enrollment, or PHYSICS 248 or concurrent enrollment

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

PHYSICS 307 – INTERMEDIATE LABORATORY-MECHANICS AND MODERN PHYSICS

2 credits.

Experiments in modern physics, with discussion of statistical uncertainties and error analysis. Propagation of error. Available labs include gamma-ray spectroscopy, X-ray physics and diffraction, blackbody radiation, and Cavendish measurement of the gravitational constant G.

Requisites: PHYSICS 202, 208, 248 or graduate/professional standing.

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 311 – MECHANICS

3 credits.

Origin and development of classical mechanics; mathematical techniques, especially vector analysis; conservation laws and their relation to symmetry principles; brief introduction to orbit theory and rigid-body dynamics; accelerated coordinate systems; introduction to the generalized-coordinate formalisms of Lagrange and Hamilton.

Requisites: (PHYSICS 202, 208, or 248) and (MATH 234, 321, or 376), or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 321 – ELECTRIC CIRCUITS AND ELECTRONICS

4 credits.

Direct current circuits, circuit theorems, alternating current circuits, transients, non-sinusoidal sources, Fourier analysis, characteristics of semiconductor devices, typical electronic circuits, feedback, non-linear circuits; digital and logic circuits.

Requisites: PHYSICS 202, 208, 248 or graduate/professional standing.

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 322 – ELECTROMAGNETIC FIELDS

3 credits.

Electrostatic fields, capacitance, multi-pole expansion, dielectric theory; magnetostatics; electromagnetic induction; magnetic properties of matter; Maxwell's equations and electromagnetic waves; relativity and electromagnetism. Experiments for this course are covered in Physics 308.

Requisites: (PHYSICS 202, 208 or 248) and (MATH 234, 321 or 376), or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 323 – ELECTROMAGNETIC FIELDS

3 credits.

Special relativity, electromagnetic momentum, electromagnetic waves: propagation, interference, scattering, reflection and refraction at a dielectric interface, waves in a conductor. Wave packets and group velocity, dispersion. Waveguides and transmission lines. Retarded potentials. Radiation.

Requisites: PHYSICS 322 or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2022

PHYSICS 325 – OPTICS

4 credits.

Classical and modern optics, including imaging, polarization optics, optical telescopes, optical microscopes, interference and interferometers, optical fibers and fiber-optic communication, optical resonators, lasers, optical modulators, introduction to quantum and nonlinear optics. Concepts covered in lecture reinforced by weekly laboratory experiments.

Requisites: (PHYSICS 202, 208, or 248) and (PHYSICS 322 or concurrent enrollment), or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 361 – MACHINE LEARNING IN PHYSICS

3 credits.

A detailed introduction to the use of machine learning techniques in physics. Topics will include basics of probability theory and statistics, basics of function fitting and parameter inference, basics of optimization, and machine learning techniques. A selection of physics topics that are particularly amenable to analysis using machine learning will be discussed. These might include processing collider data, classifying astronomical images, solving the Ising model, parameter estimation from physics data sets, learning physical probability distributions, finding string theory compactifications, and finding symbolic physical laws.

Requisites: MATH 234 and (PHYSICS 104, 202, 208, or 248), or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 371 – ACOUSTICS FOR MUSICIANS

3 credits.

Intended for music students who wish to learn about physical basis of sound, sound perception, musical scales, musical instruments, and room acoustics.

Requisites: Satisfied Quantitative Reasoning (QR) A requirement

Course Designation: Gen Ed - Quantitative Reasoning Part B Breadth - Physical Sci. Counts toward the Natural Sci req Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2022

PHYSICS 406 – SPECIAL TOPICS IN PHYSICS

1-4 credits.

Special topics in physics at the advanced undergraduate level.

Requisites: PHYSICS 205, 241, 244, 249, or PHYSICS/E C E 235

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2023

PHYSICS 407 – ADVANCED LABORATORY

2-4 credits.

Advanced experiments in classical and modern physics. Possible experiments include beta decay, muon lifetime, nuclear magnetic resonance, Stern-Gerlach atomic beam, Mossbauer scattering, velocity of light, Zeeman effect, and Compton scattering. Techniques for the statistical analysis of experimental data and keeping a proper research lab notebook are emphasized. Two (four) credit students will typically perform four (eight) experiments.

Requisites: PHYSICS 307

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 415 – THERMAL PHYSICS

3 credits.

Thermodynamics, kinetic theory of gases, and statistical mechanics.

Requisites: (PHYSICS 205, 241, 244, 249, or PHYSICS/E C E 235) and PHYSICS 311, or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 448 – ATOMIC AND QUANTUM PHYSICS

3 credits.

Review of atomic and other quantum phenomena and special relativity; introduction to quantum mechanics treating the more advanced topics of atomic physics and applications to molecular, solid state, nuclear, and elementary particle physics and quantum statistics.

Requisites: (PHYSICS 205, 241, 244, 249, or PHYSICS/E C E 235) and PHYSICS 311 and 322, or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 449 – ATOMIC AND QUANTUM PHYSICS

3 credits.

Continuation of PHYSICS 448. Review of atomic and other quantum phenomena and special relativity; introduction to quantum mechanics treating the more advanced topics of atomic physics and applications to molecular, solid state, nuclear, and elementary particle physics and quantum statistics.

Requisites: PHYSICS 448 or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS/ENVIR ST 472 – SCIENTIFIC BACKGROUND TO GLOBAL ENVIRONMENTAL PROBLEMS

3 credits.

Designed to provide those elements of physics, atmospheric sciences, chemistry, biology and geology which are essential to a scientific understanding of global environmental problems. Specific examples of such problems include global warming, stratospheric ozone depletion, acid rain and environmental toxins.

Requisites: PHYSICS 103, 201, 207, 247, CHEM 103, 108, 109, 115, 116, or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2016

PHYSICS 498 – DIRECTED STUDY

1-3 credits.

Advanced-level mentored research project in physics.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2022

PHYSICS 499 – DIRECTED STUDY

1-3 credits.

Advanced-level mentored research project in physics.

Requisites: Consent of instructor**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions**Last Taught:** Spring 2024**PHYSICS/B M E/H ONCOL/MED PHYS 501 – RADIATION PHYSICS AND DOSIMETRY**

3 credits.

Interactions and energy deposition by ionizing radiation in matter; concepts, quantities and units in radiological physics; principles and methods of radiation dosimetry.

Requisites: (PHYSICS 323, 449 and MATH 320) or graduate/professional standing or declared in Medical Physics VISP**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Fall 2023**PHYSICS/E C E/N E 525 – INTRODUCTION TO PLASMAS**

3 credits.

Basic description of plasmas: collective phenomena and sheaths, collisional processes, single particle motions, fluid models, equilibria, waves, electromagnetic properties, instabilities, and introduction to kinetic theory and nonlinear processes. Examples from fusion, astrophysical and materials processing plasmas.

Requisites: (E C E 320 or PHYSICS 322), graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS/E C E/N E 527 – PLASMA CONFINEMENT AND HEATING**

3 credits.

Principles of magnetic confinement and heating of plasmas for controlled thermonuclear fusion: magnetic field structures, single particle orbits, equilibrium, stability, collisions, transport, heating, modeling and diagnostics. Discussion of current leading confinement concepts: tokamaks, tandem mirrors, stellarators, reversed field pinches, etc.

Requisites: E C E/N E/PHYSICS 525, graduate/professional standing, or member of Engineering Guest Students**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 531 – INTRODUCTION TO QUANTUM MECHANICS**

3 credits.

Historical background and experimental basis of quantum mechanics; de Broglie waves, correspondence principle, uncertainty principle, Schrodinger equation, hydrogen atom, electron spin, Pauli principle; applications of wave mechanics.

Requisites: (PHYSICS 205, 241, 244, 249, or PHYSICS/E C E 235) and PHYSICS 311 and 322, or graduate/professional standing**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 535 – INTRODUCTION TO PARTICLE PHYSICS**

3 credits.

Review of quantum physics; introduction to particles, antiparticles and fundamental interactions; detectors and accelerators; symmetries and conservation laws; electroweak and color interactions of quarks and leptons; unification theories.

Requisites: PHYSICS 448 or concurrent enrollment, PHYSICS 531 or concurrent enrollment, or graduate/professional or special student standing**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**PHYSICS 545 – INTRODUCTION TO ATOMIC STRUCTURE**

3 credits.

Nuclear atom; hydrogen atom; Bohr-Sommerfeld model, wave model, electron spin, description of quantum electron spin, description of quantum electrodynamic effects; external fields; many-electron atoms; central field, Pauli principle, multiplets, periodic table, x-ray spectra, vector coupling, systematics of ground states; nuclear effects in atomic spectra; interaction with coherent radiation, optical forces, laser cooling and trapping.

Requisites: PHYSICS 448 or concurrent enrollment, PHYSICS 531 or concurrent enrollment, or graduate/professional or special student standing**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Fall 2023

PHYSICS/E C E 546 – LASERS

2-3 credits.

General principles of laser operation; laser oscillation conditions; optical resonators; methods of pumping lasers, gas discharge lasers, e-beam pumped lasers, solid state lasers, chemical lasers, and dye lasers; gain measurements with lasers; applications of lasers.

Requisites: (PHYSICS 322 or E C E 420) and (PHYSICS 449, 531, or 545), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2015

PHYSICS 551 – SOLID STATE PHYSICS

3 credits.

Mechanical, thermal, electric, and magnetic properties of solids; band theory; semiconductors; crystal imperfections.

Requisites: PHYSICS 205, 241, 244, 249, 448, 531, PHYSICS/E C E 235, or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS/MED PHYS 588 – RADIATION PRODUCTION AND DETECTION

4 credits.

Fundamental physics of ionizing radiation production and detection applied to medical science. Topics: scintillator/semiconductor detectors, ionizing radiation detectors, charged and neutral particles for external beam radiotherapy, production of radionuclides with cyclotron and linear accelerators for diagnostic and therapeutic applications, radiochemistry, and X-ray tube physics.

Requisites: PHYSICS/B M E/H ONCOL/MED PHYS 501

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 601 – SCIENTIFIC PRESENTATION

2 credits.

Oral and written reports to give practice in the presentation of scientific papers.

Requisites: Senior standing and declared in an Honors program or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Honors - Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Fall 2016

PHYSICS 603 – WORKSHOP IN COLLEGE PHYSICS TEACHING

1-2 credits.

Discussion, practice, and occasional lectures on various aspects of the teaching of physics. Course planning; course materials; lecture, demonstration, and discussion techniques; laboratory; problem solving; examinations, grading, and evaluation. Problems arising in the teaching of physics; levels of difficulty, differences in talents and backgrounds; methods of presentation of various specific topics.

Requisites: PHYSICS 311 and 322

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2021

PHYSICS/B M E/MED PHYS/PHMCO-M/RADIOL 619 – MICROSCOPY OF LIFE

3 credits.

Survey of state of the art microscopic, cellular and molecular imaging techniques, beginning with subcellular microscopy and finishing with whole animal imaging.

Requisites: PHYSICS 104, 202, 208, or 248 or PHYSICS/MED PHYS 265

Course Designation: Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 623 – ELECTRONIC AIDS TO MEASUREMENT

4 credits.

Fundamentals of electronics, electronic elements, basic circuits; combinations of these into measuring instruments.

Requisites: (PHYSICS 202, 208, or 248) and (MATH 234 or 376), or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 625 – APPLIED OPTICS

4 credits.

Optical methods in research and technology. Reflection, refraction, absorption, scattering. Imaging. Sources and sensors. Schlieren methods. Interferometry. Instrumental spectroscopy. Fourier optics, image processing, holography. Laser technology, Gaussian beams, nonlinear optics.

Requisites: PHYSICS 322 or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 681 – SENIOR HONORS THESIS

3 credits.

Mentored individual research and study for students completing Physics Honors in the Major.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Honors - Honors Only Courses (H)

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

PHYSICS 682 – SENIOR HONORS THESIS

3 credits.

Mentored individual research and study for students completing Physics Honors in the Major.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Honors - Honors Only Courses (H)

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

PHYSICS 691 – SENIOR THESIS

2-3 credits.

Mentored individual research and study for students completing a thesis.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2022

PHYSICS 692 – SENIOR THESIS

2-3 credits.

Mentored individual research and study for students completing a thesis.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2023

PHYSICS 701 – GRADUATE INTRODUCTORY SEMINARS

1 credit.

Designed to give new students an introduction to the broad range of modern research going on at UW Physics, and to help students find research opportunities in the department. Each week, faculty from each major research area will present their research in a seminar setting. The research areas will include selected topics both in theory and experiment from biophysics; atomic, molecular, and optical physics; plasma; condensed matter; quantum information and computation; high energy and nuclear physics; particle physics, astrophysics, and cosmology.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 707 – QUANTUM COMPUTING LABORATORY

4 credits.

Provides an intensive introduction to the experimental techniques of quantum computing. Students will do 8 experiments chosen from: Bell violation with entangled photons, Stern-Gerlach, Pulsed NMR, Optical pumping of Rb, Nanofabrication, Fiber optics communication, Diode pumped YAG laser, and Acousto-optic modulator.

Requisites: PHYSICS 709 and (PHYSICS 531 or 731)

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 709 – INTRODUCTION TO QUANTUM COMPUTING

3 credits.

A detailed introduction to quantum computation and quantum information processing. Basic topics of quantum mechanics that are most relevant to quantum computing, particularly measurement theory. Specialized topics such as entanglement, other measures of quantum correlation and the Bell inequalities. Classical and quantum information theory, classical and quantum complexity theory. Qubits, quantum gates, quantum circuits. Teleportation, quantum dense coding, quantum cryptography. Quantum algorithms: Deutsch, Simon, Shor, Grover, and adiabatic algorithms. Basic quantum error correction: 5-qubit, Steane and Shor codes. Completion of one undergraduate course in quantum mechanics recommended, such as PHYSICS 448 or 531.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 711 – THEORETICAL PHYSICS-DYNAMICS

3 credits.

Lagrange's equations, Principle of Least Action, orbits and scattering, kinematics of rotation, rigid body dynamics, small oscillations, special relativistic dynamics, Hamiltonian formulation, canonical transformations, Hamilton-Jacobi theory, canonical perturbation theory, chaos, continuum mechanics, introduction to general relativity.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

PHYSICS 715 – STATISTICAL MECHANICS

3 credits.

Statistical foundations, Liouville's theorem, ensembles, classical and quantum distribution functions, entropy and temperature, connection with thermodynamics, partition functions, quantum gases, non-ideal gases, phase transitions and critical phenomena, non-equilibrium problems, Boltzmann equation and the H-theorem, transport properties, connections with quantum field theory, applications of statistical mechanics to selected problems.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

PHYSICS 716 – STATISTICAL MECHANICS II

3 credits.

Symmetries and symmetry breaking, phase transitions, mean field theory, critical exponents, scaling hypothesis, renormalization group, diagrammatic expansion, epsilon-expansion, exact solution of the 2d Ising model. Boltzman kinetic equation, H-theorem, Fokker-Planck and Langevin equations, Born-Markov master equation, Lindblad superoperators, classical and quantum noise, theory of amplifiers.

Requisites: PHYSICS 715 and 731**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2017**PHYSICS 717 – RELATIVITY**

3 credits.

Special and general theories of relativity, relativistic electrodynamics, cosmology, unified field theories.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2022**PHYSICS 721 – THEORETICAL PHYSICS-ELECTRODYNAMICS**

3 credits.

Electrostatics, magnetostatics, Green functions, boundary value problems, macroscopic media, Maxwell's equations, the stress tensor and conservation laws, electromagnetic waves, wave propagation, dispersion, waveguides, radiation, multipole expansions, diffraction and scattering, special relativity, covariance of Maxwell's equations, Lienard-Wiechert potentials, radiation by accelerated charges. Knowledge of electrodynamics (such as PHYSICS 322) strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**PHYSICS/E C E/N E 724 – WAVES AND INSTABILITIES IN PLASMAS**

3 credits.

Waves in a cold plasma, wave-plasma interactions, waves in a hot plasma, Landau damping, cyclotron damping, magneto-hydrodynamic equilibria and instabilities, microinstabilities, introduction to nonlinear processes, and experimental applications. Basic knowledge of plasmas [such as PHYSICS/E C E/N E 525] and advanced electromagnetics [such as PHYSICS 721 or E C E 740] strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**PHYSICS/E C E/N E 725 – PLASMA KINETIC THEORY AND RADIATION PROCESSES**

3 credits.

Coulomb Collisions, Boltzmann equation, Fokker-Planck methods, dynamical friction, neoclassical diffusion, collision operators radiation processes and experimental applications. Basic knowledge of plasmas [such as PHYSICS/E C E/N E 525] and advanced electromagnetics [such as PHYSICS 721 or E C E 740] strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**PHYSICS/E C E/N E 726 – PLASMA MAGNETOHYDRODYNAMICS**

3 credits.

MHD equations and validity in hot plasmas; magnetic structure and magnetic flux coordinates; equilibrium in various configurations; stability formulation, energy principle, classification of instabilities; ideal and resistive instability in various configurations, evolution of nonlinear tearing modes; force-free equilibria, helicity, MHD dynamo; experimental applications. Basic knowledge of plasmas [such as PHYSICS/E C E/N E 525] and advanced electromagnetics [such as PHYSICS 721 or E C E 740] strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2023**PHYSICS 731 – QUANTUM MECHANICS**

3 credits.

Schrodinger equation, operator theory, matrix mechanics, transformation theory, Heisenberg representation, orbital angular momentum, bound-state problems, scattering theory, stationary perturbation theory, degenerate systems, time-dependent perturbation theory, Born approximation, other approximation methods. Knowledge of quantum mechanics and atomic physics (such as PHYSICS 449 or 531) strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**PHYSICS 732 – QUANTUM MECHANICS**

3 credits.

Interaction of electromagnetic radiation with matter, quantization of the electromagnetic field, spontaneous transitions, identical particles and spin, addition of angular momenta, tensor operators, complex atoms, Hartree approximation, molecules, Dirac equation, relativistic effects in atoms.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024

PHYSICS 735 – PARTICLE PHYSICS

3 credits.

Structure of elementary particles, quarks and gluons, introduction to calculational techniques of particle interactions (Feynman diagrams), constituent models of electroweak and strong interactions and associated phenomenological techniques. Knowledge of introductory particle physics and quantum mechanics (such as PHYSICS 535) strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**PHYSICS 736 – EXPERIMENTAL METHODS IN NUCLEAR-, PARTICLE-, AND ASTROPHYSICS**

3 credits.

Interaction of particles with matter; detector techniques at colliding beam machines, in nuclear and particle physics, astrophysics, and cosmology; experimental strategies in detector design; principles of simulation and Monte Carlo methods, error analysis and statistical techniques in data analysis. Knowledge of introductory particle physics (such as PHYSICS 535) strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**PHYSICS/E C E 746 – QUANTUM ELECTRONICS**

3 credits.

Elementary aspects of Lagrange theory of fields and field quantization; Bose, Fermi and Pauli operators; interaction of fields; quantum theory of damping and fluctuations; applications to lasers, nonlinear optics, and quantum optics. Knowledge of lasers [such as PHYSICS/E C E 546] and graduate-level electromagnetics [such as E C E 740 or PHYSICS 721] strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**PHYSICS/E C E 748 – LINEAR WAVES**

3 credits.

General considerations of linear wave phenomena; one dimensional waves; two and three dimensional waves; wave equations with constant coefficients; inhomogenous media; random media. Lagrangian and Hamiltonian formulations; asymptotic methods. Knowledge of electromagnetics [such as E C E 320 or PHYSICS 321], mechanics [such as M E 340], or vibrations [such as M E 440] strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2022**PHYSICS/E C E/N E 749 – COHERENT GENERATION AND PARTICLE BEAMS**

3 credits.

Fundamental theory and recent advances in coherent radiation charged particle beam sources (microwave to X-ray wavelengths) including free electron lasers, wiggler/wave-particle dynamics, Cerenkov masers, gyrotrons, coherent gain and efficiency, spontaneous emission, beam sources and quality, related accelerator concepts experimental results and applications.

Requisites: E C E 740**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2019**PHYSICS 751 – ADVANCED SOLID STATE PHYSICS**

3 credits.

Lattice dynamics; band theory; Fermi surfaces; electrostatics of metals; optical properties; transport properties. Knowledge of introductory solid state physics (such as PHYSICS 551) strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**PHYSICS 772 – HIGH ENERGY ASTROPHYSICS**

3 credits.

Interactions among the particles, fields, and radiation of interstellar and intergalactic space. Gamma-ray, x-ray, and cosmic ray production, propagation, and detection. Knowledge of electromagnetics (such as PHYSICS 322) strongly encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2022**PHYSICS 779 – ADVANCED QUANTUM COMPUTING**

3 credits.

Explores applications of quantum theory to both the hardware and the software that underpin modern quantum information technology. Advanced quantum circuit theory: Clifford group and Gottesman-Knill theorem, Mathematica code. Decoherence: density matrices, probability distributions, T1 and T2. Advanced error correction: master equation, Kraus operators, fault tolerance, quantum tomography. Hardware: Trapped ions, Paul traps, sideband cooling, CZ and MS gates, neutral atoms, superconductors, quantum dots.

Requisites: PHYSICS 531 or 731**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024

PHYSICS 799 – INDEPENDENT STUDY

1-3 credits.

Graduate-level mentored research project in physics.

Requisites: Consent of instructor**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**PHYSICS 801 – SPECIAL TOPICS IN THEORETICAL PHYSICS**

1-3 credits.

Selected topics in theoretical physics.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2023**PHYSICS 805 – SPECIAL TOPICS IN PHYSICS**

1-3 credits.

Special topics in physics at the graduate level.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**PHYSICS 831 – ADVANCED QUANTUM MECHANICS**

3 credits.

Quantum theory of free and interacting fields, formal scattering theory, dispersion theory.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**PHYSICS 832 – ADVANCED QUANTUM MECHANICS**

3 credits.

Continuation of PHYSICS 831. Quantum theory of free and interacting fields, formal scattering theory, dispersion theory.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**PHYSICS 835 – COLLIDER PHYSICS PHENOMENOLOGY**

2-3 credits.

Standard model. Application to e^+e^- , proton-antiproton, pp, and ep colliders. Jets. Weak boson, heavy-quark, and Higgs boson production and decay. Quarkonia. Neutral B meson mixing. Grand unification. Supersymmetry.**Requisites:** Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2021**PHYSICS/E C E 848 – NONLINEAR WAVES**

3 credits.

General considerations of nonlinear wave phenomena; nonlinear hyperbolic waves; nonlinear dispersion; nonlinear geometrical optics; Whitham's variational theory; nonlinear and parametric instabilities; solitary waves; inverse scattering method. Knowledge of electromagnetics [such as E C E 320 or PHYSICS 321] or mechanics [such as M E 340] encouraged.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2019**PHYSICS 900 – COLLOQUIUM**

0-1 credits.

Lectures by staff and visitors.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**PHYSICS/ASTRON 910 – SEMINAR IN ASTROPHYSICS**

0-1 credits.

Current topics in astrophysics.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**PHYSICS/E C E/N E 922 – SEMINAR IN PLASMA PHYSICS**

0-1 credits.

Current topics in plasma physics.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**PHYSICS 990 – RESEARCH**

1-12 credits.

Research supervised by individual faculty members.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024