PHYSICS 103 — GENERAL PHYSICS
4 credits.

Introduction at the non-calculus level. Not recommended for students in the physical sciences and engineering. Principles of mechanics, heat, and sound, with applications to a number of different fields. Two lectures, two discussions, plus one two-hour lab per week. High school algebra, geometry and some trig; Not open to those who have taken PHYSICS 201, 207, or 247; Open to Freshman. Recommended for students who do not need a calculus level course; Not recommended for students in the physical sciences and engineering
Requisites: Completion of QR-A.
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: Fall 2017

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. Two lectures, two discussions and one two-hour lab per week. Not open to those who have taken PHYSICS 202, 208, or 248; Open to Freshman
Requisites: PHYSICS 103.
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: Fall 2017

PHYSICS 107 — THE IDEAS OF MODERN PHYSICS
3 credits.

For non-science majors. 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. Three lectures per week. High school algebra geometry. Not open to students who have taken an intermediate or advanced level physics course. Open to Freshmen
Requisites: Completion of QR-A.
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: Fall 2017

PHYSICS 109 — PHYSICS IN THE ARTS
3 credits.

A course on sound and light for non-science majors. 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. Two lectures and one two-hour lab per week. High school algebra geometry. Not open to students who have had an intermediate or advanced level physics course, including PHYSICS 371. Open to Freshmen
Requisites: Completion of QR-A.
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: Fall 2017

PHYSICS 115 — ENERGY
3 credits.

A one-semester introduction, focusing on a central concept: energy, energy sources, and the environment. Gives students the necessary physics background to form opinions on energy questions. The physical laws of thermodynamics, electricity, and magnetism, and nuclear physics in connection with energy related topics such as: thermal pollution, fossil power, fission and fusion, nuclear power, and solar power. Two lectures and one discussion per week. High school algebra and geometry. Not open to students who have taken PHYSICS 103, 201, 207, or 247
Requisites: Completion of QR-A.
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: Fall 2017

PHYSICS 198 — DIRECTED STUDY
1-3 credits.

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 2006

PHYSICS 199 — DIRECTED STUDY
1-3 credits.

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: Summer 2017
PHYSICS 201 — GENERAL PHYSICS
5 credits.
Primarily for engineering students. Mechanics and heat. Two lectures, two discussions and one three-hour lab per week. Not open to students who have taken PHYSICS 207 or 247; Open to Freshmen
Requisites: MATH 211 or 221 or 1 year high school calculus or instructor consent.
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 2017

PHYSICS 202 — GENERAL PHYSICS
5 credits.
Primarily for engineering students. Electricity, magnetism, light, and sound. Two lectures, two discussions and one three-hour lab per week. Not open to students who have taken PHYSICS 208 or 248
Requisites: PHYSICS 201, 207, or EMA 201 and EMA 202, or EMA 201 and ME 240, or equivalent.
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 2017

PHYSICS 205 — MODERN PHYSICS FOR ENGINEERS
3 credits.
Introduction to atomic, solid state, and nuclear physics. Not open to students who have taken PHYSICS 241, 244, or 249
Requisites: Physcis 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: Fall 2017

PHYSICS 206 — SPECIAL TOPICS IN PHYSICS
1-5 credits.
Special topics in physics at the intermediate undergraduate level.
Requisites: Prereqs vary according to topic
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 2017

PHYSICS 207 — GENERAL PHYSICS
5 credits.
Recommended for those majoring in science or mathematics. Also suitable for others who have the math prerequisite. Mechanics, heat and sound. Two lectures, two discussions and one three-hour lab per week. Not open to students who have taken PHYSICS 201 or 247; Open to Freshmen
Requisites: MATH 221 or 211 or 1 year high school calculus or instructor consent.
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 2017

PHYSICS 208 — GENERAL PHYSICS
5 credits.
Continuation of PHYSICS 207. Electricity, magnetism, light, and modern physics. Two lectures, two discussions and one three-hour lab per week. Not open to students who have taken PHYSICS 202 or 248; Open to Freshmen
Requisites: PHYSICS 201, 207, or 247.
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 2017

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.
MATH 222 PHYSICS 202
Requisites: Open to Fr.
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2017

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. Experiments for this course are covered in PHYSICS 307. Not open to students who have taken PHYSICS 205, 244, or 249
Requisites: PHYSICS 202 or 208 or 248 MATH 222.
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 2017
PHYSICS 244 — MODERN PHYSICS (PRIMARILY FOR ECE MAJORS)
3 credits.
Quantum mechanics, atomic structure of matter, physical properties of solids, nuclear physics; emphasis on fundamental concepts to aid the student in engineering applications. Not open to students who have taken PHYSICS 205, 241, or 249
Requisites: PHYSICS 202 or 208 or 247 MATH 234 or concurrent registration.
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 2008

PHYSICS 247 — A MODERN INTRODUCTION TO PHYSICS
5 credits.
Introduction to physics recommended for students who are considering majoring in physics, astronomy-physics, or AMEP. Also suitable for those majoring in other sciences or mathematics who desire a rigorous physics course. Mechanics, relativity, cosmology. Three lectures, one discussion, and one three-hour lab per week. Intended primarily for physics, AMEP, astronomy-physics majors; Also suitable for those majoring in science or mathematics
Requisites: MATH 222 or concurrent registration or instructor consent; Open to Freshmen.
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 2017

PHYSICS 248 — A MODERN INTRODUCTION TO PHYSICS
5 credits.
Continuation of PHYSICS 247. Electricity, magnetism, and topics from thermodynamics, radiation, plasma physics, and statistical mechanics. Three lectures, one discussion, and one three-hour lab per week. Intended primarily for physics, AMEP, and astronomy-physics majors
Requisites: PHYSICS 247, MATH 234 or concurrent enrollment; Open to Freshmen.
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 2017

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. Not open to students who have taken PHYSICS 241; Open to Freshmen. Intended primarily for physics, AMEP, astronomy-physics majors
Requisites: PHYSICS 248 MATH 234, or consent of instructor; concurrent registration in PHYSICS 307 required.
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 2017

PHYSICS/MED PHYS 265 — INTRODUCTION TO MEDICAL PHYSICS
2 credits.
Primarily for premeds and other students in the medical and biological sciences. Applications of physics to medicine and medical instrumentation. Topics: biomechanics, sound and hearing, pressure and motion of fluids, heat and temperature, electricity and magnetism in the body, optics and the eye, biological effects of light, use of ionizing radiation in diagnosis and therapy, radiation safety, medical instrumentation. Two lectures with demonstrations per week.
Requisites: A yr crse of college level intro physics
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 2017

PHYSICS 298 — DIRECTED STUDY
1-3 credits.
Requisites: Intro physics and cons inst
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 2017

PHYSICS 299 — DIRECTED STUDY
1-3 credits.
Requisites: Intro physics and cons inst
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 2017
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 208 or equiv
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 2017

PHYSICS 307 — INTERMEDIATE LABORATORY-MECHANICS AND MODERN PHYSICS
2 credits.

Experiments in quantum effects and modern physics, and statistical uncertainties and error propagation. This is mainly associated with the subject matter of PHYSICS 205, 241, 244, 247, or 249, so concurrent registration with one of these courses is recommended.

Requisites: PHYSICS 202, 208, or 248
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 2017

PHYSICS 308 — INTERMEDIATE LABORATORY-ELECTROMAGNETIC FIELDS AND OPTICS
2 credits.

Experiments in electromagnetic fields and optics, mainly associated with the subject matter of PHYSICS 205 and 325. Enroll info: Prior completion of or concurrent registration in PHYSICS 205 and 325 recommended. Prior completion of PHYSICS 205, 241, 244, 247, or 249 recommended.

Requisites: PHYSICS 202, 208, or 248
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 2017

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 or 208, MATH 320 or 319 or cons inst
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 2017

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; three lectures and one three-hour lab per week.

Requisites: PHYSICS 202 or 208, MATH 320 or 319 or cons inst
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 2017

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 311
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 2017

PHYSICS 325 — WAVE MOTION AND OPTICS
3 credits.

Wave phenomena with specific applications to waves in media and electromagnetic phenomena. Wave equations, propagation, radiation, coherence, interference, diffraction, scattering. Light and its interactions with matter, geometrical and physical optics. Experiments for this course are covered in PHYSICS 308. PHYSICS 322 or concurrent enrollment recommended

Requisites: PHYSICS 205, 241, or 244, and PHYSICS 311.
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 2017
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. May not be taken by Physics majors to count as physics credit. Intended primarily for musicians and others with some music background.

Requisites: Completion of QR-A, High school algebra.

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 2017

PHYSICS 406 — SPECIAL TOPICS IN PHYSICS
1-4 credits.

Special topics in physics at the advanced undergraduate level.

Requisites: PHYSICS 241 or cons inst

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 2017

PHYSICS 407 — ADVANCED LABORATORY
2-4 credits.

Advanced experiments in classical and modern physics, many associated with the subject matter of PHYSICS 415, 448, 449. 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 are emphasized. One (two) credit students will typically perform 4 (8) experiments.

Requisites: Must have taken PHYSICS 307 or 308.

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 2017

PHYSICS 415 — THERMAL PHYSICS
3 credits.

Thermodynamics, kinetic theory of gases, and statistical mechanics.

Requisites: PHYSICS 241, 244, or 205 311

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 2016

PHYSICS 448 — ATOMIC AND QUANTUM PHYSICS
3 credits.

First semester of a two-semester senior course. 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. Experiments underlying this course are covered in PHYSICS 407. Not open to those who have had PHYSICS 531.

Requisites: PHYSICS 205, 241, or 244, and 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 2017

PHYSICS 449 — ATOMIC AND QUANTUM PHYSICS
3 credits.

A continuation of 448.

Requisites: PHYSICS 448

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 2017

PHYSICS/ENVIR ST 472 — SCIENTIFIC BACKGROUND TO GLOBAL ENVIRONMENTAL PROBLEMS
3 credits.

A one-semester course 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. Three lectures per week.

Requisites: PHYSICS 103, 201, 207, or 247 or CHEM 103, 108, 109, 115, or 116

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.

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 2017
PHYSICS 499 — DIRECTED STUDY
1-3 credits.

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 2017

PHYSICS/B M E/H ONCOL/MED PHYS 501 — RADIOLOGICAL 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: Calculus and modern physics
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 2017

PHYSICS 507 — GRADUATE LABORATORY
2 credits.

Students perform typically advanced modern physics experiments and utilize advanced statistical techniques for data analysis. Scientific writing is emphasized and one scientific paper is required.

Requisites: Must have taken PHYSICS 307 or 407.
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2016

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: NEEP/Phys/ECE 525 or equiv
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 2017

PHYSICS 531 — INTRODUCTION TO QUANTUM MECHANICS
3 credits.

Historical background and experimental basis, de Broglie waves, correspondence principle, uncertainty principle, Schrodinger equation, hydrogen atom, electron spin, Pauli principle; applications of wave mechanics. Not open to those who have had PHYSICS 448

Requisites: PHYSICS 311 322 a course in modern physics, or equiv, or cons inst.
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 2017

PHYSICS 535 — INTRODUCTION TO PARTICLE PHYSICS
3 credits.

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 531 or equiv
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 2017

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.

Requisites: A course in quantum mechanics or cons inst
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 2017
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 ECE 420 or equiv; PHYSICS 545, or 449 or 531

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: A course in quantum mechanics or cons inst

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 2017

PHYSICS/MED PHYS 563 — RADIONUCLIDES IN MEDICINE AND BIOLOGY
2-3 credits.

Physical principles of radioisotopes used in medicine and biology and operation of related equipment; lecture and lab.

Requisites: PHYSICS 205, PHYSICS 241, or PHYSICS 249, or Graduate 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
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

PHYSICS 603 — WORKSHOP IN COLLEGE PHYSICS TEACHING
1-2 credits.

Requisites: At least 9 cr in intmed physics

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 2017

PHYSICS/B M E/MED PHYS/PHMCOL-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 MED PHYS/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 2017

PHYSICS 623 — ELECTRONIC AIDS TO MEASUREMENT
4 credits.

Fundamentals of electronics, electronic elements, basic circuits; combinations of these into measuring instruments. Three lectures and one three-hour lab per week.

Requisites: Undergraduates who have 3 semesters of calculus level physics may enroll with consent of instructor

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 2017

PHYSICS 625 — APPLIED OPTICS
4 credits.


Requisites: Three semesters of calculus level physics or equiv.

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 2017

PHYSICS 601 — SCIENTIFIC PRESENTATION
2 credits.

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

Requisites: Grad st or Sr st in the Honors program or cons inst

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 681 — SENIOR HONORS THESIS
3 credits.

Note that no credit for physics 681 will be received until successful completion of 682. Must be taken as a sequence with 682.
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 2017

PHYSICS 682 — SENIOR HONORS THESIS
3 credits.

Must be taken as a sequence following 681
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 2017

PHYSICS 691 — SENIOR THESIS
2-3 credits.

Note that no credit for PHYSICS 691 will be received until successful completion of 692. Must be taken as a sequence with 692
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 2017

PHYSICS 692 — SENIOR THESIS
2-3 credits.

Must be taken as a sequence following 691
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 2015

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, chaos, continuum mechanics, introduction to general relativity.
Requisites: PHYSICS 311 or equiv
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

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, applications of statistical mechanics to selected problems.
Requisites: PHYSICS 711, 531 415, or equiv
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

PHYSICS 716 — STATISTICAL MECHANICS II
3 credits.

Requisites: PHYSICS 715, PHYSICS 731, and PHYSICS 732
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: PHYSICS 721
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

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.
Requisites: PHYSICS 322 or equiv
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017
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.

Requisites: NEEP/ECE/PHYSICS/E C E/N E 525 PHYSICS 721 or ECE 740 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

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.

Requisites: Physics, ECE, NEEP 525 PHYSICS 721 or ECE 740 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2016

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.

Requisites: NEEP/ECE/PHYSICS/E C E/N E 525 PHYSICS 721 or ECE 740 or cons inst
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: Spring 2017

PHYSICS 731 — QUANTUM MECHANICS
3 credits.


Requisites: PHYSICS 449 or 531, or equiv
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

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: PHYSICS 721 731
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

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.

Requisites: PHYSICS 535, 731 or equiv or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

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.

Requisites: PHYSICS 535 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

PHYSICS 741 — EXPERIMENTAL NUCLEAR PHYSICS
3 credits.

Basic properties of nuclei, nuclear forces and energetics; scattering, reaction, radioactivity; nuclear radiations, their interactions with matter and detection.

Requisites: PHYSICS 531 or 449
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2008
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.

**Requisites:** ECE-PHYSICS/E C E 546; PHYSICS 721 or ECE 740

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

**Repeatable for Credit:** No

**Last Taught:** Fall 2011

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; inhomogeneous media; random media. Lagrangian and Hamiltonian formulations; asymptotic methods.

**Requisites:** ECE 440 or PHYSICS 322 or cons inst

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

**Repeatable for Credit:** No

**Last Taught:** Fall 2017

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:** ECE 740 or PHYSICS 721, or equiv, or cons inst

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

**Repeatable for Credit:** No

**Last Taught:** Fall 2014

PHYSICS 751 — ADVANCED SOLID STATE PHYSICS
3 credits.

Lattice dynamics; band theory; Fermi surfaces; electrodynamics of metals; optical properties; transport properties.

**Requisites:** PHYSICS 731 and 551 or equiv

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

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

PHYSICS 752 — MANY-BODY PROBLEMS IN SOLID STATE PHYSICS
3 credits.

Introduction to many-body problems in solids: phonons, magnons, homogeneous electron gas, superconductivity, disordered systems.

**Requisites:** PHYSICS 731

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

**Repeatable for Credit:** No

**Last Taught:** Spring 2011

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.

**Requisites:** PHYSICS 721 or 322, basic knowledge of spec relativity, basic diff equations, or cons inst

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

**Repeatable for Credit:** No

**Last Taught:** Spring 2016

PHYSICS/B M E/MED PHYS 775 — ADVANCED ULTRASOUND PHYSICS
3 credits.

Foundations of acoustic wave equations, diffraction phenomena and acoustic beam formation, models for acoustic scattering from discrete structures and inhomogeneous continua, speckle statistics including speckle correlation, applications of these topics in medical imaging.

**Requisites:** MED PHYS/B M E 575, PHYSICS 311, 322, 325, MATH 234, or cons inst

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

**Repeatable for Credit:** No

**Last Taught:** Fall 2013

PHYSICS 799 — INDEPENDENT STUDY
1-3 credits.

**Requisites:** Consent of instructor

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

**Repeatable for Credit:** No

**Last Taught:** Summer 2017

PHYSICS 801 — SPECIAL TOPICS IN THEORETICAL PHYSICS
1-3 credits.

Can be repeated for credit.

**Requisites:** Graduate or professional standing

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

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Fall 2017

PHYSICS 805 — SPECIAL TOPICS IN PHYSICS
1-3 credits.

Can be repeated for credit.

**Requisites:** Graduate or professional standing

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

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Fall 2017
PHYSICS 831 — ADVANCED QUANTUM MECHANICS
3 credits.
Quantum theory of free and interacting fields, formal scattering theory, dispersion theory.
Requisites: PHYSICS 732
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

PHYSICS 832 — ADVANCED QUANTUM MECHANICS
3 credits.
Continuation of 831.
Requisites: PHYSICS 831
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

PHYSICS 833 — ADVANCED MATH IN QUANTUM FIELD THEORY
3 credits.
The use in physics, most specifically nonabelian gauge field theory, of differential forms, homology, cohomology, homotopy, index theorems, fiber bundles, parallel transport, connections, curvature, characteristic classes, moduli space, Morse theory, and assorted other mathematics, is motivated, developed, and illustrated.
Requisites: PHYSICS 731, 732 831; or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2009

PHYSICS 835 — COLLIDER PHYSICS PHENOMENOLOGY
2-3 credits.
Requisites: Phys 735 or equiv or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

PHYSICS 838 — 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.
Requisites: ECE 748 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2016

PHYSICS 900 — COLLOQUIUM
1 credit.
Lectures by staff and visitors.
Requisites: Cons inst if taken for 1 cr
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2013

PHYSICS 903 — SEMINAR-THEORETICAL PHYSICS
1 credit.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2009

PHYSICS/ASTRON 910 — SEMINAR IN ASTROPHYSICS
1 credit.
Current topics.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

PHYSICS/E C E/N E 922 — SEMINAR IN PLASMA PHYSICS
1 credit.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

PHYSICS 951 — SEMINAR-SOLID STATE PHYSICS
1 credit.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2012

PHYSICS 990 — RESEARCH
1-12 credits.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017