

# PHYSICS (PHYSICS)

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## **PHYSICS 1001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

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## **PHYSICS 1101 Introduction To Physics** (LEC 1.0)

An introduction to the study of physics and its intellectual and professional opportunities. The student will be acquainted with the various areas of physics and with departmental and campus facilities useful to their future studies. Required of all freshman majors.

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## **PHYSICS 1111 General Physics I** (LEC 4.0)

An introduction to the fundamental ideas of physics, including mechanics, heat, and sound. Prerequisite: Preceded by Math 1208 or Math 1214.

PHYSICS 1111 - MOTR PHYS 150: Physics I

PHYSICS 1111 - MOTR PHYS 150L: Physics I with Lab

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## **PHYSICS 1119 General Physics Laboratory** (LAB 1.0)

Experiments related to topics studied in Physics 1111. Prerequisites: Preceded or accompanied by Physics 1111.

PHYSICS 1119 - MOTR PHYS 150L: Physics I with Lab

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## **PHYSICS 1135 Engineering Physics I** (LAB 1.0 and LEC 1.5 and RSD 1.5)

An introduction to mechanics, with an emphasis on topics needed by engineering students, including kinematics, dynamics, statics, and energetics. Prerequisite: A grade of "C" or better in Math 1208 or Math 1211 or Math 1214.

PHYSICS 1135 - MOTR PHYS 200L: Advanced Physics I with Lab

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## **PHYSICS 1145 College Physics I** (LAB 1.0 and LEC 3.0)

An introduction to the ideas of physics, including mechanics, heat, and sound. Prerequisites: Math 1160 and either of Math 1120 or Math 1140.

PHYSICS 1145 - MOTR PHYS 150: Physics I

PHYSICS 1145 - MOTR PHYS 150L: Physics I with Lab

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## **PHYSICS 1505 Introductory Astronomy** (LEC 3.0)

An introductory course in basic astronomy designed primarily for students other than those in science and engineering. Topics include history, the sky, the solar system, stars, stellar evolution, galaxies and the origin and evolution of the universe. Credit will not be given for both Physics 1505 and Physics 1515.

PHYSICS 1505 - MOTR ASTR 100: Astronomy

PHYSICS 1505 - MOTR ASTR 100L: Astronomy with Lab

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## **PHYSICS 1509 Astronomy Laboratory** (LAB 1.0)

A science laboratory course in which the student analyzes and interprets astronomical data and makes observations with a telescope.

Prerequisite: Preceded or accompanied by Physics 1505 or 1515.

PHYSICS 1509 - MOTR ASTR 100L: Astronomy with Lab

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## **PHYSICS 1605 Environmental Physics I** (LEC 3.0)

A course for non-science majors which will consider, without mathematics, the production of energy and the environmental consequences of its use, and the physical problems associated with pollution.

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## **PHYSICS 1609 Laboratory For Environmental Physics** (LAB 1.0)

A laboratory course to accompany the Environmental Physics lecture course as an option. A set of experiments will be performed related to environmental impacts studied in Environmental Physics 1605. To be taken simultaneously with Environmental Physics 1605. Prerequisite: Corequisite Physics 1605.

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## **PHYSICS 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

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## **PHYSICS 2111 General Physics II** (LEC 4.0)

An introduction to the fundamental ideas of physics including electricity, magnetism, and light. Prerequisites: Preceded by Physics 1111 or Physics 1135 and preceded or accompanied by Math 1221 or Math 1215.

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## **PHYSICS 2119 General Physics Laboratory** (LAB 1.0)

Experiments related to topics studied in Physics 2111. Prerequisite: Preceded or accompanied by Physics 2111.

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## **PHYSICS 2129 Intermediate Physics Laboratory** (LAB 2.0 and LEC 1.0)

A laboratory study of the principles of instrumentation used in all modern branches of physics. Analog and digital methods of data gathering are surveyed. Laboratory practice evolves from elementary operations to the design and assembly of a simple instrument.

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## **PHYSICS 2135 Engineering Physics II** (LAB 1.0 and LEC 1.5 and RSD 1.5)

An introduction to electricity, magnetism, and light, with emphasis on topics needed by engineering students. Prerequisites: Physics 1135 or Physics 1111, Math 1221 or Math 1215.

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## **PHYSICS 2145 College Physics II** (LAB 1.0 and LEC 3.0)

An introduction to the ideas of physics, including electricity, magnetism, and light. Prerequisites: Math 1160, Physics 1145.

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## **PHYSICS 2305 Introduction To Modern Physics** (LEC 3.0)

An elementary survey of the modern concepts in physics and their applications; relativity, quantum mechanics, atomic physics, solid state physics, nuclear and particle physics. Prerequisites: Math 2222 and Physics 2135 or 2111.

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## **PHYSICS 2311 Modern Physics I** (LEC 3.0)

An introduction to quantum mechanics, atomic physics, and solid state physics. Topics include historically important experiments and interpretations. Prerequisites: Physics 2135 or 2111, preceded or accompanied by Math 3304 or 3329.

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## **PHYSICS 2401 Introduction To Theoretical Physics** (LEC 3.0)

Fundamental physical concepts are elaborated in mathematical terms emphasizing the coherence and economy of Physics. Topics include elementary vector analysis, introduction to physical mechanics (motion of a point mass, conservation laws, relativity), Fourier series, and introduction to partial differential equations. Prerequisites: Math 3304 co-requisite; Physics 2135 or 2111.

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**PHYSICS 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

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**PHYSICS 3001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

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**PHYSICS 3119 Advanced Physics Laboratory I** (LAB 3.0)

A laboratory study of the principles of basic experiments in all major branches of physics. The experiments stress design of apparatus, and procedures and analysis in projects involving electronic, optical, mechanical, and vacuum techniques. Prerequisite: Physics 2129.

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**PHYSICS 3129 Advanced Physics Laboratory II** (LAB 3.0)

A senior laboratory involving experimental design. The student must specify his objectives, assemble apparatus, take measurements, analyze the results, form conclusions, write a report, and deliver an oral presentation of the results. Prerequisite: Physics 2129.

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**PHYSICS 3201 Physical Mechanics** (LEC 3.0)

This course covers topics of rigid body motion in three dimensions, moving coordinate frames, two body collisions, conservation laws, small oscillations, generalized coordinates, and LaGrange's and Hamilton's equations. Prerequisite: Physics 2401.

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**PHYSICS 3211 Electricity And Magnetism I** (LEC 3.0)

A study of electric and magnetic fields, leading to Maxwell's equations. Topics covered include the electrostatic field, the electric potential, and the electrostatic field in matter. Prerequisite: Physics 2401.

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**PHYSICS 4001 Special Topics** (LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

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**PHYSICS 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor.

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**PHYSICS 4203 Introduction To General Relativity** (LEC 3.0)

An introduction to the theory of general relativity. Topics covered include the formalism of general relativity, Einstein's gravitational field equations, the Schwarzschild solution, black holes, and cosmological models of the universe. Prerequisite: Physics 2401.

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**PHYSICS 4211 Electricity And Magnetism II** (LEC 3.0)

A continuation of Physics 3211. Topics covered include the magnetostatic field, the magnetic vector potential, the magnetostatic field in matter, electrodynamics, and electromagnetic waves. Prerequisite: Physics 3211.

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**PHYSICS 4301 Introduction To Quantum Mechanics** (LEC 3.0)

The fundamental concepts, postulates and methods of quantum mechanics and their applications to physical systems. Topics include solutions of the Schrodinger equation for simple systems and operator methods. Prerequisites: Physics 2305 or 2311, 2401.

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**PHYSICS 4311 Thermal Physics** (LEC 3.0)

A study of the equilibrium states of matter as governed by the first and second laws of thermodynamics. Emphasis is placed on the microscopic approach with an introduction to statistical mechanics. Topics include the kinetic theory of (uniform) gases, phase equilibria in pure systems, and an introduction to quantum statistics. Prerequisite: Physics 2305 or 2311.

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**PHYSICS 4323 Elementary Solid State Physics** (LEC 3.0)

An introductory study of the structure and physical Properties of crystalline solids. Included are topics in crystal structure, x-ray diffraction, crystal binding, thermal properties of solids, free electron theory and elementary energy band theory. Prerequisites: Math 3304 and Physics 2305 or 2311.

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**PHYSICS 4333 Nuclear and Particle Physics** (LEC 3.0)

An introduction to nuclear and particle physics. Topics include nuclear models, decays, and reactions, and elementary particles and fundamental forces. Prerequisites: Physics 2305 and Math 3304.

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**PHYSICS 4343 Atomic Physics** (LEC 3.0)

An introduction into the structure and dynamics of atomic and molecular systems and their interaction with light. Topics include basic theories, fine and hyperfine interaction, QED corrections, energy shifts in external fields, electron correlation effects, and spectroscopic methods (e.g., laser spectroscopy, electron spectroscopy, atomic clocks). Prerequisites: Physics 2305.

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**PHYSICS 4503 Classical Optics** (LEC 3.0)

Physical optics and advanced topics in geometrical optics. Topics include ray propagation, electromagnetic propagation, mirrors, lenses, interference, diffraction, polarization, imaging systems, and guided waves. Prerequisites: Math 2222 and Physics 2135 or 2111. (Co-listed with Elec Eng 5200).

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**PHYSICS 4513 Laser Physics** (LEC 3.0)

The generation of coherent radiation by lasers and the interaction of laser radiation with matter. Topics include stimulated emission, population inversion, optical cavities, optical gain, properties of laser media and other applications. Prerequisite: Physics 2305 or 2311.

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**PHYSICS 4523 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Met Eng 5810, Cer Eng 5810).

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**PHYSICS 4533 Transport in Nanostructures: An Introduction** (LEC 3.0)

The course overviews how wave interference, energy quantization and tunneling phenomena influence the wave (electron and light) transport in modern nanostructured materials and devices such as quantum dots, quantum wells, quantum wires, and photonic crystals. Prerequisite: Physics 2305 or 2311.

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**PHYSICS 4543 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Nuc Eng 4370).

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**PHYSICS 4553 Astrophysics** (LEC 3.0)

The structure, physical characteristics and evolution of stars, binary systems, nebulae and galaxies. Prerequisite: Physics 2305.

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**PHYSICS 4563 Astrophysical Concepts** (LEC 3.0)

A comprehensive course in modern astrophysics. Topics include: Earth and sky, planetary science, stellar structure and evolution, galaxies, and structure and evolution of the universe. The course includes hands-on computer simulation and telescope use. (For secondary teachers or Master of Science for Teachers candidates.) Prerequisite: Math 2222 or admission to the MST program.

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**PHYSICS 4605 Physics For Elementary School Teachers** (LAB 1.0 and LEC 2.0)

A nonmathematical review of the fundamental ideas of physics, including mechanics, matter, energy, sound, electricity, magnetism, astronomy, and light. Emphasis is placed on the development of hands-on activities. (For elementary school teachers or Master of Science for Teachers candidates only.)

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**PHYSICS 4615 Physics For Secondary School Teachers** (LEC 3.0)

A review of the fundamental ideas of physics, including mechanics, matter, energy, sound, electricity, magnetism, and light with an emphasis on how mathematics can be used to help understand the underlying concepts. (For secondary teachers or Masters of Science Teachers candidates only.) Prerequisites: Math 2222 and admission to the MST program.

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**PHYSICS 4625 Science Education and Quantitative Literacy for Middle School Teachers** (LEC 3.0)

An integrated science-mathematics course for middle school teachers. Course covers selected science/mathematics topics/skills specified in Missouri standards for grades 5-7. Inquiry based methods of teaching these topics in an integrated manner will be emphasized. Prerequisite: Current enrollment in a Teacher Education Program or a full or part-time teacher in a K-12 school. (Co-listed with Stat 5904).

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**PHYSICS 4635 Physics, Energy, and the Environment** (LEC 3.0)

Applications of physics to the environment, including energy, its conservation and transformation, environmental consequences of energy use; world energy resources; atmospheric physics; sources of air, water, and land pollution, and the role physics plays in controlling those resources. May not be used as a 3000- or 4000-level elective for a B.S. in Physics. Prerequisite: Admissions to the Master of Science for Teachers program.

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**PHYSICS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

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**PHYSICS 5001 Special Topics** (IND 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

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**PHYSICS 5333 Subatomic Physics** (LEC 3.0)

An introduction to elementary particles. Topics include particle properties, nuclear forces, particle interactions, the Standard Model for quarks and leptons, fundamental forces in gauge field theory models, and the role of elementary particle interactions in cosmology. Prerequisite: Physics 3311.

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**PHYSICS 5403 Computational Physics** (LAB 1.0 and LEC 3.0)

An introduction to modern computer simulations for solving physics problems. The course will be project-oriented with examples including planetary motion, chaotic dynamics, quantum scattering, structure of atoms and clusters, molecular dynamics, and Monte-Carlo simulations. Prerequisites: Physics 2305 or Physics 2311; Math 3304; programming experience.

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**PHYSICS 5413 Chaos, Fractals, and Nonlinear Dynamics** (LEC 3.0)

An introduction into nonlinear dynamics, deterministic chaos, and fractals. Topics covered include phase plane analysis, iterated maps, routes to chaos, Lyapunov exponents, strange attractors and pattern formation with applications to chaotic vibrations, population dynamics, chemical oscillations and lasers. Prerequisites: Math 3304; Physics 2135 or Physics 2111.

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**PHYSICS 5503 Fourier Optics** (LEC 3.0)

Applications of Fourier analysis and linear system theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: Both Elec Eng 3430 and Elec Eng 3600 or Physics 4211. (Co-listed with ELEC ENG 5210).

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**PHYSICS 5513 Fiber And Integrated Optics** (LEC 3.0)

Introduction to optical waveguides and their applications to communication and sensing. Topics include dielectric waveguide theory, optical fiber characteristics, integrated optic circuits, coupled-mode theory, optical communication systems, and photonic sensors. Prerequisite: Elec Eng 3600 or Physics 4211. (Co-listed with Elec Eng 5220).

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**PHYSICS 5603 Advanced Physics Laboratory Teaching Methods** (LEC 3.0)

Objectives, methods and problems related to teaching of introductory physics, with an emphasis on laboratory instruction, the development of educational laboratory experiments and techniques, student learning styles, student assessment, student work groups, computer-based data acquisition, and communication techniques. Prerequisite: Graduate standing.

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**PHYSICS 6000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department Consent of instructor required.

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**PHYSICS 6001 Special Topics** (LEC 0.0 and RSD 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

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**PHYSICS 6002 Coop Registration** (IND 0.0-1.0)

Doctoral candidates participating in a cooperative program with another UM campus must enroll for one hour of credit for their first semester in the program and zero hours of credit for successive registration periods until degree is completed. Failure to do so may invalidate candidacy. Billing is automatic as is registration upon payment.

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**PHYSICS 6010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

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**PHYSICS 6040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

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**PHYSICS 6050 Continuous Registration** (IND 1.0)

Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

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**PHYSICS 6099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

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**PHYSICS 6101 Classical Mechanics I** (LEC 3.0)

Methods of Newton, Lagrange, and Hamilton applied to the motion of particles and rigid bodies. Introduction to canonical transformations and Poisson brackets. Classical scattering and small oscillations. Prerequisites: Math 3304 and Physics 3201.

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**PHYSICS 6111 Electrodynamics I** (LEC 3.0)

A rigorous development of the fundamentals of electromagnetic fields and waves. Electrostatics, magnetostatics, Maxwell's equations--Green's function, boundary value problems, multipoles, conservation laws. Prerequisites: Physics 4211.

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**PHYSICS 6201 Quantum Mechanics I** (LEC 3.0)

Basic formalism applied to selected problems. Schroedinger equation and one dimensional problems, Dirac notation, matrix mechanics, harmonic oscillator, angular momentum, hydrogen atom, variational methods, introduction to spin. Prerequisite: Physics 4301 or equivalent.

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**PHYSICS 6211 Electrodynamics II** (LEC 3.0)

A continuation of Physics 5211+D1067. Applications of time-dependent Maxwell's equations to such topics as plasmas, wave guides, cavities, radiation; fields of simple systems and multipoles. Relativity; covariant formulation of Maxwell's equations and conservation laws, fields of uniformly moving and accelerated charges. Prerequisite: Physics 5211.

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**PHYSICS 6301 Quantum Mechanics II** (LEC 3.0)

Perturbation theory, treatment of spin, angular momentum addition, Wigner-Eckart theorem; scattering theory including partial wave analysis, born approximation, and formal scattering theory; identical particles, introduction to second quantization, and structure of complex atoms. Prerequisite: Physics 5301.

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**PHYSICS 6311 Statistical Mechanics** (LEC 3.0)

A study of statistical ensembles; Maxwell-Boltzmann, FermiDirac and Einstein-Bose distribution laws, application to some simple physical systems. Prerequisites: Physics 4311, Physics 5301.

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**PHYSICS 6323 Quantum Statistical Mechanics** (LEC 3.0)

Techniques for calculation of the partition function with examples drawn from interacting Fermi gas, interacting Bose gas, superconductors, and similar sources. Prerequisites: Physics 6311 and 6301.

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**PHYSICS 6333 Condensed Matter Physics** (LEC 3.0)

A course in the physics of hard and soft matter including solids, liquids, and complex materials. Topics: atomic structure, mechanical properties, phonons, electronic structure, energy band theory, electronic correlations, transport properties, magnetism, superconductivity. Prerequisite: Physics 5301.

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**PHYSICS 6353 Atomic And Molecular Structure** (LEC 3.0)

Applications of quantum mechanics to the structure of atoms and molecules; perturbation and variational calculations, self-consistent field, multiplets, angular momenta, Thomas-Fermi model, diatomic molecules, spectral intensities. Prerequisite: Physics 5301.

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**PHYSICS 6363 Atomic Collisions** (LEC 3.0)

Basic quantum mechanical concepts involved in atomic scattering theory. Topics include the Born approximation elastic collisions, and inelastic collisions. Other specific topics will be chosen from the general areas of electron, ion, and atom collisions with atoms and molecules. Prerequisite: Physics 6353 or 6301.

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**PHYSICS 6403 Mathematical Physics I** (LEC 3.0)

Vector spaces, generalized coordinate transformations, vector analysis, tensors, partial differential equations in physics and boundary value problems, orthogonal functions and solutions to ordinary differential equations, hypergeometric, confluent hypergeometric, Legendre, Laguerre, and Bessel functions, Hermite polynomials, Green's functions in one dimension. (Co-listed with Math 6802).

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**PHYSICS 6413 Mathematical Physics II** (LEC 3.0)

Green's functions in three dimensions, integral equations, complex variable theory and contour integration, group theory with applications to quantum mechanics, solid state and molecular physics. Prerequisite: Math 6802 or Physics 6403. (Co-listed with Math 6803).

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