

**MASTER OF SCIENCE  
PHYSICS  
Program code: 0430**

**INTRODUCTION**

The Department of Physics (College of Science) offers a Master of Science program in **Physics**. The program is designed to prepare individuals for a career in college or university teaching and research; a leadership role in secondary school science education; employment in technically oriented positions in government, business, or industrial laboratories, and to continue graduate education towards the Ph.D. degree. A wide range of potential areas for research are available for students to choose from. This includes: Atomic, Molecular, Solid State, Nuclear and Digital Electronics. Only thesis option is offered.

*According to the University Council decision dated 4/2/2007, Thesis students admitted with effect from September 2007 are exempted from the comprehensive examination.*

**PROGRAM REQUIREMENTS****31 TOTAL COURSE CREDITS****13 COMPULSORY (credits in parenthesis)**

0430-501	Classical Mechanics	(3)
0430-503	Classical Electrodynamics	(3)
0430-505	Quantum Mechanics I	(3)
0430-507	Mathematical & Computational Methods	(3)
0430-590	Seminar	(1)

**9 ELECTIVES\* (3 credits each)**

0430-508	Special Topics I. Physics
0430-509	Special Topics II. Engineering Physics
0430-510	Atomic Spectra
0430-512	Laser Physics
0430-514	Theory of Atomic Collisions
0430-520	Molecular Spectroscopy I
0430-521	Molecular Spectroscopy II
0430-523	Photo physics
0430-525	Raman Spectroscopy
0430-530	Solid State Physics I
0430-531	Solid State Physics II
0430-533	Semiconductors
0430-535	Thermal Solar Processes
0430-540	Quantum Mechanics II

- 0430-542 Field Theory
- 0430-545 Particles and Symmetries
- 0430-550 Nuclear Physics I
- 0430-551 Nuclear Physics II
- 0430-563 Advanced Digital Signal Processing
- 0430-570 Physics and Applications of GPS
- 0430-571 Synthetic Aperture Radar Interferometry
- 0430-572 Synthetic Aperture Radar Processing
- 0430-574 Solar Plasma and Cosmic Rays

\*Students may substitute up to 6 credit hours from the upper elective Physics undergraduate courses (400 level) with the approval of the Program Director.

## 9 COMPULSORY COURSES

- 0430-597 Thesis (0)
- 0430-598 Thesis (0)
- 2000-599 Thesis (9)

### ***COURSE DESCRIPTION***

**0430-501: CLASSICAL MECHANICS**  
**CR: 3**

Mechanics in the Lagrangian formulation; two body central force problem; rigid body dynamics; Hamiltonian formulation; canonical transformations; covariant relativistic mechanics; small oscillations.

**0430-503: CLASSICAL ELECTRODYNAMICS**  
**CR: 3**

Electrostatics; boundary value problems; multiple expansion; Maxwell's equations; electromagnetic waves; radioactive systems.

**0430-505: QUANTUM MECHANICS I**  
**CR: 3**

Theory of states and operators in Hilbert space; the Schrodinger equation. Heisenberg and interaction representation; perturbation theory; approximation methods; spin and the identity of particles; scattering theory; application to actual quantum systems.

**0430-507: MATHEMATICAL AND COMPUTATIONAL METHODS**  
**CR: 3**

Special functions; integral equations; integral transforms; Green's functions; computer programming techniques; programming languages; computer operating systems; computer-aided solutions of physical problems.

**0430-510: ATOMIC SPECTRA**  
**CR: 3**

Methods of atomic structure calculations; many-electron configurations; coupling schemes in complex spectra; fine structure and multiple analysis; series perturbations and ionization limits; Zeeman and Stark effects; spectral line shape theory; plasma spectroscopy.

**0430-512: LASER PHYSICS**  
**CR: 3 PR:0430-505 or equivalent**

Interaction of atomic systems with radiation field; semiclassical theory of laser; multimode operation; quantum theory of radiation and laser; coherent states; laser fluctuations, photon statistics and noise.

**0430-514: THEORY OF ATOMIC COLLISIONS**

**CR: 3 PR:0430-505 or equivalent**

Quantum statement of the problem; partial wave analysis; Ramsauer effect; variational principles for phase shift; electron hydrogen scattering problem; Pauli principle and spin in collision processes; Stueckelberg theory; Coulomb scattering; excitation and ionization by electron and heavy ion impact.

**0430-520: MOLECULAR SPECTROSCOPY I**

**CR: 3 PR: 0430-505 or equivalent**

Angular momentum and symmetry in diatomic and polyatomic molecules; molecular orbital theory.

**0430-521: MOLECULAR SPECTROSCOPY II**

**CR: 3 PR: 0430-520 or equivalent**

Ligand field theory; group theory; applications.

**0430-523: PHOTOPHYSICS**

**CR: 3 PR: 0430-520 or equivalent**

Excited states of polyatomic molecules; absorption, fluorescence, and phosphorescence; excimers (liquids and crystals); molecular complexes and exciplexes; energy migration and transfer (liquids and crystals); quenching of excited states; delayed emission.

**0430-525: RAMAN SPECTROSCOPY**

**CR: 3 PR: 0430-520 or equivalent**

Introduction to the Raman effect; polarizability tensor and selection rules; symmetry effects; vibrational Raman effect; rotational and electronic Raman effect; applications.

**0430-530: SOLID STATE PHYSICS I**

**CR: 3**

A review of band structure of solids, Fermi surfaces and metals; Optical processes, dielectrics and optical properties of solids, ferroelectrics; Magnetism and its applications, superconductivity.

**0430-531: SOLID STATE PHYSICS II**

**CR: 3 PR: 0430-530, 0430-505**

Interacting electron gas model of solids, Hartree-Fock Approximation, Inhomogeneous interacting electron gas, the Thomas Fermi theory leading to the density functional theory, one-electron band theory of solids, Band structure calculation methods, the tight-binding and multiple scattering

approaches, Metallic magnetism-local magnetic moments, mean-field theory of magnetic.

**0430-533: SEMICONDUCTORS**

**CR: 3**

Physical principles of semiconductors and their application to various electronic and optical devices; band structure; intrinsic and extrinsic semiconductors and their statistical transport properties; optical properties; the junction diode and the transistor; tunnel diode; Gunn diode; infrared detectors; solar cell; semiconductor lasers; etc.

**0430-535: THERMAL SOLAR PROCESSES**

**CR: 3**

Solar insulation; absorption, transmission and reflection of radiation by surfaces; blackbody radiation and absorption; solar collectors, application of solar thermal energy to heating and cooling of buildings; solar thermal stations; advanced applications.

**0430-540: QUANTUM MECHANICS II**

**CR: 3 PR: 0430-505 or equivalent**

Theory of angular momentum, symmetry; coherence of states; the density matrix; the Dirac equation; quantization of the electromagnetic field; applications.

**0430-542: FIELD THEORY**

**CR: 3 PR: 0430-501, 0430-503, 0430-505**

Klein-Gordon equation; Dirac equation; second quantization of fields with spins 0, 1/2 and 1, interaction between fields; scattering and the S-matrix; Feynman diagrams; renormalization theory.

**0430-545: PARTICLES AND SYMMETRIES**

**CR: 3 PR: 0430-542 or equivalent**

Hadrons and leptons; conservation laws; resonance; Lie algebras; SU(2) and SU(3); Young diagrams and representations; multiplets; mass formulas; cross sections; strong and weak interactions; gauge symmetries.

**0430-550: NUCLEAR PHYSICS I**

**CR: 3**

Static properties of nuclei; nuclear forces; nuclear models; single particle and shell models;

vibrational and collective models; liquid drop model; nuclear fission.

**0430-590: SEMINAR  
CR:1**

**0430-551: NUCLEAR PHYSICS II  
CR: 3 PR: 0430-550 or equivalent**

**0430-597: THESIS  
CR: 0**

Nuclear reactions; direct and compound nuclear reactions; deep inelastic collisions; alpha decay; beta decay; electromagnetic transitions.

**0430-598: THESIS  
CR: 0**

**0430-563: ADVANCED DIGITAL SIGNAL  
PROCESSING  
CR: 3**

**2000-599: THESIS  
CR: 9**

Review of discrete transforms for LTI analysis, Digital filters, Multirate DSP, Design of Linear Filters for Prediction and Optimization, Adaptive filters, Power spectrum analysis, Wavelets, Digital speech processing, Digital image processing, Applications and examples.

**0430-570: PHYSICS AND APPLICATIONS  
OF GPS  
CR: 3**

Precession position measurement, three dimensional transformation equations, atmospheric and relativist error sources, signal characterization and analysis, correlation studies, GAMIT software.

**0430-571: SYNTHETIC APERTURE RADAR  
INTERFEROMETRY  
CR: 3**

Concepts of interferometry, review of radar fundamentals, statistical techniques, image formation, Digital Elevation Models, GPS, land subsidence and deformation vectors.

**0430-572: SYNTHETIC APERTURE RADAR  
INTERFEROMETRY  
CR: 3**

Radar systems, SAR geometry, range compression, azimuth compression, pixel migration, focusing, band width and phase concepts.

**0430-574: SOLAR PLASMA AND COSMIC RAYS  
CR:3**

Start with our nearest star and its atmosphere, solar plasma and interplanetary magnetic field, transport and acceleration of particles in space, galactic cosmic rays, solar flares and coronal mass ejections, space weather and geomantic activity, time series analysis.