GRADUATE COURSE DESCRIPTIONS- Department of Physics

20-10-501 Classical Mechanics 3 Cr. A Summary of Newtonian mechanics, principle of least action, Lagrangian and Hamiltonian formulations, canonical transformations, Poison's brackets, Hamilton-Jacobi theory, introduction to classical field theory.

20-10-506 Advanced Quantum Mechanics I 3 Cr. Fundamental concepts: Kets. bras, and operators, measurements, observables and the uncertainty relations, quantum dynamics: the Schrodinger, Heisenberg and interaction pictures, propagators and Feynman path integrals, theory of angular momentum: Addition of angular momentum, symmetry in quantum mechanics.

20-10-507 Advanced Quantum Mechanics II 3 Cr. Approximation methods: perturbation theory, hydrogen like atoms, variational methods, energy shift and decay width, identical particles: permutation symmetry, 2 electron system, young tableaux, scattering theory: Born and Eikonal approximation, method of partial waves, identical particles and scattering and coulomb scattering.

Prerequisite: Advanced Quantum Mechanics I 20-10-506

20-10-510 Electrodynamics 4 Cr. Methods of solving electrostatic boundary value problems, Green functions, physics of dielectric media, magnetostatics, dynamics of electromagnetic fields, covariant formulation of electrodynamics, interactions of relativistic charged particles and fields.

20-10-512 Advanced Statistical Mechanics 3 Cr. The statistical basis of thermo-dynamics, elements of ensemble theory, the canonical ensemble, the grand canonical ensemble, formulation of quantum statistics, the theory of simple gases, ideal Bose systems, ideal Fermi systems.

20-12-513 Advanced Solid State Physics I 3 Cr. Free electron models, crystal structure, electron in a weak periodic potential, methods for calculating band structures, semiclassical models of electron dynamics, fermi surfaces, pseudopotential.

20-12-514 Advanced Solid State Physics II 3 Cr. Beyond the independent electron approx, hartree approx, hartree Fock approx, exchange correlation, surface effects, cohesive energy, Lattice dynamics, magnetism.

Prerequisite: Advanced Solid State I 20-12-513

20-14-515 Advanced Nuclear Physics I 3 Cr. Nuclear reactions, reaction mechanisms, nuclear models, shell model, collective model.

20-14-516 Advanced Nuclear Physics II 3 Cr. Nuclear orientation, nuclear forces, fundamental particles properties, classification, the weak and strong interactions, miscellaneous topics.

Prerequisite: Advanced Nuclear Physics I 20-14-515

20-16-526 Advanced Particle Physics 1

20-16-702 Advanced Elementary Particles II

Prerequisite: Advanced Particle Physics 1

20-10-717 Quantum Many-body course:

Second quantization for Bosons and Fermions, Perturbation theory and its failure for jellium model, Mean Field Theory,Equation of Motion (EOM),Interaction picture and Wick theorem, Feynman diagrams for impurity scattering,Feynman diagrams for electron gas, Fermi liquid theory, Digression on other many-body techniques,

20-10-724 Advanced Mathematical Physics

Mathematical Preliminaries, Homology Groups, Homotopy Groups, Manifolds, De Rham Cohomology Groups, Riemannian Geometry, Complex Manifolds.

20-10-729 Critical Phenomenea

Phase transitions, critical behavior,Scaling hypothesis and critical exponents,Landau-Ginzburg Hamiltonian, meanfield Theory and saddle point approximation,Fluctuations and correlations to saddle point approximation,Renorxmalization group,Series expansions.

20-12-515 Advance Physics of Solid Thin Films and Interfaces

A brief introduction to Vacuum Science and Technology, Physical and Chemical Vapor Deposition, Film Formation and Structure, Interdiffusion and Reactions in Thin Films, Mechanical Properties of Thin Films, Electrical and Magnetic properties of Thin Films, Optical Properties of Thin Films, Metallurgical and Protective Coatings, Modification of Surface and Films, Emerging Thin-Film Materials and Applications.

Prerequisite: Statistical Mechanics, Advance Solid State.

20-12-713 Advanced Condensed Matter Physics

Linear response theory, Classical transport ,Quantum transport, Disordered systems and localization, Microscopic BCS theory of superconductivity, Quantum Hall effect,Fermi liquid theory.

20-12-715 Density functional theory
Statistical mechanics and the density matrix,Independent electron approximations,Hartree and Hartree-Fock approximation,Thomas-Fermi-Dirac approximation,Density functional theory (Hohenberg-Kohn theorems),Spin density functional theory,Finite temperature density functional theory,The Kohn-Sham ansatz,Exchange-correlation hole,Functionals for exchange and correlation,Quantum molecular dynamics.

20-12-718 Magnetic properties of materials
Magnetostatics,Classical and Quantum phenomenology of magnetism,Quantum mechanics, magnetism and exchange in atoms and oxides,Quantum mechanics, magnetism and bonding in metals,Magnetic anisotropy,Magnetic domain walls and domains,Magnetism in nanostructures.

20-16-526 Advanced Particle Physics 1
Elementary Particle Physics,Relativistic Quantum Mechanics and Introduction to Quantum Field Theory,Dirac fermions,Introduction to Scattering,Electrodynamics,Loop Corrections,Weak interactions.

20-16-702 Advanced Elementary Particles II
Weak Interactions ,Symmetries and Gauge Theories,The Standard Model of Electroweak Interactions, Quantum Chromodynamics,Nutrino Masses and Neutrino Oscillations, Supersymmetry.