Plan No.				

Study Plan for Ph.D in Physics (2011/2012)

Offered Degree: Ph.D in Physics

1. **General Rules and Conditions:-**
   - This plan conforms to the regulations of the general frame of the higher graduate studies programs.
   - Areas of specialty of admission in this program:
     - Holders of the Master degree of Science in Physics or its equivalence.
2. **Special conditions:** None
3. **The Plan:** Studying a total of (54) credit hours as follows:-

Course No.	Course Title	Credit hrs	Pre-requisite
❖ Obligatory Courses: (21 credit hours)			
0302952	Classical Mechanics-2	3	-
0332953	Classical Electrodynamics-2	3	-
0302954	Quantum Mechanics-2	3	-
0302956	Statistical Mechanics-2	3	-
0302959	Quantum Physics-3	3	0302954
0302974	Solid State Physics-2	3	-
0332981	Mathematical Physics-2	3	-
❖ Elective Courses: (15 credit hours)			
0332951	Nonlinear Dynamics	3	-
0302955	Group Theory	3	-
0302957	Many Body Theory	3	-
0332958	Quantum Field Theory-1	3	-
0302962	Atomic and Molecular physics -2	3	Department agreement
0302963	Nuclear Physics-2	3	Department agreement
0332965	Accelerators Physics	3	-
0332966	Elementary Particles Physics	3	-
0302967	Plasma Physics	3	-
0332971	Semiconductor Physics	3	-
0302982	Classical Electrodynamics -3	3	0332953
0302992	Special Topics	3	-
0301901	Methods in Applied Mathematics	3	-
0301902	Ordinary Differential Equations	3	0301901
0301903	Partial Differential Equations	3	-
0333941	Applications in Quantum Chemistry	3	-

- ❖ Pass the Ph.D qualifying Exam (0302998).
- ❖ Dissertation: (18) credit hours (0302999).

Transient Plan of the Courses for Ph.D in Physics

Old Study Plan (2005/2006)			New Study Plan (2011/2012)		
Course No.	Course Title	Credit hrs	Course No.	Course Title	Credit hrs
0302951	Nonlinear Physics	3	0332951	Nonlinear Dynamics	3
			0302952	Classical Mechanics-2	3
0302953	Classical Electrodynamics-2	3	0332953	Classical Electrodynamics-2	3
0302954	Quantum Mechanics-2	3	0302954	Quantum Mechanics-2	3
0302955	Group Theory	3	0302955	Group Theory	3
0302956	Statistical Mechanics-2	3	0302956	Statistical Mechanics-2	3
0302957	Many Body Theory	3	0302957	Many Body Theory	3
0302958	Quantum Field Theory-1	3	0332958	Quantum Field Theory-1	3
			0302959	Quantum Mechanics-3	3
0302962	Atomic and Molecular Physics	3	0302962	Atomic and Molecular Physics	3
0302963	Nuclear Physics-2	3	0302963	Nuclear Physics-2	3
0302965	Accelerators Physics	3	0332965	Accelerators Physics	3
0302966	Elementary Particle Physics	3	0332966	Elementary Particle Physics	3
0302967	Plasma Physics	3	0302967	Plasma Physics	3
0302968	Quantum Field Theory-2	3			
0302971	Semiconductor Physics	3	0332971	Semiconductor Physics	3
			0302974	Solid State Physics-2	3
0302981	Mathematical Physics-2	3	0332981	Mathematical Physics-2	3
			0302982	Classical Electrodynamics-3	3
0302992	Special Topics	3	0302992	Special Topics	3
0302998	Ph.D Qualifying Exam		0302998	Ph.D Qualifying Exam	
0302999	Dissertation	18	0302999	Dissertation	18
0301901	Methods in Applied Physics	3	0301901	Methods in Applied Physics	3
0301902	Ordinary Differential Equations	3	0301902	Ordinary Differential Equations	3
0301903	Partial Differential Equations	3	0301903	Partial Differential Equations	3
0303941	Applications in Quantum Chemistry	3	0333941	Applications in Quantum Chemistry	3

Course Description (Ph.D. in Physics)

(0332951) Nonlinear Dynamics

3 credit hrs

Pre-requisite: None

One Dimensional Flows: Flows on the Line, Bifurcations, Flows on the Circle. Two Dimensional Flows: Linear system, Phase plane, Limit Cycles, Bifurcations. Chaos: Lyapunov Exponents, Chaotic Orbits, Logistic Map, Lorenz Equations, Strange Attractors, Two Dimensional Maps, Chaos in Differential Equations.

(0302952) Classical Mechanics-2

3 credit hrs

Pre-requisite: None

Legendre's Transformations and Hamilton's Equations of Motion; Cyclic Coordinates and Conservation Theorems; Routh's Procedure; Canonical Transformations; The Harmonic Oscillator; Hamilton-Jacobi Theory; The Harmonic Oscillator Problem; Action-Angle Variables; Poisson Brackets; Field Theory of Small Oscillations in The Continuum Limit; Solution to The Wave Equation of a Continuous String; Lagrangian for a Continuous String; Hamilton's Principle for a Continuous System; D'Alembert's Solution of the Wave Equation; Eigen Function Expansion; Variational Principle; Perturbation Theory; Membranes.

(0332953) Classical Electrodynamics-2

3 credit hrs

Pre-requisite: None

Plane Electromagnetic Waves and Wave Propagation; Wave Guides and Resonant Cavities; Simple Radiating Systems, Scattering and Diffraction; Special Theory of Relativity and Dynamics of Relativistic Particles and Electromagnetic Fields.

(0302954) Quantum Mechanics-2

3 credit hrs

Pre-requisite: None

Rotation Operator for Spin-1/2 System; Orthogonal Group and Euler's Rotations, Density Operator and Quantum Statistics; Addition of Angular Momenta; Schwinger's Oscillator Model of Angular Momentum; Spin Correlation Measurements and Bell's Inequality; Time-Dependent Perturbation Theory and Transition Probability; Fermi's Golden Rule; Auger Transition; Harmonic Perturbation; Absorption and Emission of Radiation by a H-Atom; Second-Order Perturbation Theory and Applications; Sudden Approximation; Adiabatic Approximation; Identical Particles.

(0302955) Group Theory

3 credit hrs

Pre-requisite: None

Hilbert Spaces and Operators, Representation Theory of Finite Groups, Continuous Groups and their Representations, Group Theory and Quantum Chemistry, Crystallographic and Molecular Symmetries, Group Theory in Solid State Physics.

(0302956) Statistical Mechanics-2

3 credit hrs

Pre-requisite: None

Quantum Statistics and the Density Matrix; Quantum Statistics of the Various Ensembles and Examples; The Ideal Bose Gas; Photons and Phonons; Bose-Einstein Condensation; The Ideal Fermi Gas; Magnetic Behavior of An Ideal Fermi Gas; The Electron Gas in Metals; Special Topics from: Phase Transitions; Spin-Spin Correlation; The Ising Model.

(0302957) Many Body Theory

3 credit hrs

Pre-requisite: None

Second Quantization: Schrödinger's Equation, Fields, The Degenerate Electron Gas; Ground-State (Zero-Temperature) Formalism: Quantum Pictures, Adiabatic "Switching On", The Gell-Mann-Low Theorem, Green's Functions, Wick's Theorem, Diagrammatic Analysis of Perturbation Theory; Applications: Fermi Systems, Linear Response and Collective Modes, Bose Systems; Selected Topics.

(0332958) Quantum Field Theory-1

3 credit hrs

Pre-requisite: None

Classical field Theory; Free-Field Theories: Klein-Gordon and Dirac Fields; Interacting Fields Theories: S-Matrix and Feynman Diagrams; Quantum Electrodynamics.

(0302959) Quantum Mechanics-3

3 credit hrs

Pre-requisite: 0302954

Elastic and Inelastic Scattering Cross Section, Partial Wave Analysis, Resonance, Lippmann-Schwinger Equation; T-Matrix; Scattering of Identical Particles; Introduction to Relativistic Quantum Mechanics; Klien-Gordon Equation; Dirac Equation.

Quantization of the Electromagnetic Field; Interaction of Electromagnetic Field with Charged Particles; Applications.

(0302962) Atomic and Molecular Physics-2

3 credit hrs

Pre-requisite: Department agreement

N-Electron Atoms, Addition of Angular Momenta, Coupling Schemes and Coefficients, Tensor Operators, Hartree-Fock Central Field Approximation, Multiplet Wave Functions, Matrix Elements, Hyperfine Structure, Interaction of the Magnetic Field with Atoms. General Properties of Molecules, Electronic States of Molecules, Molecular Spectra.

(0302963) Nuclear Physics-2

3 credit hrs

Pre-requisite: Department agreement

Theories of Beta and Gamma Decays. Nuclear Models: Vibrational Model, Nuclear Deformation, Deformation Parameters, Rotational Model. Nuclear Reactions: Conservation Laws, Kinematics, Resonances; Compound Nucleus: Formation and Decay, Optical Potential. Theory of Direct Reactions, Heavy Ion Reactions, Fission, Mass Distribution of Fission Fragments, Neutrons Emitted in Fission, Cross Section for Fission.

(0332965) Accelerators Physics

3 credit hrs

Pre-requisite: None

The Van de Graaff Accelerator, Accelerator Calibration, Rutherford Scattering and RBS/Channeling, Nuclear Reaction Cross Section Measurements, Kinematics of Nuclear Reactions, Thin and Thick Target Yields, Angular Distribution Measurements, Nuclear Reaction Analysis NRA, Particle Induced Gamma Emission PIGE and X-Ray Emission PIXE, Neutron Production and Detection, Neutron Activation Analysis, Time-of-Flight Techniques, Coincidence Measurements, Radiation Protection.

(0332966) Elementary Particle Physics

3 credit hrs

Pre-requisite: None

Basic Concepts; Leptons, Quarks and Hadrons; Experimental Methods; Space-Time Symmetries; Hadrons: Quantum Numbers and Excited States, Quark States and Color; QCD, Jets and Gluons; Weak Interactions.

(0302967) Plasma Physics

3 credit hrs

Pre-requisite: None

Introduction, Properties of a Coulomb Gas With and Without a Magnetic Field: Equilibrium, Oscillations, Instabilities, Fluctuations, Collective Phenomenon, Transport Properties and Radiations. Description of Single-Particle Orbit Theory, Magneto Hydrodynamics and Kinetic Equations of Various Types.

(0332971) Semiconductor Physics

3 credit hrs

Pre-requisite: None

Elementary Electron Theory of Conductivity; The Fundamentals of the Band Theory of Semiconductors; Electron and Hole Statistics in Semiconductors; Kinetic Phenomena in Semiconductors; The Theory of Charge Carriers Scattering; Phenomena of Charge Carrier Recombination in Semiconductors; Contact Phenomena in Semiconductors and Heterostructures; Optical and Photoelectrical Phenomena in Semiconductors; General Methods of Preparing Semiconductor Materials; General Properties of Some elementary Semiconductors and Semiconducting Compounds; Amorphous and Organic Semiconductors.

(0302974) Solid State Physics-2

3 credit hrs

Pre-requisite: None

Energy Bands in The Tight-Binding Approximation; Valence-Band Wave Functions; Survey of Methods for Band Structure Calculations: Wigner-Seitz Cellular Method, Augmented Plane-Wave Method (APW), KKR Green's Function Method, The Orthogonalized Plane-Wave (OPW) Method, The Pseudopotential Method; Semiclassical Model of Electron Dynamics; Semiclassical Theory of Conduction in Metals; Surface Effects; Classical Theory of Harmonic Crystals; Quantum Theory of Harmonic Crystals; Anharmonic Effects in Crystals.

(0332981) Mathematical Physics-2

3 credit hrs

Pre-requisite: None

Revision of Calculus of Variations; Chebyshev Polynomials, Hypergeometric Functions; Fourier Series; Integral Transforms; Confluent Hypergeometric Functions; Riemann Zeta Function.

(0302982) Classical Electrodynamics-3

3 credit hrs

Pre-requisite: 0332953

Scattering of Charged Particles and Energy Loss; Radiation by Moving Charges; Bremsstrahlung and Radiative Beta Decay; Multipole Fields; Radiation Damping, Scattering and Absorption of Radiation.

(0302992) Special Topics

3 credit hrs

Pre-requisite: None

This course lays the foundations for experimental and theoretical backgrounds relevant to current research topics in the Department. It could also involve advanced topics in physics. This course should assist students in their research fields, and equip them with a wealth of advanced knowledge in physics.

(0301901) Methods in Applied Mathematics

3 credit hrs

Pre-requisite: None

Boundary Value Problems for Ordinary and Partial Differential Equations, Integral Transforms, Volterra and Fredholm Equations, Variational Methods, Asymptotic Methods, Distribution Theory.

(0301902) Ordinary Differential Equations

3 credit hrs

Pre-requisite: 0301901

Existence and Uniqueness, Poincare-Bendxion Theory, Stability Theory of Linear and Almost Linear Systems, Periodic Solutions and Generalized Solutions of Ordinary Differential Equations, Nonlinear Equations and Stability.

(0301903) Partial Differential Equations

3 credit hrs

Pre-requisite: None

General Theory of First-Order Equations, The Cauchy Problem, Second-Order Equations: Characteristics and Normal Forms, Equations of Mathematical Physics, Advanced Techniques of Solutions.

(0333941) Applications in Quantum Chemistry

3 credit hrs

pre-requisite: None

Methods of Modern Quantum Chemistry and Its Computational Techniques in The Study of Molecules, Its Electronic Composition, Geometry and Physical and Chemical Characteristics. Molecular Orbital and Computational Techniques. Approximation Methods in Calculating Energy Levels in Other Fields like Electronic Spectroscopy and Magnetic Resonance Spectroscopy.