SYLLABUS

For

POST GRADUATE COURSE
PHYSICS

2023-2024

Under Choice Based Credit System
With
Semester Pattern

P.G. DEPARTMENT OF PHYSICS

Dharanidhar University,

Keonjhar-758001 (Odisha)

CHOICE BASED CREDIT SYSTEM
M.Sc. PHYSICS
COURSE STRUCTURE

SEMESTER-I

Course code	Course name	Credit	Marks		
			MID SEM	END SEM	TOTAL
PHYC101	Classical Mechanics	4	20	80	100
PHYC102	Mathematical Methods-I	4	20	80	100
PHYC103	Quantum Mechanics-I	4	20	80	100
PHYC104	Electronics-I	4	20	80	100
PHYP105	Electronics-I (Lab)	3		50	50
PHYP106	Computational Methods in Physics-I (Lab)	3		50	50

Total Credit=22, Total Marks =500

SEMESTER-II

Course code	Course name	Credit	Marks		
			MID SEM	END SEM	TOTAL
PHYC201	Quantum Mechanics-II	4	20	80	100
PHYC202	Mathematical Methods-II	4	20	80	100
PHYC203	Statistical Mechanics	4	20	80	100
PHYC204	Basic Condensed Matter Physics	4	20	80	100
PHYP205	Modern Physics and Optics –I (Lab)	3		50	50
PHYP206	Computational Methods in Physics-II (Lab)	3		50	50
PHYVAC1	Acoustics and Entertainment Physics				

Total Credit=22, Total Marks =500

SEMESTER-III

Course code	Course name	Credit	Marks		
			MID SEM	END SEM	TOTAL
PHYC301	Classical Electrodynamics	4	20	80	100
PHYC302	Atomic and Molecular Physics	4	20	80	100
PHYC303	Electronics-II	4	20	80	100
PHYE304	Elective-I (Advanced Condensed Matter Physics-I / Advanced Particle Physics-I)	4	20	80	100
PHYP305	Elective Paper-I(Lab)	3		50	50

PHYP306	Electronics-II (Lab)	3		50	50
PHYVAC2	Renewable Energy Sources				

Total Credit=22, Total Marks =500

SEMESTER-IV

Course code	Course name	Credit	Marks		
			MID SEM	END SEM	TOTAL
PHYC401	Advanced Quantum Mechanics	4	20	80	100
PHYC402	Nuclear and Particle Physics	4	20	80	100
PHYE403	Elective-II (Advanced Condensed Matter Physics-II / Advanced Particle Physics-II)	4	20	80	100
PHYP404	Modern Physics and Optics-II (Lab)	3		50	50
PHYP405	Elective Paper-II(Lab)	3		50	50
PHYD406	PROJECT	4			100

Total Credit=22, Total Mark=500

Project:

Dissertation Topics include:

(i)General Theory of Relativity.
(ii) Cosmology.
(iii) Astroparticle Physics.
(iv) High Energy Physics.
(vi) Materials Science.
(vii) Nuclear Matter.
(viii) Black Hole Physics.
(ix) Accelerators Physics.
(x) Data Analysis and Computational Simulation
(xi) Neutrino Physics.

Grand Total credit of 4 semesters = 88 ; Grand Total Mark = 2000

A: Core Compulsory Papers:

1st Semester:

PHYC101: Classical Mechanics
PHYC102: Mathematical Methods-I
PHYC103: Quantum Mechanics-I
PHYC104: Electronics-I
PHYP105: Electronics-I (Lab)
PHYP106: Computational Methods in Physics-I (Lab)

2nd Semester:
PHYC201: Quantum Mechanics-II
PHYC202: Mathematical methods-II
PHYC203: Statistical Mechanics
PHYC204: Basic Condensed Matter Physics
PHYP205: Modern Physics and Optics-I(Lab)
PHYP106: Computational Methods in Physics-II(Lab)
PHY VAC1: Acoustics and Entertainment Physics.

3rd Semester:
PHYC301: Classical Electrodynamics
PHYC302: Atomic and Molecular Physics.
PHYC303: Electronics-II
PHYE304: Elective Paper-I
PHYP305: Elective paper-I (Lab)
PHYP306: Electronics-II (Lab)
PHY VAC2: Renewable Energy Sources

4th Semester:
PHYC401: Advanced Quantum Mechanics
PHYC402: Nuclear and Particle Physics
PHYE403: Elective Paper-II
PHYP404: Modern Physics and Optics-II (Lab)
PHYP405: Elective paper-II (Lab)
PHYD406: Project Dissertation

B: Core Elective Papers:

Theory:
PHYE304(A): Advanced Condensed Matter Physics- I (3rd Sem)
PHYE304(B): Advanced Particle Physics- I (3rd Sem)
PHYE403(A): Advanced Condensed Matter Physics -II (4th Sem)
PHYE403(B): Advanced Particle Physics- II (4th Sem)

Mark and Credit Distribution		
Semester	**Credit**	**Marks**
First	22	500
Second	22	500
Third	22	500
Fourth	22	500
Total	**88**	**2000**

M.Sc. Physics Syllabus (D.D. University)

SEMESTER-I
Classical Mechanics
PHYC101

Full Marks : 100 (20+80)

Unit-I (20 Marks)

Lagrangian Formulation:

Mechanics of a System of Particles, Lagrangian Formulation, Velocity-Dependent Potentials and Dissipation Function, Conservation Theorems and Symmetry Properties, Homogeneity and Isotropy of Space and Conservation of Linear and Angular Momentum, Homogeneity of Time and Conservation of Energy. Calculus of Variations and Euler-Lagrange's Equation, Brachistochrone Problem.

Hamiltonian Formulation:

Hamilton's Principle, Extension of Hamilton's Principle to Non-holonomic Systems, Legendre Transformation and the Hamilton Equations of Motion, Physical Significance of Hamiltonian. Derivation of Hamilton's Equations of Motion from a Variational Principle, Routh's Procedure, $\Delta-$ Variation, Principle of Least Action.

Unit-II (20 Marks)

Routhian Formulation:

Canonical Transformations:

Canonical Transformation, Types of Generating Function, Conditions for Canonical Transformation, Integral Invariance of Poincare, Poisson Bracket, Poisson's Theorem, Lagrange Bracket, Poisson and Lagrange Brackets as Canonical Invariants, Infinitesimal Canonical Transformation and Conservation Theorems, Liouville's Theorem.

Unit-III (20 Marks)

Hamilton Jacobi Theory:

Hamilton-Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator and Kepler problem by Hamilton-Jacobi Method, Action-Angle Variables for completely Separable System, Kepler Problem in Action-Angle Variables, Geometrical Optics and Wave Mechanism.

Small Oscillations:

Problem of Small Oscillations, Example of Two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal Modes of Vibration, Free Vibrations of a Linear Triatomic Molecule.

Unit-IV (20 Marks)

Rigid Body Motion

The Independent of Coordinates of a Rigid Body, Orthogonal Transformations. The Euler's angles. The Cayley-Klein parameters, Euler's Theorems on the Motion of a Rigid body, Infinitesimal Rotations, Rate of Change of a Vector, The Coriolis Force.

Rigid Body Dynamics:

Angular Momentum and Kinetic Energy of Motion about a Point. The Inertia Tensor and Moment of Inertia, Eigen values of Inertia Tensor and the Principal Axis Transformation. The Euler Equations of Motion, Torque-free motion of a rigid body. The Heavy Symmetrical Top with One Point Fixed.

Text Books:

Classical Mechanics - H. Goldstein ,C.P. Poole,J.Safko, Pearson Education Dorling Kinderslay,3rd Ed.

Reference:

Classical Machanics by N.C. Rana &P.S. Joag,Mc Graw Hill Education
Mechanics - Landau and Liftshitz
Analytical Mechanics, L. Hand and J. Finch
Classical Mechanics - Corben&Stehle
Classical Dynamics - Marion & Thornton
Classical Dynamics- J.C. Upady

Mathematical Methods in Physics-I
PHYC102

Full Mark : 100 (20+80)

Unit-I (20 Marks)

Vector spaces:

Definition of vector space, Linear vector space, scalar product, Norm and metric, Metric spaces with examples, Trivial and Non-trivial linear combinations, Linear dependence and Independence, Basis vectors and their orthonormality and completeness, spanning of a vector space, Change of basis, Complex vector spaces, Dual space.

Unit-II (20 Marks)

Matrix fundamentals:

Trace, rank, determinant ,Transpose, conjugate, adjoint and Inverse of a matrix, Solution of system of linear equations in two and three unknowns, Cramer's rule, Partitioning of matrices, Commuting and non commuting matrices, Algebra of Pauli Spin matrices.

Diagonalisation of matrices and Transformations:

Orthogonal, Unitary, Hermitian and Lorentz matrices. Orthogonal, Similarity, and Unitary Transformations with examples having physical relevance. Matrix representation of vectors and groups. Eigenvalues and eigenvectors of matrices. Diagonalisation of matrices. Cayley-Hamilton theorem, condition for diagonalisability.

Unit-V (20 Marks)

Calculus of variations:

Functions and functional, Fundamental concept of variation. Problem of extrimization of a functional. Euler-Lagrange equation. Applications - (1) The shortest distance between two points on a plane. (2) The shortest distance between two points on a curved surface. Principle of least action. Noether's theorem and symmetry.

Lorentz Transformations and Lorentz Invariance:

Lorentz Transformations. Concept of 4-vectors. Co-variant and contravariant vectorsin Minkowski space. Metric with signature (1, -1, -1, -1). 4- displacement, 4-velocity,4-acceleration, 4-force. Covariant equations of motion. Lorentz invariance with examples. Lagrangian of a charged relativistic particle in an electromagnetic field.

Text Books:

Mathematical Physics I & II by S. D. Jogeleker

Mathematical Methods for Physics - Arfken and Weber

Introduction to Mathematical Physics by C. Harper.

Reference:

Mathematical Methods of Physics - J. Mathews & R. L. Walker

Mathematics for Physicists- Denner&Krzywicki

Group Theory - M. Hamermesh

Matrices and Tensors in Physics - A. W. Joshi

Methods of Theoretical Physics- Morse and Feshbach Vol-I, Vol-II.

Quantum Mechanics-I
PHYC103

Full Mark : 100 (20+80)

Unit-I (20 Marks)

General Principles of Quantum Mechanics:

Linear vector space formulation, Hilbert space, linear superposition of general quantum states, orthonormality of basis vectors, completeness, Schmidt's orthonormalisation procedure, Dual space, Bra and Ket vectors and their algebra. linear, Adjoint, hermitian, unitary, inverse, antilinear operators, Non commutativity and uncertainty relation.

Quantum Measurements:

Complete set of compatible operators, Simultaneous Measurement, Projection operator, Eigenvalues and eigenvectors of linear, hermitian, unitary operators, Matrix representation of vectors and operators, matrix elements, eigenvalue equation and expectation values, algebraic result on eigenvalues, transformation of basis vectors, similarity transformation of vector and operator representation, diagonalisation. Vectors of LVS and wave function in coordinate, momentum and energy representations.

Unit-II (20 Marks)

Quantum Dynamics

Time evolution of quantum states, Time evolution operator and its properties, Schrodinger picture, Heisenberg picture, Interaction picture, Equations of motion, Operator method solution of 1D Harmonic oscillator, Matrix representation and time evolution of creation and annihilation operators, Density matrix, Solving Schrodinger equation for simple 1D problems.

Rotation and Orbital Angular Momentum:

Rotation Matrix, Angular momentum operators as the generators of rotation,L_x, L_y, L_z and L^2 and their commutator relations, Raising and lowering operators. (L_+ and L_-). L_x, L_y, L_z and L^2 in spherical polar coordinates, Eigenvalues and Eigenfunctions of L_z, L^2 (OP method) spherical harmonics, Matrix representation of L_+ , L_- and L^2.

Unit-III (20 Marks)

Spin Angular Momentum:

Spin of particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spinor transformation under rotation.

Addition of angular momenta:

Total angular momentum J. Eigen value problem of J_z and J^2, Angular momentum matrices. Addition of angular momenta and Clebsch-Gordan coefficients, Angular momentum states for composite systems in the angular momenta (1/2,1/2) and(1,1/2).Examples from atomic and Nuclear physics.

Unit-IV (20 Marks)

Motion in Spherically symmetric Field:

Hydrogen atom, Reduction to equivalent one body problem, Schrodinger equation in spherical polar coordinates, Radial equation and its solution, Energy eigenvalues and eigenfunctions, degeneracy, radial probability distribution. Calculation of expectation values of various powers of the radial coordinate.

Text Books:

Quantum Physics - S. Gasiorowicz
Quantum Mechanics- L-I Schiff/ J.Sukurai/ E.Merzbacher/ A.Messiah (Vol.I)
Advanced Quantum Mechanics - P.Roman
Quantum Mechanics -R. Shankar
Quantum Mechanics -A. Ghatak and S. Lokanathan
Quantum Mechanics - S. N. Biswas

Reference:

Quantum Mechanics - A. Das
Elementary Theory of Angular Momentum - M.E. Rose
Principles of Quantum Mechanics - P. A. M. Dirac
Quantum Mechanics (Non-relativistic theory) - L. D. Landau and E. M. Lifshitz
Feynman's Lectures on Physics (Vol-III)- R. P. Feynaman, R. B. Leighton and M sands
Introduction to Quantum Mechanics by D.J. Griffiths

ELECTRONICS-I
PHYC104

Full Mark : 100 (20+80)

Unit-I (20 Marks)

Electronic Devices and Instrumentation:

Semiconductor, Metal Semiconductor and metal Oxide Semiconductors: BJT, FET, JFET ,MESFET and MOSFET, SCR, DIAC, TRIAC, VTVM and CRO.

Oscillators:

Feedback Criteria for Oscillation, phase shift, Wien bridge Oscillator, Crystal Controlled Oscillator, Klystron Oscillator.

Unit-II (20 Marks)

Operational Amplifiers:

Basic Operational Amplifiers, Inverting and non- inverting OPAMP, Rejection of common mode signals, Ideal operational amplifier, Input and Output impedance. Applications of OPAMPs - Unitary gain buffer, Adder, Substractor, Integrator, Differentiator, Logarithmic Amplifier.

Unit-III (20 Marks)

Radio Communication

Antenna, Basic Antenna Action, Current and Voltage distribution in linear Antenna, Dipole Antenna, Power Radiator Different Types of antenna (only descriptive study),Horn Antenna, Yagi Antenna, TV Transmitter and Receiver Antenna.

Unit-IV (20 Marks)

Fiber Optic Communication

Optical Fibers- Characteristic and fundamental parameters, Propagating modes, Low Loss Fibers Transmission distance with Optical fibers, Example of Optical Transmission Techniques, Instrumentation and Control with Optical Fibers

Text Books:

Electronic Fundamental and Application - J.D. Ryder
Foundation of Electronics -Chattopadhyay , Rakshit
Electronics Fundamentals by Thomas L.Floyd,Prentice Hall
The Art of Electronics by Paul Horowitcz and Winfield Hill,Cambridge University Press.
Op.amps and linear Integrated Circuits by R.A. Gayakwad,Prentice Hall of India

Reference:

Optical Fiber Communication - GerdKeisern
Semi Condutor and Opto electronic devices - P.Bhattacharya (PHI)
Grob's Basic Electronics - Mitchel E. Schultz (Mc Grow Hill Publication)
Instruction to Fiber Optics - Ghatak ,Thyagrajan

Electronics (Lab.)
PHYP105

Full Mark : 50

Practical Paper:

1. Setting of a transistor amplifier and determination of the amplification factor at various frequencies.
2. Frequency response of transistor amplifier with feedback and without feedback.
3. Characteristics of Hartley oscillator
4. Determination of different parameters of transistor
5. Study of multivibrator - Bistable.
6. Study of multivibrator - Monostable
7. Study of multivibrator -Astable
8. “VSWR” in a microwave transmission line

Computational Methods in Physics- I (Lab.)
PHYP106

Full Mark : 50

Practical Paper:

Introduction to computer hardware and software, introduction to storage in computer memory, stored programme concepts, storage media, computer operating system, compilers, LINUX commands.

Programming with FORTAN:

Programme solving on computers - algorithm and ow charts in FORTAN data types, expressions an statements, input/output commands, sub-programme.

Programming with C++ :

Structure of C++ programme, compilation , Data types, variable and constant, declaration of variables, initializing variables, arithmetic operators, Increment and Decrement operators, I/O statements, arithmetic expressions, functions, Control statements: decision making and looping statements, array.

Exercises for acquaintance:

1. To find the largest or smallest of a given set of numbers.
2. To generate and print first hundred prime numbers.
3. Sum of an AP series, GP series, Sine series, Cosine series.
4. Factorial of a number.
5. Transpose a square matrix.
6. Matrix multiplication, addition.
7. Trace of a matrix.
8. Trace of a matrix.
9. Solution of quadratic equation.
10. Division of two complex numbers.
11. To find the sum of the digits of a number.

Text Books:

Computer Programming in FORTRAN 90 and 95, V. Rajaraman
V. Rajaraman - Fundamentals of Computers (Printice Hall, India)
Object Oriented Programming withC++, E Balagurusamy.
Programming with C++, J. R. Hubbard (Mc GRAW-HILL).
Computer Oriented Numerical Methods- R.S.Salaria

Reference:

An Introduction to computational Physics, T. Pang, Cambridge Univ. Press.
W.H. Press, S. A. Teukolsky, W.T. Vetterling and B.P. Flannery - Numerical Recipe(Cambridge Univ. Press)
V. Rajaraman - Elements of Parallel Processing (Printice Hall, 1990)Fortran 77 and Numerical methods - C. Xavier
P.S. Grover - Programming and Computing with FORTRAN 77/90, (Allied Publishers 1992)

SEMESTER-II

Quantum Mechanics - II
PHYC201

Full Mark : 100 (20+80)

Unit-I (20 Marks)

Approximation Methods for Stationary States:

Rayleigh Schrodinger Method for Time-Independent Non-Degenerate Perturbation Theory, First and Second Order Correction, Perturbed Harmonic Oscillator, Anharmonic Oscillator, The Stark Effect, Quadratic Stark Effect and Polarizability of Hydrogen atom.

Degenerate Purturbation:

Degenerate Perturbation Theory, Removal of Degeneracy, Parity Selection Rule, Linear Stark Effect of Hydrogen atom, Spin-Orbit Coupling, Relativistic Correction, Fine Structure of Hydrogen like Atom, Normal and Anomalous Zeeman Effect, The Strong Field Zeeman Effect, The Weak-Field Zeeman Effect and Lande g-factor.

Unit-II (20 Marks)

Variational Methods:

The Variational method. Ground State, First Excited State and Second Excited State of One-Dimensional Harmonic Oscillator, Ground State of H-atom and He-atom.

WKB Approximation Method:

General Formalism, Validity of WKB Approximation Method, Connection Formulas, Bohr Somerfield Quantization Rule, Application to Harmonic Oscillator. Application of WKB method to Bound States for Potential Wells with One Rigid Wall and Two Rigid Walls, Tunneling Through a Potential Barrier, Cold Emission, Alpha Decay and Geiger-Nuttal relation.

Unit-III (20 Marks)

Time Dependant Perturbation Theory:

Transition Probability, Constant and Harmonic Perturbation, Fermi Golden Rule, Interaction of one electron atoms with electromagnetic radiation, Basic Principles of Laser and Maser. Electric Dipole Radiation and Selection rules. Spontaneous and Induced Emissions, Einstein's A and B Coefficients, radiation, Quantum description of spontaneous emission.

Unit-IV (20 Marks)

Scattering Theory:

Free particle problem: Incoming and outgoing spherical waves, expansion of plane waves in terms of spherical waves. Scattering amplitude and differential and total cross Section, Relation between Lab and CM cross sections, Green's functions, Born Approximation, Born series, Application to Coulomb and Screened Coulomb Potential, Partial Wave Analysis for Elastic and Inelastic Scattering, Effective Range and Scattering Length, Optical Theorem, Black Disc-Scattering, Hard-Sphere Scattering, Resonance Scattering from a Square Well Potential, Reduction to equivalent one-body problem in CM frame, transformation from CM to Lab frame, Scattering of identical bosons and fermions.

Text Books:

Quantum Physics - S. Gasiorowicz.
Quantum Mechanics- N. Zettili
Quantum Mechanics- B.H. Bransden, C.J. Joachain
Quantum Mechanics - R. Shankar
Quantum Mechanics - A. K. Ghatak and S. Lokanathan
Quantum Mechanics- A. Das

Reference:

Introductory Quantum Mechanics- R. Liboff
Quantum Mechanics- E. Merzbacher
Quantum Mechanics - S. N. Biswas
Quantum Mechanics - L.I. Schiff
Quantum Mechanics vol I -A.Messiah
Principles of Quantum Mechanics - P. A. M. Dirac
Quantum Mechanics (Non-relativistic theory)- Landau and Lifshitz
Modern Quantum Mechanics - J. J. Sakurai
Advanced Quantum Mechanics -P. Roman
Elementary Theory of Angular Momentum -M.E. Rose

Mathematical Methods -II
PHYC202

Full Marks : 100 (20+80)

Unit-I (20 Marks)
Complex Variables
Cauchy's Integral Theorem, Cauchy's integral formula, Singularities and Calculus of Residues, Cauchy's residue theorem, Evaluation of definite integrals using the circles ,infinite semi-circle and rectangular contours.

Unit-II (20 Marks)
Tensor Analysis and Differential geometry:
Metric tensor, Cartesian tensors in three-space, Curves in three space and Frenet formula, General Tensor Analysis, covariant and contravariant tensors, Raising and Lowering of indices, Inner product, Outer product and contraction of tensors, Symmetric and antisymmetric tensors, Uses of Kronecker and Levi-civita symbols, Covariant derivative and Christofel symbol, Riemann & Ricci tensors.

Unit-III (20 Marks)
Groups and Group Representations:
Definition of groups, Finite groups, examples from Solid State Physics, Sub- groups and classes, Group Representations, Characters, Infinite groups and Lie groups, Irreducible representations of SU(2), SU(3) and O(3), SO(3,1).

Unit-IV (20 Marks)
Differential Equations and Special Functions:
Solutions of Bessel, Laguerre, Legendre, Hermite differential equations by generating function method and their properties. Spherical Bessel functions and Hankel functions, Associated Legendre and Associated Laguerre polynomials and their properties. Hypergeometric and Confluent hyper geometric equations and their solutions by generating function method and their properties. Concept of Green's function, Solutions of in homogeneous Partial Differential Equations by Green's function method and applications.

Text Books:
Mathematical Methods of Physics - J. Mathews & R. L. Walker
Mathematics for Physicists - Dennery&Krzywicki
Mathematical Methods for Physics - Arfken and Weber
Group Theory - M. Hamermesh
Group Theory by M Tinkham

Reference:
Methods of Theoretical Physics , Morse and Feshbach Vol-I, Vol-II.
Matrices and Tensors in Physics- A. W. Joshi

Statistical Physics
PHYC203

Full Mark : 100 (20+80)

Unit-I (20 Marks)
Classical Statistical Mechanics:
Postulate of classical statistical mechanics, Liouville's theorem, micro canonical ensemble, Derivation of thermodynamic functions, equipartition theorem, classical ideal gas, Gibb's Paradox.
The Partition function for Canonical ensemble and energy fluctuation, thermodynamics of classical ideal gas, grand partition function for grand canonical ensemble and density fluctuation, Equivalence of canonical and grand canonical ensemble.

Unit-II (20 Marks)
Formulation of Quantum Statistical Mechanics:
The density matrix, ensembles in quantum statistical mechanics. Distribution functions, Ideal gas in microcanonical, Canonical and grand canonical ensembles. Classical limit of Quantum Statistics

Unit-III (20 Marks)
Applications of Quantum Statistical mechanics:
Equation of state for ideal Fermi gas, Theory of white dwarf stars. Chandrasekhar Limit. Ideal Bose Gas, Photons and Planck's law, Phonons and the theories of Einstein and Debye for specific heat of solids, Bose-Einstein condensation.

Unit-IV (20 Marks)
Phase Transition:
Thermodynamic description of phase transitions, phase transitions of second kind, Discontinuity of specific heat, change in symmetry in a phase transition of second kind. Ising model: Definition of Ising model, One Dimensional Ising model.

Text Books:
Statistical Mechanics - K. Huang
Statistical Mechanics - R. K. Pathria and P.D. Beale
Introduction to Modern Statistical Mechanics by D.Chandler

Reference:
Elementary Statistical Physics - C. Kittel
Statistical Mechanics - F. Mohling
Statistical Mechanics - Landau and Lifsitz
Phase Transitions & Critical Phenomena - H.E. Stanly
Thermal Physics - C. Kittel
Fundamentals of Statistical & Thermal Physics - F. Reif

Basic Condensed Matter Physics
PHYC204

Full Mark : 100 (20+80)

Unit-I (20 Marks)
Crystal Binding:
Crystal of inert gases, ionic crystals, covalent crystals, Metallic binding and hydrogen bonded crystals..
Phonons and lattice vibration:
Vibrations of monatomic and diatomic lattices, dispersion relation, optic and acoustic modes, phonon as quantum of lattice vibration, phonon momentum, inelastic scattering of neutrons and photons by phonons.
Thermal Properties of insulators:
Lattice heat capacity, Einstein and Debye models. Anharmonic crystal interactions, thermal conductivity and thermal expansion.

Unit-II (20 Marks)
Band theory:
Electrons in periodic potential, Bloch's theorem, Kronig Penney model, origin of band gap,Wave equation for an electron in a periodic potential, Bloch functions, Brillouinzones, E-k diagram under free electron approximation.

Unit-III (20 Marks)
Free Electron Fermi Gas :
Density of states in one dimension, effect of temperature on Fermi-Dirac distribution, Free electron gas in three dimensions, Heat capacity of electron gas, The Boltzmann equation, Electrical conductivity, General Transport co-efficient, Thermal conductivity, Thermoelectric effect.
Semiconductors:
Intrinsic and impurity semiconductors, band gap, law of mass action, intrinsic carrier concentration, mobility in the intrinsic region, p-n junction rectifier.

Unit-IV (20 Marks)
Superconductivity:
Experimental survey, Meissner effect, Type-I and Type-II superconductors, thermodynamics of superconductors, London's theory, Electron-electron attractive interaction due to virtual phonon exchange, Cooper pairs and BCS Hamiltonian, Superconducting ground state and the gap equation at T= 0 K. Macroscopic quantum mechanical tunneling effect, DC Josephson effect, Effect of electric field- AC/ Inverse AC Josephson effect, Effect of magnetic field, SQUID. High Tc superconductors: Basic ideas and applications.

Text Books:
Introduction to Solid State Physics - C. Kittcl
Solid State Physics - Ashcroft and Mermin
Principles of Condensed Matter Physics - P. M. Chaikin and T. C. Lubensky

Reference:

Solid State Physics- A.J. Dekker
Quantum Theory Solid State - J. Callaway
Solid State Physics - O.F. Animaler

Modern Physics and Optics-I (Lab.)
PHYP205

Full Marks : 50

Practical Paper:

1. Verification of Richardson's $T^{3/2}$ law.
2. Determination of Planck's constant by Reverse Photoelectric effect method
3. Hysteresis loop tracer
4. Ferroelectric transmission point by Dielectric Constant
5. Babinet's compensator
6. Dielectric constant of solid (wax) by Lecher Wire
7. Determination of Planck's constant by total Radiation Method
8. Ferroelectric transmission point by Dielectric Constant Measurement.
9. Determination of 'e' by Millikan's oil drop experiment.

Computational Methods in Physics-II (Lab.)
PHYP206

Full Marks : 50

Practical Paper:

Introduction to computer hardware and software, introduction to storage in computer memory, stored programme concepts, storage media, computer operating system, compilers, LINUX commands.

Programming with FORTAN:

Programme solving on computers algorithm and flow charts in FORTAN data types ,expressions an statements, input/output commands, sub-programme.

Programming with C++ :

Structure of C++ programme, compilation , Data types, variable and constant, declaration of variables, initializing variables, arithmetic operators, Increment and Decrement operators, I/O statements, arithmetic expressions, functions, Control statements: decision making and looping statements, array.

Numerical Analysis:

1. Interpolation by Lagrange method.
2. Numerical solution of simple algebraic equation by Newton- Raphson method.
3. Least Square fit using rational functions.
4. Numerical integration: Trapezoidal method, Simpons method, Romberg integration, Gauss quadrature method.
5. Eigenvalues and eigenvectors of a matrix.
6. Solution of linear homogeneous equations.
7. Matrix inversion.
8. Solution of ordinary differential equation by Runge-Kutta Method.
9. Solution of Radioactive decay, Simple harmonic oscillator, Schrdinger Equation.

Text Books:

Computer Programming in FORTRAN 90 and 95, V. Rajaraman
V. Rajaraman - Fundamentals of Computers (Printice Hall, India)
Object Oriented Programming withC++, E Balagurusamy.
Programming with C++, J. R. Hubbard (McGRAW-HILL).
Computer Oriented Numerical Methods- R.S.Salaria

Reference:

An Introduction to Computational Physics, T. Pang, Cambridge Univ. Press.
W.H. Press, S. A. Teukolsky, W.T. Vetterling and B.P. Flannery - Numerical Recipe (Cambridge Univ. Press)
V. Rajaraman - Elements of Parallel Processing (Printice Hall, 1990)
Fortran 77 and Numerical methods - C. Xavier
P.S. Grover - Programming and Computing with FORTRAN 77/90, (Allied Publisers 1992)

SEMESTER-III
Classical Electrodynamics
PHYC301

Full Marks : 100 (20+80)

Unit-I (20 Marks)
Maxwell's Equations:
Maxwell's equations in free space, Magnetic charge, Maxwell's equations inside matter, Displacement current, Vector and scalar potentials, Wave equation for potentials Lorentz and Coulomb gauge conditions, Wave equation for Electric and Magentic fields in absence of sources, Poynting vector.
Green's Function Solution:
Green's function solution of potential form of Maxwell's equations, Retarded and advanced Green's Functions, Lienard-Wiechert potentials.

Unit-II (20 Marks)
Covariant Formulation of Maxwell's Equations:
Lorentz transformation, Scalars, vectors and Tensors, Maxwell's equations and equations of continuity in terms of A_μ and J_μ, Electromagnetic field tensor and its dual, Covariant form of Maxwell's equations; Lagrangian for a charged particle in presence of external electromagnetic field and Maxwell's equation as Euler-Lagrange equations.

Unit-III (20 Marks)
Plane Waves in Non-Conducting Media:
Plane waves in non-conducting media, velocity of wave propagation and energy flow, linear, circular and elliptic polarisations, Reection and refraction of electromagnetic waves at a plane interface between dielectrics at normal and oblique incidences, total internal reection and polarisation by reection, waves in dispersive media, Kramers-Kronig relation.
Plane Waves in Conducting Media:
Plane waves in conduction media, Reflection and transmission at a conducting surface, Cylindrical cavities and wave guides, Modes in rectangular wave guide and resonant cavities.

Unit-IV (20 Marks)
Radiation by Point Charge:
Electric and Magnetic Fields due to a point charge, Angular distribution of radiation and total power radiated by an accelerated charge, Larmor's formula.
Multipole Radiation:
Potentials, Fields and radiation due to an oscillating electric dipole; radiation due to a centre-fed linear antenna, angular distribution of power radiated, Rayleigh Scattering. Magnetic dipole and Electric quadrupole radiation.

Text Books:

Classical Electrodynamics - J. D. Jackson.

Reference:

Classical Theory of Fields - L. Landau & E. M. Lifshitz

Introduction to Electrodynamics - D. J. Gri_ths.

Principles of Optics- M. Born and E. Wolf

Introduction to Electrodynamics- Capri and Panat

Atomic and Molecular Physics
PHYC302

Full Mark : 100 (20+80)

Unit-I (20 Marks)

Quantum mechanics of H atom:

Atomic Orbital's and Hund's rule, Magnetic dipole moment, Electron spin and vector atom model, Spin Orbit interaction, Hydrogen Fine structure, L-S & J-J Coupling: spectroscopic terms, selection rule, Lande Interval rule.

Unit-II (20 Marks)

Atomic behaviour in magnetic field:

Zeeman Effect (normal and Anomalous) and Paschen-Back Effect: Splitting of spectral lines and selection rules, Hyperfine Structure Spectral Lines: Isotope Effect, Nuclear spin and Hyperfine Splitting and selection rules, Zeeman Effect in Hyperfine structure, Back- Goudsmit effect.

Unit-III (20 Marks)

Solution of nuclear equation; Molecular rotation: rigid and non-rigid rotator, Centrifugal distortion, Symmetric top molecules, Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Morse potential.

Unit-IV (20 Marks)

Spectra of Diatomic Molecules:

Electronic transitions and electronic spectra, Franck-Condon principle, Rotational structure of electronic transitions, Dissociation energy of molecules, Raman transitions and Raman spectra.

Text Books:

Physics of Atoms and Molecules - Bransden and Joachain, Prentice Hall, 2nd Edition, 2003
Atomic and Molecular Spectra- Laser, Raaj Kumar, Kedar Nath Ram Nath, India, 6th Edition, 2012. 3
Introduction to Atomic and Molecular Spectroscopy - V. K. Jain, Narosa, 4th Edition, 2007

Reference:

Fundamentals of Molecular Spectroscopy, C. N. Banwell, Tata McGraw Hill, 4th Edition, 2012.
Molecular spectroscopy, J.M. Brown, Oxford University Press, 1st edition, 1998.
Molecular spectroscopy, Jeanne, L. McHale, C R C press, 2nd Edition, 2017
Spectra of atoms and molecules, P. F. Bemath, Oxford University Press, 3rd Edition, 2016.
Modern spectroscopy, J.M. Holias, John Wiley and Sons ltd., 4th edition, 2004

ELECTRONICS-II
PHYC303

Full Mark: 100 (20+80)

Unit-I (20 Marks)

Digital Electronics:,

Number systems, Binary Octal (Inter conversion), Grey Code, Binary Algebra (Addition, Subtraction, multiplication, division). Boolean Theorem, OR gate, AND gate ,NAND gate, Universal Building Block, Exclusive OR and NOR gate, De-Morgan's Theorem. Half Adder, Full Adder, Simplification of digital. Boolean Theorem, OR gate, AND gate, NAND gate, Universal Building Block, Exclusive OR and NOR gate, De. Morgan's Theorem. Half Adder, Full Adder, Simplification of digital circuit using Karnaugh maps, Don't care condition.

Unit-II (20 Marks)

Decoder, Encoder, BCD to 7-segment decoder, Digital Comparator, Multiplexer, De-Multiplexer, Digital to Analog converter with Ladder Network, Analog to Digital Converter.

Mesh and Mode circuit Analysis, Reduction of complicated Network, Conversion between T & section, The bridge Network, Lattice Network, super position Theorem, Reciprocity Theorem, Thevenin and Norton's Theorem, Milliman's Theorem, Maximum Power Transform Theorem.

Unit-III (20 Marks)

Linear wave shaping High pass, low pass R.C Circuit, Their response for sinusoidal, step, pulse, square and ramp inputs, R C Network as differentiator and integrator ,RL and R LC Circuit and their response for step input ringing Circuit.

Unit-IV (20 Marks)

Non-linear wave shaping Diode clipper, Transistor Clipper, Transfer Characteristics of clipper, Emitter coupled clipper, Comparator, Application Clamping Operation.

Text Books:

Networks, Lines and Fields - J.D. Ryder, Pretice Hall Of India Pvt Ltd.
Digital Electronics - W.H. Gothmann

Reference:

Digital Electronics using - R.P.Jain& M.M.S. Anand Integrated Circuit
Digital Electronics And Computer - M.M. Mano (PHI) Design

Advanced Condensed Matter Physics-I
(Elective paper-1)
PHYE304(A)

Full Mark : 100 (20+80)

Unit-I (20 Marks)
Lattice Vibrations :
Born-Oppenheimer Approximation, Hamiltonian for lattice vibrations in the harmonic approximation, Normal modes of the system and quantization of lattice vibrations, phonons. Electron-phonon interaction, Second quantized form of Hamiltonian for electrons and phonons in interaction.

Unit-II (20 Marks)
Energy Bands:
Nearly free electron approximation - Diffraction of electrons by lattice planes and opening of gap in E-k diagram. Effective mass of electrons in crystals, Holes, Tight binding approximation, S and P state band, Wannier functions Density of states: Dynamical Mean field Theory.

Unit-III (20 Marks)
Fermi Surface:
Construction of Fermi surface, Experimental methods of study of Fermi surface, Cyclotron Resonance, de Hass-van-Alphen effect.
Electron Interaction:
Perturbation formulation, Dielectric function of an interacting electron gas (Lindhard's expression), Static screening, Screened impurity. Kohn effect, Friedel Oscillations and sum rule, Dielectric constant of semiconductor, Plasma oscillations.

Unit-IV (20 Marks)
Electronic and Lattice defects:
Lattice defects, Frenkel and Schottky defects, Line Defects, edge and screw dislocations, Burger's Vector. planner (stacking) faults-twin planes and grain boundaries, Color centers-mechanism of coloration of a solid, F-center, Other color centers.
Excitons:
Loosely bound, tightly bound, Excitonic waves, electron-hole droplets.
Hall effect:
Elementary ideas on Quantum Hall Effect, Magneto resistance, Elementary ideas on Giant magneto-resistance and Colossal magneto-resistance.

Text Books:
Principles of the Theory of Solids - J.M. Ziman
Introduction to Solid State Physics- C. Kittel
Advanced Solid State Physics- Philip Phillips, Overseas Press, India Pvt. Ltd.
Reference:
Introduction to Modern Solid State Physics - Yuri M. Galperin
Solid State Physics - Aschroft, Mermin
Introduction to Solids - Azaroff
Elementary Solid State Physics - Omar

Principles of Condensed Matter Physics - Chaikin and Lubensky
Solid State Physics-Essential Concepts - David W. Snoke, Pearson Education. 2009

Advanced Particle Physics - I

(Elective paper-1)

PHYE304(B)

Full Mark : 100 (20+80)

Unit- I (20 Marks)

Two nucleon state vectors, Isospin, Strangeness and Hypercharge, Lepton and Baryon number conservation, Yukawa's theory, Neutrinos, Parity, Parity conservation and non conservation, Time reversal, Consequences of time reversal invariance, Charge conjugation, G-parity.

Unit- II (20 Marks)

Statement of CPT theorem and its consequences, Proof of equality of mass and life time for particle and anti particle**.** Unitary Symmetry and the classification of state, Hadrons and SU (3) multiplets, properties of representations, Young- Tableux method for direct products of representations.

Unit- III (20 Marks)

Applications of SU(3) flavor symmetry and of broken SU(3) flavour symmetry, Gell-Mann- Okubo mass formula for Baryons and Mesons. Coleman-Glashow relation, Quarks and Gluons, Colour hypothesis, Evidence of colour, Magnetic moment of baryons, Baryon wave functions

Unit- IV (20 Marks)

Quantum Electrodynamics (QED) :

The S-matrix expansion, Time ordered product, Normal ordered product, Wick's theorem, Feynman diagrams in configuration and momentum space, First order terms in S-matrix, Compton scattering, Electron electron scattering, closed loop, Feynman rules for QED, QED Lagrangian and gauge invariance.

Text Books :

Introduction of High Energy Physics- D.H. Perkins
Elementary Particle Physics- D.J.Griffiths
Elementary Particles- I.J. Hughes
Quantum Field Theory – F. Mandl and G.Shaw

Reference Books:

Modern Elementary particle Physics (Addison Wesley) - G. Kane
Concept of Particle Physics - V. Weisskopf G.K. Gottfried Quarks & Leptons - F. Halzen & A.D. Martin Quantum Field Theory - Itzyksen and Zuber
Quantum Field Theory – M. E. Peskin and D. V. Shroeder
Quantum Field Theory – L. H. Ryder

Condensed Matter Physics (Lab.)
PHYP305

Full Mark : 50

Practical Paper:

1. Determination of ferroelectric transition point (Curie temperature) of the given sample.
2. Study of the dispersion relation for the mono atomic and lattices using the given electrical transmission line.
3. Determination of magnetic susceptibility by Guoy-balance.
4. Study of thermo luminescence of F-centre in alkali halide crystals.
5. Study of phase transition using feedback amplifier circuit.

Electronics -II (Lab.)
PHYP306

Full Mark : 50

Practical Paper:

1. Study of square wave response of R.C. Network
2. Modulation of detection.
3. Lock-in-amplifier
4. Design of a field-effect transistor crystal oscillator.
5. Study of different gates.
6. Study of digital voltmeter and frequency counter.
7. Study of different gates
8. Design of operational amplifier circuit.

FOURTH SEMESTER

Advanced Quantum Mechanics
PHYC401

Full Mark : 100 (20+80)

Unit-I (20 Marks)
(Relativistic Quantum Mechanics)
Klein-Gordon Equation:
Relativistic non-invariance of Schrodinger equation, Relativistic energy momentum relation and KIein-Gordon equation, Positive and negative energy solutions of KG equation and problems of negative energy.
Dirac Equation:
Dirac's Linearization of the relativistic squared energy operator and Dirac equation, Properties of Dirac matrices, Non relativistic reduction of Dirac equation, magnetic moment, Drawins term, Spin-Orbit coupling, Poincare transformation, Lorentz group, Covariant form of Dirac equation, Bilinear covariants, Gordon decomposition.

Unit-II (20 Marks)
Free particle solution of Dirac equation, Projection operators for energy and spin. Physical interpretation of free particle solution, Zitter bewegung, Hole theory, Charge conjugation, space reection and time reversal symmetries of Dirac equation.

Unit-III (20 Marks)
Continuous systems and fields, Transition from discrete to continuous systems, Lagrangian and Hamiltonians Formulations, Noether's theorem, symmetries and conservation laws. Second quantization and Field operators, Equal Time Commutators of field operators, Normal Ordering of field oparators.

Unit-IV (20 Marks)
Excitons:
Loosely bound, tightly bound, Excitonic waves, electron-hole droplets. Quantization of free fields: Covariant quantization of electromagnetic field, Quantization of scalar, electromagnetic and Dirac Fields, Propagators for scalar, spinor and vector fields.

Text Books:
Advanced Quantum Mechanics -J.J. Sakurai
Relativistic Quantum Mechanics - J.D. Bjorken and S.D. Drell
Relativistic Quantum Fields - J.D. Bjorken and S.D. Drell
Quantum Field Theory - F. Mandl and G. Shaw
Quantum Mechanics (Vol. I& Vol. II) by C.Cohen-Tannoudji,B. Diu &F.Laloe
Reference:
Quantum Field Theory - C. Itzykson and J. Zuber
Quantum Field Theory - M. E. Peskin and D. V. Schroeder
Quantum Field Theory- L. H. Ryder
Quantum Field Theory-S.Weinberg

Basic Nuclear and Particle Physics
PHYC402

Full Mark : 100 (20+80)

Unit-I (20 Marks)

Nuclear models:

Liquid drop model, Semi-empirical mass formula, Explanation of Nuclear fission using Liquid Drop Model, Magic numbers, Shell model, Analysis of shell model predictions

Nuclear reactions:

Energetics of nuclear reaction, compound nucleus theory, Resonance scattering, Breit-Wigner formula for Cross-section, Hopfstadter form factor.

Nuclear Deacys:

Gamow's theory of Alpha decay, Fermi's theory of beta decay. Selection rules forallowed transitions. Parity violation in beta decay.

Unit-II (20 Marks)

Two Nucleon Problem:

Central and non central forces, deuteron and its magnetic moment and quadrupole moment, Isospin dependence of Nuclear force, exchange force, charge independence and charge symmetry of nuclear force, mirror nuclei.

Unit-III (20 Marks) (Particle Physics:)

Elementary particles and their Interactions:

Particle classification, fermions and bosons, Quantum numbers of leptons and Baryons, Hyperons, Mesons and Hadrons, electromagnetic, weak, and strong interactions, Gauge Bosons, Spin and parity determination, Isospin, strangeness, hypercharge, baryon number, lepton number. Discrete and Continuous symmetries and conservation laws for corresponding quantum numbers.

Unit-IV (20 Marks)

Standard Model:

Gell-Mann-Nishijima Scheme, Quark properties: mass, charge, spin, colour, Flavour, Baryon Number, strangeness, charm and Beauty. Quarks composition of hadrons, Meson and baryon octet, Baryon decuplet, Prediction of Omega hyperon and its detection, charmonium, charmed mesons and B mesons. Chirality and avour of Leptons. Neutrino masses and avor oscillations. Elementary ideas of Weinberg-Salam model for Electroweak Unification, Spontaneous Symmetry Breaking and Role of Higgs Boson, its prediction and detection in LHC.

Text Books:

Introduction to Nuclear Theory -L .R .S Elton.
Nuclear Physics- B.B.Roy and B.P.Nigam.
Nuclear Physics - K. S. Krane.
Subatomic Physics-Frauenfelder and Henley.
Concepts of Particle Physics-Gottfried and Weisskopff.
Elementary Particle Physics: D.J.Grifiths
Introduction to Nuclear Physics- P.E. Hodgson & E Gadioli
Introduction to Particle Physics by D.J.Perkins

Reference:

Theoritical Nuclear Physics-Blatt and Weisokoff
Introductory NucelarPhysics-S.S. Wong
Particle Phsics- R. Omnes

Advanced Condensed Matter Physics-II
PHYE403 (A)

Full Mark : 100 (20+80)

Unit-I (20 Marks)

Magnetism:

Weiss theory of ferromagnetism, Curie-Wesis Law susceptibility, Heisenberg model. Conditions for ferro- and antiferro- magnetic order, Spin waves and magnons, Bloch's $T^{3/2}$ law , Antiferromagnetic order, Neel Temperature. Diluted Magnetic Semiconductors.

Ferroelectricity:

Ferroelectric crystals, Classification of ferroelectric crystals, Polarization catastrophe ,Soft optical phonons, Landau theory of phase transition - second and first order transitions.

Multiferroics:

Basic ideas preparations and applications.

Unit-II (20 Marks)

Nanoscale Systems:

Length scales in physics. Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nano rods), Band structure and density of states of materials a tnanoscale. Size Effects in nano systems.

Quantum confinement:

Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit-III (20 Marks)

Characterization of Nanostructure Materials:

X-Ray Diffraction, Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Unit-IV (20 Marks)

Applications of Nanostructure Materials:

Applications of nano particles, quantum dots, nano wires and thin films for photonic devices (LED. solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots hetero structure lasers. optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS). Nano Electromechanical Systems (NEMS).

Text Books:

Introduction to Solid state Physics.- C. Kittel, John Willey & Sons. New York.
Quantum Theory of Solids - C. Kittel
Text Book of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, B. Raj,B.B.Rath and J. Murday.

Reference:

Introduction to Superconductors - Ketterson
The Physics of quasicrystals, (Eds), Steinhardt and Ostulond
Principles of Nanoscience and Nanotechnology,M.A. Shah and T . Ahmad
Handbook of Nanostructured materials and Nanotechnology (Vol.l-4) Ed. H. S. Nalwa
Solid State Physics, S.O. Pillai. New Age International Publishers, 2010

Introduction to Solid State Physics,Arun Kumar
Solid State Physics, Wahab M.A
Solid State Physics and Electonics. R.K. Puri,V.K. Babbar
Solid State Physics. H. E. Hall
Fundamentals of Solid State Physics, Saxena,Gupta, Saxena.

Advanced Particle Physics -II
PHYE403 (B)

Full Mark: 100 (20+80)

Unit-I(20 Marks)

QED processes in lowest order

Cross section, spin sums, photon polarization sums, Lepton-pair production in electron-positron collisions, Bhabha scattering, Compton Scattering, Scattering by an external field and Mott Scattering Formula, Bremsstrahlung.

Unit-II (20 Marks)

Radiative Corrections:

The second order radiative corrections of QED and Feynmann amplitudes involving Photon self energy, Electron self energy, Vertex modification, elementary ideas of charge and mass renormalizations.

Unit-III (20 Marks)

Weak interaction:

Classification of weak interactions, Parity violation and V-A form of weak interaction, Calculations for the decay of Muon and decay of Pion , Elementary notions of leptonic decay of strange particles, The Cabibbo angle and Cabibbo hypothesis , Cabibbo- GIM Mechanism, Inter mediate vector Boson, Neutral current.

Unit-IV (20 Marks)

Electroweak Interactions: Weak isospin and Hypercharge, The basic electroweak interaction, Spontaneous symmetry breaking of discrete symmetry and global gauge symmetry, Spontaneous symmetry breaking of local gauge symmetry and Higgs Mechanism, masses of W and Z bosons, SU(2) X U(1) invariant Standard model (Salam- Weinberg) Lagrangian.

Text Books:

Quantum Field Theory - F. Mandl and G. Shaw
Introduction to High Energy Physics - D. H. Perkins (Cambridge U. Press)
Elementary Particles - I.J.Hughes
Elementary Particle Physics - D.J.Griffiths
Quarks and Leptons – F.Halzen and A.D. Martin

Reference Books

Modern Elementary particle Physics - G.Kane (Addision Wesley)
Concept of Particle Physics - V.Weisskopf & K.Gottfried
Quantum Field Theory - Itzyksen and Zuber
Quantum Field Theory - M.Peskin and Schroeder(Addision Wesley)
Lectures on Quantum Field Theory – Ashok Das (World Scientific)

Modern Physics and Optics-II (Lab.)

PHYP404

Full Mark : 50

Practical Paper:

1. Michelson Interferometer
2. e/m measurement by Magnetron Valve Method.
3. Magnetic field measurement by search coil.
4. Existence of discrete energy level by Frank Hertz experiment.
5. Rectification by junction Diode using various filters.
6. Fabry-Perot Interferometers.
7. e/m measurement by Thomson Method.
8. Ferroelectric transmission point by Dielectric Constant Measurement.
9. RF characteristics of coil.

Condensed Matter Physics (Lab.)

PHYP405

Full Mark : 50

Practical Paper:

1. Determination of ferroelectric transition point (Curie temperature) of the given sample.
2. Study of the dispersion relation for the mono atomic and lattices using the given electrical transmission line.
3. Determination of magnetic susceptibility by Guoy-balance.
4. Study of thermo luminescence of F-centre in alkali halide crystals.
5. Study of phase transition using feedback amplifier circuit.

Project Dissertation
PHYD406

Full Mark : 100

Topics include:

1. The Classical Harmonic Oscillator in Physics: Newtonian mechanics, Lagrange formulation, Hamilton formulation, Hamilton Jacobi formulation.
2. The Quantum harmonic oscillator: Uncertainty principle, Schrodinger equation, Heisenberg operator Formulation, Feynman Path Integral formulation.
3. Foundations of Quantum Theory, Interpretation problem, Quantum Measurement problem, Delayed choice experiments, Interaction-free measurements.
4. Examples of objections to Uncertainty principle and their resolution
5. Examples of objections to Special Theory of Relativity and their resolution.
6. General Theory of Relativity, Relativistic Astrophysics, Cosmological Models, Stellar evolution, Black hole Physics
7. Astroparticle Physics, Neutrino Physics, Quark Gluon Plasma, Dark Matter and Dark Energy.
8. High Energy Physics, Quantum Field Theory, Unifcation of Forces, Standard Model,
9. Grand Unifcation, Super symmetry, Fundamentals of String theory.
10. Symmetries in Physics: Continuous and Discrete symmetries and Gauge Symmetris Lagrangian.
11. Nuclear Matter, Stellar equilibrium, Nucleo synthesis,
12. Accelerators Physics, Data Analysis and Computational Simulation, Particle detectors .
13. Nano Science and Nano Technology, Materials Science, Meta materials, Smart Materials,
14. Magnetic Monopoles, Symmetric Maxwell equations, Quantum Hall Effect
15. Advances in Superconductivity, Super fluidity.

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