M.Sc. Physics Syllabus (Utkal University)

P.G. Department of Physics
Choice Based Credit System

FIRST SEMESTER

Theory	Credit Point	Teaching Hours	Marks
PHY101: Classical Mechanics	6	60-65	100
PHY102: Mathematical Methods in Physics	6	60-65	100
PHY103: Quantum Mechanics-I	6	60-65	100
Practical			
PHY104: Modern Physics and Optics/ Computational Methods in Physics	6	150-180	100

Total credit = 24, Total Mark = 400

SECOND SEMESTER

Theory	Credit Point	Teaching Hours	Marks
PHY201: Quantum Mechanics -II (Application to Atomic and Molecular Physics)	6	60-65	100
PHY202: Classical Electrodynamics	6	60-65	100
PHY203: Basic Condensed Matter Physics	6	60-65	100
Practical			
PHY204: Modern Physics and Optics/ Computational Methods in Physics	6	150-180	100

Total credit = 24, Total Mark = 400

THIRD SEMESTER

	Credit Point	Teaching Hours	Marks
PHY301: Advanced Quantum Mechanics	6	60-65	100
PHY302: Basic Nuclear and Particle Physics	6	60-65	100
PHY303 a/b/c/d (Core Elective Papers-Theory)	6	60-65	100
PHY304: Electronics Theory+Practical	4+2=6	150-180	100
PHY305: Dissertation/Project:	6		200

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

Total credit = 30, Total Mark = 600

FOURTH SEMESTER

	Credit Point	Teaching Hours	Marks
PHY401: Statistical Mechanics	6	60-65	100
PHY402: Laboratory Instrumentation	6	60-65	100
PHY403 a/b/c/d (Core Elective Papers-Theory)	6	60-65	100
PHY404 a/b/c (Core Elective Papers-Practical)	6	150-180	100

Total credit = 24, Total Mark = 400

****

Grand Total credit of 4 semesters = 102 ; Grand Total Mark = 1800

****

A: Core Compulsory Papers:

1st Semester:

PHY101: Classical Mechanics,
PHY102: Mathematical Methods in Physics,
PHY103: Quantum Mechanics-I,
PHY104: Modern Physics and Optics/ Computational Methods in Physics.

2nd Semester:

PHY201: Quantum Mechanics-II (Application to Atomic and Molecular Physics),
PHY202: Classical Electrodynamics,
PHY203: Basic Condensed Matter Physics,
PHY204: Modern Physics and Optics/Computational Methods in Physics

3rd Semester:

PHY301: Advanced Quantum Mechanics,
PHY302: Basic Nuclear and Particle Physics,
PHY304: Basic Electronics (Theory+Practical)

4th Semester:
PHY401: Statistical Mechanics,
PHY402: Laboratory Instrumentation.

B: Core Elective Papers:

Theory	**Credit Point**	**Teaching Hours**	**Marks**
PHY303a: Advanced Particle Physics and Field Theory-I (3rd Sem)	6	60-65	100
PHY303b: Advanced Condensed Matter Physics- I (3rd Sem)	6	60-65	100
PHY303c: Advanced Nuclear Physics -I (3rd Sem)	6	60-65	100
PHY303d: Electronics & Instrumentation-I (3rd Sem)	6	60-65	100

PHY403a: Advanced Particle Physics and Field Theory-II (4th Sem)	6	60-65	100
PHY403b: Advanced Condensed Matter Physics –II (4th Sem) (Magnetism and Nanoscience)	6	60-65	100
PHY403c: Advanced Nuclear Physics -II (4th Sem)	6	60-65	100
PHY403d: Electronics & Instrumentation -II (4th Sem)	6	60-65	100

Practical

PHY404a: Particle and Nuclear Physics (4th Sem)	6	150-180	100
PHY404b: Condensed Matter Physics (4th Sem)	6	150-180	100
PHY404c: Electronics & Instrumentation (4th Sem)	6	150-180	100

C: Allied Elective Papers

Theory	**Credit Point**	**Teaching Hours**	**Marks**
PHY103 Quantum Mechanics-I	6	60-65	100
PHY104: Computational Methods in Physics	6	60-65	100
PHY203: Basic Condensed Matter Physics	6	60-65	100
PHY303a: Advanced Particle Physics and Field Theory-I	6	60-65	100
PHY303b: Advanced Condensed Matter Physics- I			

* The **Core Compulsory Papers** given in "A" are compulsory for all the M.Sc. (Physics) students.
* M.Sc. (Physics) students have to choose one theory paper out of the core elective papers (Special Papers) in "B" during their 3rd Semester. They have to choose one theory and one practical paper out of the core elective papers (Special Papers) in "B" during their 4th Semester.
* M.Sc. (Physics) students have to choose one dissertation/project topic in 3rd Semester.
* Allied Elective Papers as given in 'C' can be chosen by M.Sc. students of Physics Department as well as allied departments.

Mark and Credit Distributions

Semester	***Credit***	***Marks***
1st	24	400
2nd	24	400
3rd	30	600
4th	24	400
Total	**102**	**1800**

M.Sc. Physics Syllabus (Utkal University)

FIRST SEMESTER

PHY101

Classical Mechanics **Full Mark-100**

Unit- I- 34 Marks

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.

Hamiltonian Formulation:

Calculus of Variations and Euler-Lagrange's Equation, Brachistochrone Problem, Hamilton's Principle, Extension of Hamilton's Principle to Nonholonomic 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, Δ-Variation, Principle of Least Action

Unit- II- 32 Marks

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 Invariant, Infinitesimal Canonical Transformation and Conservation Theorems, Liouville's Theorem.

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

Unit- III- 34 Marks

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.

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, Eigenvalues 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. Elementary Idea about Nonlinearity and Chaos.

Books :

Text : Classical Mechanics – H. Goldstein

Ref : Mechanics – Landau and Liftshitz
Analytical Mechanics, L. Hand and J. Finch
Classical Mechanics – Corben & Stehle
Classical Dynamics – Marion & Thornton

PHY102

Mathematical Methods in Physics **Full Mark-100**

Unit-I- 34 Marks

Complex Variables:

Cauchy's Integral Theorem, Cauchy's integral formula, Calculus of Residues, Cauchy's residue theorem, Evaluation of definite integrals.

Tensor Analysis and Differential geometry:

Cartesian tensors in three-space, Curves in three space and Frenet formula, General Tensor Analysis, Covariant derivative and Christoffel symbol, Riemann & Ricci tensor.

Unit II – 34 Marks

Special Functions :

Solutions of Bessel, Laguerre, Legendre, Hermite, Hypergeometric and Confluent Hypergeometric Equations by generating function method and their properties.

Solutions of inhomogeneous Partial Differential Equations by Green's function method.

Unit III – 32 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 representation of SU(2), SU(3) and O(3), SO(3,1).

Books :

Text : 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

Reference:

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

PHY103

Quantum Mechanics-I 100 Marks

Unit-I-32 Marks

General Principles of Q.M.

Linear Vector Space Formulation: Linear Vector Space (LVS) and its generality, Vectors – scalar product, metric space, basis vectors, linear independence, linear superposition of general quantum states, orthonormality of basis vector, completeness, Schmidt's orthonormalisation procedure, Dual space, Bra and Ket vectors.

Operators – linear, Adjoint, hermitian, unitary, inverse, antilinear operators, Noncommutativity and uncertainty relation, complete set of compatible operators, Simultaneous Measurement, Projection operator, Eigenvalues and eigen vectors 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.

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.

Unit-II-34 Marks

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.

Spin Angular Momentum:

Spin $\frac{1}{2}$ particles, Pauli spin matrices and their properties Eigenvalues and Eigenfunctions, Spinor transformation under rotation.

Addition of angular momentum :

Total angular momentum J. Eigen value problem of J_z and J^2, Angular momentum matrices. Addition of angular momenta and C.G. coefficients, Angular momentum states for composite systems in the angular momenta (1/2, 1/2) and (1, 1/2)

Unit – III – 34 Marks

Motion in Spherically symmetric Field:

Hydrogen atom, Reduction to equivalent one body problem, Radial equation, Energy eigenvalues and eigenfunctions, degeneracy, radial probability distribution. Free particle problem incoming and outgoing spherical waves, expansion of plane waves in terms of spherical waves, Bound states of a 3-D square well, particle in a sphere.

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

Ref. Books:

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

PHY104/204

Computational Methods in Physics Full Marks -100

(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 and 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. Evaluation of log and exponentials
9. Solution of quadratic equation
10. Division of two complex numbers

11. To find the sum of the digits of a number

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, Schrödinger Equation

Books:

1. Computer Programming in FORTRAN 90 and 95, V. Rajaraman
2. V. Rajaraman -- Fundamentals of Computers (Printice Hall, India)
3. Object Oriented Programming with C++, E Balagurusamy.
4. Programming with C++, J. R. Hubbard (McGRAW-HILL).
5. Computer Oriented Numerical Methods- R.S.Salaria
6. An Introduction to computational Physics, T. Pang, Cambridge Univ. Press.
7. W.H. Press, S. A. Teukolsky, W.T. Vetterling and B.P. Flannery – Numerical Recipe (Cambridge Univ. Press)
8. V. Rajaraman – Elements of Parallel Processing (Printice Hall, 1990)
9. Fortran 77 and Numerical methods – C. Xavier
10. P.S. Grover – Programming and Computing with FORTRAN 77/90, (Allied Publishers 1992)

PHY 104/204

Modern Physics and Optics Full Mark-100

(Practical Paper)

Michelson Interferometer
Fabry-Perot Interferometers
Measurement of Rydberg constant
Babinet's compensator
Constant deviation spectroscope
e/m measurement byBraun tube
e/m measurement by Magnetron Valve Method
e/m measurement by Thomson Method
Magnetic field measurement by search coil
Ferroelectric transmission point by Dielectric Constant Measurement
Rectification by junction Diode using various filters

Characteristics of a Transistor
Dielectric constant of solid (wax) by Lecher Wire
Verification of Richardson's $T^{3/2}$ low
Determination of Planck's constant by total Radiation Method
Determination of Planck's constant by Reverse Photoelectric effect method
Hysteresis loop tracer
Determination of 'e' by Millikan's oil drop experiment
Measurement of attenuation and phase shift of A.C. in L.C.R. net work
RF characteristics of coil
Study of power supply
Calibration of an oscilloscope
Stefan's constant measurement
Existence of discrete energy level by Frank Hertz experiment.
M.Sc. Experiments developed by Indian Academy of Sciences

SECOND SEMESTER

PHY201

Quantum Mechanics – II (Application to Atomic and Molecular Physics) Full Marks –100

Unit-I- 34 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 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 Anomalus Zeeman Effect, The Strong-Field Zeeman Effect, The Weak-Field Zeeman Effect and Lande's g-factor.

Variational Methods:

Ground State, First Excited State and Second Excited State of One-Dimensional Harmonic Oscillator, Ground State of H-atom and He-atom, Hydrogen molecule, Hydrogen molecule ion, Rotational and Vibrational Degrees of Freedom.

UNIT II 34 Marks

WKB Approximation Method:

General Formalism, Validity of WKB Approximation Method, Connection Formulas, Bohr Somerfield Quantization Rule, Application to Harmonic Oscillator, 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.

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 Emission Einstein's A, B-Co-efficients, radiation, Quantum description of spontaneous emission.

UNIT III 32 Marks

Scattering Theory:

Scattering amplitude and differential cross Section, Relation between Lab and CM cross sections, Born Approximation. 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, Scattering of identical particles

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 Books :

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 Theoryof Angular Momentum - M.E. Rose

PHY202

Classical Electrodynamics Full Marks -100

Unit. I-32 Marks

Maxwell's Equations:

Maxwell’s equations in free space, Magnetic charge, Maxwell’s equations inside matter, Displacement current, Vector and scalars potentials, Wave equation for potentials, Lorentz and Coulomb gauge conditions, Wave equation for Electric and Magentic fields in absence of sources, Poynting vector.

Covariant Formulation of Maxwell’s Equation:

Lorentz transformation, Scalars, vectors and Tensors, Maxwells 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.II-34 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, Reflection and refraction of electromagnetic waves at a plane interface between dielectrics at normal and oblique incidences, total internal reflection and polarisation by reflection, waves in dispersive media,Kramer-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. III-34 Marks

Green's Function Solution for Retarded Potential:

Green's function solution of potential form of Maxwell's equations, Retarded and advanced Green's Functions, Lienard-Wiechert potential.

Multipole Radiation:

Potential, Fields and radiation due to an oscillating electricc dipole; radiation due to a centre -fed linear antenna, angular distribution of power radiated, Rayleigh Scattering.
Magnetic dipole and Electric Quadrupole radiation.

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.

Books:

Text Books:
Classical Electrodynamics - J. D. Jackson

Reference Books:
Classical Theory of Fields - L.Landau & Lifsitz
Introduction to Electrodynamics - D.J.Griffiths.
Principles of Optics-M.Born and E. Wolf
Introduction to Electrodynamics- Capri and Panat

PHY203

Basic Condensed Matter Physics Full Marks –100

Unit-I-32 Marks

Crystal binding :

Crystal of inert gases, ionic crystals, covalent crystals, Metallic binding, and hydrogen bounded crystals.

Phonons and lattice vibration:

Vibrations of monatomic and diatomic lattices, dispersion, relation, optic and acoustic modes, Quantum of lattice vibration and phonon, phonon momentum, inelastic scattering of neutrons and photons by phonons.

Thermal Properties of insulators:

Lattice heat capacity, Debye & Einstein model, Anharmonic crystal interactions, thermal conductivity and thermal expansion.

Unit II-34 Marks

Free Electron Fermi Gas :

Density of state in one dimension, effect of temperature on Fermi-Dirac distribution, Free electron gas in three dimensions, Heat capacity of electron gas, The Boltzmann transport equation, Electrical conductivity, General Transport coefficients, Thermal conductivity, Thermoelectric effect.

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, Brillouin zones, E-k diagram under free electron approximation.

Unit-III-34 Marks

Semiconductors:

Intrinsic and impurity semiconductors, band gap, law of mass action, intrinsic carrier concentration, mobility in the intrinsic region, p-n junction rectification.

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.

Josephson effect- macroscopic quantum mechanical effect, DC Josephson effect, Effect of electric field- AC/Inverse AC Josephson effect, Effect of magnetic field, SQUID.

High T_c superconductors: Basic ideas and applications

Textbooks:
Introduction to Solid State Physics - C. Kittel
Solid State Physics - Ashcroft and Mermin
Principles of Condensed Matter Physics - P. M. Chaikin and T. C. Lubensky
Reference books:
Solid State Physics- A.J. Dekker
Quantum Theory Solid State - J. Callaway
Solid State Physics – O.E. Animaler

(comments from the expert is awaited)

PHY 104/204

Modern Physics and Optics (Practical Paper) — Full Mark-100

Michelson Interferometer
Fabry-Perot Interferometers
Measurement of Rydberg constant
Babinet's compensator
Constant deviation spectroscope
e/m measurement by Braun tube
e/m measurement by Magnetron Valve Method

e/m measurement by Thomson Method
Magnetic field measurement by search coil
Ferroelectric transmission point by Dielectric Constant Measurement
Rectification by junction Diode using various filters
Characteristics of a Transistor
Dielectric constant of solid (wax) by Lecher Wire
Verification of Richardson's $T^{3/2}$ low
Determination of Planck's constant by total Radiation Method
Determination of Planck's constant by Reverse Photoelectric effect method
Hysteresis loop tracer
Determination of 'e' by Millikan's oil drop experiment
Measurement of attenuation and phase shift of A.C. in L.C.R. net work
RF characteristics of coil
Study of power supply
Calibration of an oscilloscope
Stefan's constant measurement
Existence of discrete energy level by Frank Hertz experiment.
M.Sc. Experiments developed by Indian Academy of Sciences

PHY104/204

Computational Methods in Physics Full Marks -100

(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 and 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.Evaluation of log and exponentials
9.Solution of quadratic equation
10.Division of two complex numbers
11.To find the sum of the digits of a number

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, Schrödinger Equation

Books:

1. Computer Programming in FORTRAN 90 and 95, V. Rajaraman
2. V. Rajaraman -- Fundamentals of Computers (Printice Hall, India)
3. Object Oriented Programming with C++, E Balagurusamy.
4. Programming with C++, J. R. Hubbard (McGRAW-HILL).
5. Computer Oriented Numerical Methods- R.S.Salaria
6. An Introduction to computational Physics, T. Pang, Cambridge Univ. Press.

7. W.H. Press, S. A. Teukolsky, W.T. Vetterling and B.P. Flannery – Numerical Recipe (Cambridge Univ. Press)

8. V. Rajaraman – Elements of Parallel Processing (Printice Hall, 1990)
9. Fortran 77 and Numerical methods – C. Xavier
10. P.S. Grover – Programming and Computing with FORTRAN 77/90, (Allied Publishers 1992)

THIRD SEMESTER

PHY301

Advanced Quantum Mechanics: Full Marks – 100

Unit-I- 34 Mark

Relativistic Quantum Mechanics:

Klein-Gordon equation and its drawbacks, Dirac equation, Properties of Dirac matrices, Non-relativistic reduction of Dirac equation, magnetic moment, Darwins term, Spin-Orbit coupling, Poincare transformation, Lorentz group, Covariant form of Dirac equation, Bilinear covariants, Gordon decomposition.

Unit-II –34 Marks

Free particle solution of Dirac equation, Projection operators for energy and spin, Physical interpretation of free particle solution, Zitterbewegung, Hole theory, Charge conjugation, space reflection and time reversal symmetries of Dirac equation. Continuous systems and fields. Transition from discrete to continuous systems, Lagrangian and Hamiltonian Formulations, Noether's theorem.

Unit-III -32 Marks

Quantization of free fields:

Second quantization, Equal Time Commutators, Normal Ordering, covariant quantization of electromagnetic field, Quantization of scalar, e.m, and Dirac fields, Propagators for scalar, spinor and vector fields.

Textbooks:
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

Reference books:
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

PHY302

Basic Nuclear and Particle Physics Full Marks – 100

Unit I -32 Marks

Two Nucleon Problem:

Central and noncentral forces, deuteron and its magnetic moment and quadrupole moment; Force dependent on isospin, exchange force, charge independence and charge symmetry of nuclear force, mirror nuclei.

Nuclear models:

Liquid drop model, fission, magic numbers, shell model, analysis of shell model predictions

Unit-II-34 Marks

Nuclear reaction:

Energetics of nuclear reaction, compound nucleus theory, resonance scattering, Breit-Wigner formula,Alpha decay, Fermi's theory of beta decay, Selection rules for allowed transition, parity violation.

Nuclear Structure:

Form factor and charge distribution of the nucleus, Hofstadter form factor.

Unit-III-34 Marks

Particle Physics:

The Standard model of particle physics, particle classification, fermions and bosons, lepton flavors, quark flavors, electromagnetic, weak and strong processes, Spin and parity determination, Isospin,strangeness, hypercharge, and baryon number, lepton number, Gell-Mann-Nishijima Scheme,Quarks in hadrons: Meson and baryon octet, Elementary ideas of SU(3) symmetry, charmonium, charmed mesons and B mesons, Quark spin and colour

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 Weisskopf
Elementary Particle Physics : D.J.Griffiths
Introduction to Nuclear Physics- P.E. Hodgson & E. Gadioli

Reference Books:

Theoritical Nuclear Physics-Blatt and Weisokoff
Introductory Nucelar Physics:S.S.Wong
Particle Physics-R.Omnes

PHY303a

Advanced Particle Physics - I Full mark-100

Unit- I – 32 Marks

Two nucleon state vectors, Isospin, Strangeness and Hypercharge, Lepton and Baryon number conservation, Yukawa's theory, Neutrinos, Parity, Parity conservation and nonconservation, Time reversal, Consequences of time reversal invariance, Charge conjugation, G-parity, Statement of CPT theorem and its consequences, Proof of equality of mass and life time for particle and anti particle.

Unit- II – 34 Marks

Unitary Symmetry and the classification of state, Hadrons and SU (3) multiplets, properties of representations, Young-Tableux method for direct products of representations, Applications of SU(3) flavour 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- III – 34 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 Pjhysics (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

PHY303b

Advanced Condensed Matter Physics-I **Full mark-100**

Unit-I-32 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.

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, Warnier functions

Density of states: Dynamical Mean field Theory

Unit-II-34 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. III – 34 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, Magnetoresistance, 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 Books

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

(comments from the expert is awaited)

PHY303c

Advanced Nuclear Physics-I Full mark-100

Unit-I – 34 Marks

Nuclear Momentum Theory:

Rotational invariance in three dimensions Eigenvalues and eigenfunctions of angular momentum operator, explicit representation of rotation matrices, Addition of angular moments, Clebsch-Gordon, Racah and 3j coefficients, irreducible spherical tensors, matrix elements of tensor operators, Wigner-Eckart theorem.

Unit-II – 32 Marks

Two Nucleon System:

Ground and excited states of the deuteron, Tensor forces and quadrupole moment of deuteron, Photo disintegration of the deuteron.

Unit-III – 34 Marks

Nuclear Models :

Shell model, analysis of shell predictions, extreme single particle model, configuration mixing individual practice model, L.S. and J.J. coupling schemes.

Books :

Nuclear Physics – R.R. Roy and B.P. Nigam (Wiley Eastern)
Elementary Theory of Angular Moemtum – M.E. Rose (John Wiley)
Introduction to Nuclear Physics- H. Enge (Addison Wesley)
Theoretical Nuclear Physics – Blatt J.M. & Weisskopf (Springer Verlag)

PHY303d

Electronics and Instrumentation Full mark-100

Unit-I - 32Marks

Elemental and Compound Semiconductors :

Elementary idea about lattice mismatched pseudomorphic materials epitexy and epitexial growth, carrier effective mass and band structure, carrier scattering phenomena, conduction processes in semiconductors, Bulk and surface recombination, non-radiative and radiative recombinations, Shockley Read Hall theory of recombination, P-N junction theory, Schottky barriers and ohmic contact.

Varactor diode, PIN diode, Schottky barrier and backward diode.

Unit-II – 34 Marks

Gunn effect, Ridly-watkin-Hilsam Mechanism device configuration, Tunnel diodes, Phenomena, theory and device configuration, IMPATT diodes.

LED, Electroluminescent process, LED materials, Device configuration and efficiency, LED structures, Laser operating principles, semiconductor, structures and proper tics, Threshold current, Heterojuction Lasers, Photodetctors, Photoconductors, junction photo diodes, Avalanche photo diodes, solar cells, basic principles, spectral response, Heterojunction and cas caded solar cells, schottky barrier cells, material and design consideration. Thin film solar cells.

Unit- III- 34 Marks

Digital Circuits :

Simplificatin of digital circuits using Karnaugh maps, characteristics of logic families, Binary adder. Subtracting Flip-flops-RS, JK. Master slave, shift-registers, CMOS dynamic shift-registers, Asynchronous counters, Divide by N Councter Decade ripple counter Synchronous counter, application of counters.

Text Books :

1. Physics of Semiconductor Device – S.M. Sze, Wiley Eastern Limited, 1987
2. Electronic Fundamentals and Applications – J. D. Ryder, Prentice Hall of India
3. Intergrated Electronics – J. Milliman and C. C. Halkies, Mc graw Hill
4. Instrumentation Devices and Systems – C.S. Rangon, G.R. Sarma dn V.S.V. Mani Tata Mc Graw Hill

5. Digital Computer Electronics – A.P Malvino, Tata Mc Graw Hill, 1989

Reference Books :

1. Physics of Semiconductor Devices – S.M. Sze, Wiley Easter Limitted, 1987
2. Semiconductor Devices & Integrated Electronics – A.G. Mllnes, Van Nostrand Reinhold Company, 1980
3. Microprocessor Fundamental – R.L. Tekhenin, Mc Graw Hill, 1986
4. Electronic Instrumentation and Measurement Techniques – W D Cooper and A.D.Helfrick, Prentice Hall of India, 1989
5. Microwave propagation and techniques – D.C. Sarkar, S. Chand& Co.Ltd.1910

PHY304

Basic Electronics (Theory + Practical)

FullMarks – 100

Unit I: 34 Marks

Amplifiers:

Frequency response of linear amplifiers, amplifier pass band, R.C.L.C. and transformer coupled amplifiers, Frequency response, gain band-width product, Feedback amplifiers, effects of negative feedback, Boot-strapping the FET, Multistage feedback, stability in amplifiers, noise in amplifiers.

Operational amplifiers:

The differential amplifiers, integral amplifier, rejection of common mode signals. The operational amplifier input and output impedances, application of operational amplifiers, unit gala buffer, summing, integrating and differentiating amplifiers, comparators and logarithmic amplifiers.

Unit II: 34 Marks

Oscillator Circuits:

Feedback criteria for oscillation, phase shift, Wien bridge oscillator, crystal controlled oscillator, klystron oscillator, Principle of multivibrator.

Digital Circuits:

Logic fundamentals, Boolean theorem, Logic gates – RTL, DTL and TTL gates, CMS switches, RS flip-flop, JK flip-flops

Unit III: 32 Marks

Radio Communication:

Ionospheric propation, Antennas of different types, super heterodyne, receiver (Block diagram). Various types of optical fibers and optical communications.

1. Setting of a transistor amplifier and determination of the amplification factor at various frequencies
2. Frequency response of transister amplifier with the without feedback
3. Characterstics of Harteley oscillator
4. Determination of different parameters of transistor
5. Study of multivibrator – Astable
6. Study of multivibrator – Bistable
7. Study of multivibrator – Monostable
8. VSWR' in a microwave transmission line
9. Study of squarewave response of R.C. Network
10. Modulation of detection
11. Lock-in-amplifier
12. Design of operational amplifier circuit
13. Design of a field-effect transistor crystal oscillator
14. Study of different gates
15. Study of digital voltmeter and frequency counter.
16. M.Sc. Experiments developed by Indian Academy of Sciences

Books :

Electronic Fundamental and application – J.D. Ryder
Int. Digital Electronics – Heap and Martin
Integrated Electronics – Millman and Halkias
Foundation of Electronics – Chattopadhyay, Rakshit, Saha and Purkalt

PHY305

Dissertation (Project)
Full mark-200

Topics include:

General Theory of Relativity, Cosmology, Astroparticle Physics, High Energy Physics, Nano Science and Nano Technology, Materials Science, Nuclear Matter, Black Hole Physics, Neutrino Physics, Accelerators Physics, Data Analysis and Computational Simulation

Dissertation: 100 marks,
Presentation and Viva: 100 marks

FOURTH SEMESTER

PHY401

Statistical Physics Full Marks – 100

Unit-I-32 Marks

Classical Statistical Mechanics:

Postulate of classical statistical mechanics, Liouville's theorem, micro canonical ensemble, Derivation of thermodynamics, equipartition theorem, classical ideal gas, Gibb's Paradox.

Canonical ensemble and energy fluctuation, grand canonical ensemble and density fluctuation, Equivalence of canonical and grand canonical ensemble.

Unit-II-34 Marks

Quantum Statistical Mechanics:

The density matrix, ensembles in quantum statistical mechanics; Ideal gas in micro-canonical and grand canonical ensembles; Equation of state for ideal Fermi gas, Theory of white dwarf stars. Ideal Bose Gas, Photons and Planck's law, Phonons, Bose-Einstein condensation.

Unit-III-34 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 Book: Statistical Mechanics – K. Huang
Statistical Mechanics – R. K. Pathria

Reference Books:

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

PHY402

Laboratory Instrumentation (Theory + Lab) Full Marks - 100

Unit I
General Purpose Characterization Instruments

Commonly used techniques for characterization – X-Ray diffractometer, Scanning Electron microscopes, Energy dispersive X-ray analysis (EDX), fluorescence microscopy, confocal microscopy, scanning probe microscopy: Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), holographic microscopy, magnetic resonance equipments, electrical conductivity measurement, magnetic susceptibility measurement
Spectroscopy: Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR), X-ray Photoelectron Spectroscopy (XPS).

Unit II
Vacuum Technology

Units used to describe vacuum, Nature of the Residual Gases in a Vacuum System, Gas flow in a pumping system, Out gassing, Various types of vacuum pumps and their operating range (Rotary pump, Turbomolecular pump, Vapor diffusion pump, Sorption Pumps, Getter Pumps, Cryopump, Ion Pumps)
Measurement of vacuum - Thermal-conductivity Gauges, Ionization Gauges,

Unit III
Nuclear radiations and detectors

Types of radiations (alpha, beta, gamma), Interaction of charge particles and radiations with matter, Different types of detectors- gas detectors, Scintillation detectors, solid state detectors, Pulse shaping techniques, Elementary ideas on cloud and bubble chambers, and Cerenkov detectors

References :

1. Elements of X-ray diffraction, B.D.Cullity
2. X-ray diffraction its theory and application, S. S.K. Chatterjee, PHI Learning Pvt. Ltd
3. Spectroscopy: Fundamentals and Data Interpretation, Neeraj Kumar Fuloria, Shivkanya Fuloria, Studium Press, India Pvt. Ltd. (2013), ISBN-13: 978-9380012582
4. Vacuum Technology (Third Edition) *A. Roth,* ISBN: 978-0-444-88010-9
5. Introduction to Nuclear and Subnuclear Physics, H. A. Enge

(new course: comments from the expert is awaited)

PHY403a

Advanced Particle Physics -II Full mark-100

Unit-I- 34 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

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-II-34 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, Intermediate vector Boson, Neutral current.

Unit-III-32 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)

PHY403b

Advanced Condensed Matter Physics-II **Full mark-100**

(Magnetism and Nanoscience)

Unit I: 32 Marks

Magnetism:

Weiss theory of ferromagnetism, Curie-Weiss Law for susceptibility, Heisenberg model– Conditions for ferro- and antiferro-magnetic order, weak ferromagnetism, 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 transition

Multiferroics – Basic ideas, preparations and applications

Unit II: 34 Marks

Nanoscale Systems:

Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, 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.

Synthesis Of Nanostructure Materials:

Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.

Unit III: 34 Marks

Characterization of Nanostructure Materials:

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

Applications of Nanostructure Materials:

Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure 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 Books:

Introduction to Modern Solid State Physics byYuri M. Galperin
Introduction to Solids- Azroff
Elementary Solid State Physics- Omar
Solid State physics- Aschroff & Mermin
Science of Engineering Materials and carbon nanotubes, CM. Srivastava & C. Srinivasan
Solid state physics, A.J. Dekkar Macmillan, London
Solid state Physics, R.L.Singhal, Kedarnath and Ramnath Co.,Meerut.
Low Dimensional Semiconductor Structures, K. Bamam and D. Vvedensky (Cambridge University Book) 2001
Semiconductor Quantum Dots, L. Banyal and S.W. Koch (World Scientific) 1993
An introduction to the physics of low dimensional semiconductors, J.H. Davies (Cambridge Press) 1998.
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.1-4) 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 Electronics, R.K. Puri, V.K. Babbar
Solid State Physics, H.E. Hall
Fundamentals of Solid State Physics, Saxena, Gupta, Saxena.

(comments from the expert is awaited)

PHY403c

Advanced Nuclear Physics-II Full mark-100

Unit-I- 32 marks

Scattering:

Rutherford scattering, cross section, the process of measurement, transformation between CM frame and the Lab frame, relativistic kinematics.

Collective model:

Collective model, rotational energy spectrum and nuclear wave function for even-even nuclei, Energy spectrum and wave function for odd-A nuclei, Nuclear moments , Collective vibration excitation, Rotational Vibration coupling.

Unit-I- 34 marks

Nuclear Reactions:

Compound nucleus, statistical theory of nuclear reactions, evaporation probability and cross section for specific reactions, experimental results, optical model, Kapur-Reierls dispersion formula for potential scattering, Giant resonances , deuteron stripping and pick up reactions

Unit-III- 34 marks

Nuclear Detectors:

Theory of detection of charged/neutral particles, Ionisation Chambers, Semiconductor counters, Proportional counters, G.M.Counter, scintillation counter, Wilson expansion Chamber,Bubble Chamber, The nuclear emulsion Neutron detection, time of flight techniques, measurements based on recoil protons, Beta and electron spectrometers, acceleration of charged particles, Van-de-Graff generator, Linear accelerator, Cyclotron, synchrocyclotron

Books:

Nuclear Physics-R.R.Roy and B.P.Nigam
Elementary theory of Angular momentum-M.E.Rose (John Wiley)
Introduction to Nuclear Physics-H.Enge (Addision Welsey)
Theoritical Nuclear Physics-Bleat J.M & Weisskopf (springer Verlag)

PHY403d

Electronics and Instrumentation-II Full mark-100

Unit-1-32 Marks

D/A and A/D Converters:

Binary weighted resistance DAC,DAC using ladder network, BCD DAC, counter ramp and successive approximation type ADC, single slope, dual slope ADC.

Unit. II – 34 Marks

Electric Test and measuring Equipment:

Cathod-ray Oscilloscope, Digital Voltmeters and Multimeters. Signal Generators. Regulated Power supplies.

Data Acquisition and Processing:

Introduction Transducer(Elementary ideas), Signal conditioning of the inputs, Single channel data acquisition system, Multichannel data acquisition system, Multiplexers and sample Hold circuits.

Unit. III – 34 Marks

Macroprocessors and Microcomputers:

Microcomputers, 8085 Microprocessor architecture, stacks, Resource sharing, Memory access and transfer, interrupts, Microprocessor Softwares, RAM,ROM,EPROM,I/O devices, Operational sequences, Applicaions.

Books:

Physics of Semiconductor Devices- S.M. Sze, Wiley Eastern Limitted,1987.
Electronic Fundamentals & Applications-J.D. Ryder, Prentice Hal of India
Integrated Electronics- J. Millman and C.C. Halkias, Mc. Graw Hill
Instrumentation devices and systems- C. Srangan, G.R. Sarma and V.S. Vmani,Tata Mc Graw Hill
Digital Computer Electronics- A.P. Malvino, Tata Mc Graw Hill, 1989.

References

Physics of Semiconductor Devices- S.M Sze,Wiley Eastern Limited,1987.
Semiconductor Devices and Integrated Electronics- A.G.Milnes, Van Nostrand Reinhold Company,1980
Microprocessor Fundamental- R.L. Tokhein, Mc Graw Hill,1986.
Electronic Instrumentation and Measurement Techniques- W.D. Cooper and A.D. Helfrick, Prentice Hall of India,1989.
Microwave Propagation and Techniques- D.C. Sarkar, S. Chand and Co. Ltd. 1910.

PHY404a

Particle and Nuclear Physics Lab Full mark-100

1. Calibration of the x-ray spectrometer and determination of x-ray energy of unknown sources.
2. Determination of resolving poser of x-ray spectrometers.
3. Study of b spectrum.
4. Determination of absorption co-efficient of Aluminum using G.M Counter.
5. X-test and operating poing determination using G-N tube.
6. Characteristics of G.M. counter.
7. Study of surface barrier detector.
8. Determination of value for DPPH using ESR.
9. Study of counter technique.
10. Study of single channel analyzer.
11. Study of photo detector and photo multiplier.
12. Study of wide-band amplifier.
13. Emulsion photograph studies.

PHY404b

Condensed Matter Physics lab Full mark-100

1. Study of energy gap of Germanium by four-probe method.
2. Callibration of magnetic field using Hall apparatus.
3. Determination of Hall Voltage and Hall coefficients.
4. Measurement of Hall angle and mobility.
5. Determination of ferroelectric transition point(Curie temperature) of the given sample.
6. Determination of magnetoresistance of bismuth.
7. Study of Laue's spot of mica sheet using X-ray diffraction technique.
8. Study of the dispersion relation for the monoatomic and lattices using the given electrical transmission line.
9. Find the Young's modulus for the given metal using composite piezoelectric oscillator technique.
10. Determination of magnetic susceptibility by Guoy-balance.
11. Velocity of ultrasonic waves in a given medium at different temperatures.
12. Measurement of Lande's g factor of DPPII by ESR at Microwave frequency.
13. Study of thermoluminescence of F-centre in alkali halide crystals.
14. Study of phase transition using feed back amplifier circuit.

PHY404c

Electronics and Instrumentation Lab Full mark-100

1. Study of the various stages of a regulated power supply and find its regulation and ripple factor.
2. Design and assemble of a single stage transistor amplifier and study of its frequency response.
3. Study of phase transition using feed- Back amplifier circuit.
4. Study of multivibrator-Astable.
5. Study of multivibrator-Bistable.
6. Study of multivibrator-Monostable.
7. Design of operational amplifier circuit.
8. Use of operational amplifier for integration and differentiation.
9. Use of operational amplifier for addition and subtraction.
10. Study of various stages of a digital voltmeter.
11. Study of various stages of digital frequency counter.
12. Study of various stages of a CRO and calibrate it for measurement of frequency and amplitude.
13. Determination of Hall voltage and Hall coefficient.
14. Study of different gates.
15. Programming using into 8085 microprocessor.

Proposed Advanced Courses to be introduced as elective/ Add-on courses:

- **Monte Carlo Techniques, data analysis**
- **Computational Solid State techniques**
- **Molecular dynamics in many body system calculation**
- **Non linear dynamics**
- **Multi scale solid State modelling**
- **Development of Source code**
- **Using Public domain code in Fluid dynamics**
- **Gravitation and Cosmology**
- **Accelerator Physics**

Syllabus for Add-on/Elective course:

Gravitation and Cosmology (Total Marks:100)

Teaching Hours: 40 Credit point: 4

Unit: I (Tensor algebra and tensor calculus) (Marks: 25)

Manifolds and coordinates, Transformation of coordinates, contravariant, co-variant and mixed tensors, elementary operations with tensors, partial and Lie derivatives of a tensor, affine connection and covariant differentiation, affine geodesics, The Riemann tensor, Riemann curvature, Ricci curvature and the Weyl tensor, Isometries: Killing equation and conserved quantities

Unit: II (The principles of general relativity and the field equations) (Marks: 25)

The equivalence principle, The equation of geodesic deviation, Derivation of vacuum Einstein equations from the action, Bianchi identities, stress-energy tensor: perfect fluid, scalar and electromagnetic fields

Unit: III (Solution and its properties) (Marks: 25)

Schwarzschild solution, Motion of particles in the Schwarzschild metric, Event horizon its properties and significance: singularities, Penrose diagram, linearized fluctuation of Einstein equation

Unit: IV (The Friedmann-Lemaitre-Robertson-Walker cosmology) (Marks: 25)

Homogeneity and isotropy, The FLRW line-element, Friedmann equations and its solutions with different types of matter

Text books:

S. Carroll, *Spacetime and Geometry* (Addison Wesley, New York, 2004).
S. Weinberg, *Gravitation and Cosmology* (John Wiley, New York, 1972).

Reference books:

J. B. Hartle, *Gravity: An Introduction to Einsteins General Relativity* (Pearson Education, 2003).
B. F. Schutz, *A First Course in General Relativity* (Cambridge University Press, Cambridge, 1985).
C. W. Misner, K. S. Thorne and J. W. Wheeler, *Gravitation* (W. H. Freeman and Company, San Francisco, 1973).
E. Poisson, *A Relativists Toolkit* (Cambridge University Press, Cambridge, 2004).
R. M. Wald, *General Relativity* (The University of Chicago Press, Chicago, 1984)