U.G. Physics Syllabus

Fourth Year

Bachelor (with Honour's) / (Honour's with Research) in Physics

Year	Sem.	Code	PAPER TITLE	Theory/Practical/Research Project	Credit	Total
4th Year	VII	RB010701T	Mathematical Physics	Theory	4	20/20 or 16/20
		RB010702T	Atomic and Molecular Physics	Theory	4	
		Choose both theory paper for U.G. (Honours) and any one for U.G. (Honours with Research)				
		RB010703T	Classical Mechanics	Theory	4	
		RB010704T	Statistical Physics	Theory	4	
		RB010705P	Practical	Practical	4	
		RB010706R	Research Project (Allocation) only for U.G. (Honours with Research)		–	
	VIII	RB010801T	Advanced Mathematical Physics	Theory	4	20/24 or 24/24
		RB010802T	Electrodynamics	Theory	4	
		Choose both theory paper for U.G. (Honours) and any one for U.G. (Honours with Research)				
		RB010803T	Nano – Science	Theory	4	
		RB010804T	X-Ray and Laser Physics	Theory	4	
		RB010805P	Practical	Practical	4	
		RB010806R	Research Project (Submission and Evaluation) Only for UG (Honours with Research)	Research Project	8	

Bachelor (With Honour's) in Physics – Paper I[st]

OR

Bachelor (Honour's with Research) in Physics – Paper I[st]

Semester VII – Mathematical Physics

Total Lectures – 45

UNIT 1:- Vector, Vector Space, Gamma and Beta Function

Component of Vector, Product of two or three vector, Gradient of scalar field, Divergence and curl of a vector field, Linear Impedence, Bases, Dimensionality, Inner product definitions, ~~relating~~ Relation between Gamma and Beta Function, Evaluation of definite integral.

Lectures: - 10

UNIT 2:- Matrices

Definition, Matric algebra, The Complex conjugate and the transpose of a product of matrix, square matrices, Singular and non-singular matrices, Inverse of a matrix, Trace of a matrix, Transformation matrices, Diagonalization matrices, Eigen value and Eigen vectors.

Lectures: - 11

UNIT 3 – Differential Equation and special function

Solution of second order linear differential equation with variable coefficient solution by series expansion. Legendre, Bessel and Hermite's equations, Physical applications, Generating functions, Recurrence relations.

Lectures: - 12

UNIT 4 – Numerical Methods

Numerical differentiation and integration, Newton-Cotes formula, error estimates, Gauss method, Random variate, Monte carlo evaluation of integrals, Numerical Solution of ordinary differential equations, Taylor's method, Euler & Runge Kutta Methods.

Lectures: -12

Text and Reference Books:

1. Applied Mathematics for Engineers and Physicists by Pipes & Harvill
2. Mathematical Physics by B.S. Rajput and H. K. Das
3. Mathematical Physics by B.D. Gupta
4. Advanced Engineering Mathematics by E. Kreyszig
5. Mathematical Method for Physicists and Engineers by K.F.Reily, M.P.Hobson and S.J.Bence

Bachelor (With Honour's) in Physics – Paper II[nd]

OR

Bachelor (Honour's with Research) in Physics – Paper II[nd]

Semester VII – Atomic and Molecular Physics

Total lectures: 45

UNIT 1 – Elements of Atomic Spectra:

Vector atom model, States of electron in an atom, Spectroscopic terms and selection rules, Qualitative idea of spin, Spin- orbit interactions and fine spectra, Magnetic moment of an atom, LS and J-J coupling schemes, Lande g-factor, Singlet and triplet states, Spectra of alkaline and alkaline earth elements.

Lectures: 13

UNIT 2 – Effects on Atomic Spectra:

Hyperfine structure of atomic spectra, energy of a magnetic dipole in a magnetic field, Effects of electric and magnetic fields on atomic spectra, Normal and anomalous Zeeman effects, expressions for energy change, Paschen-back effect, Stark effect, Quantum mechanical explanations.

Lectures: 11

UNIT 3 – Elements of Molecular Spectroscopy:

Electronic, vibrational, and rotational states of a molecule, Rotational Spectra of a Diatomic molecule (as a rigid and non-rigid rotator), Isotope Effect, Selection rules, Intensity of Spectral lines of a rotator, Diatomic molecule as harmonic oscillator: Spectra and selection rules, Anharmonicity, rotational-vibration spectra: Salient features, R and P branches.

Lectures: 11

UNIT 4 – Elements of Raman Spectroscopy:

Raman effect and its salient features, Raman's experimental arrangement, Classical and Quantum theory of Raman effect, Stokes lines and Anti-Stokes lines, Pure rotational Raman Spectra, Vibrational Raman spectra, Frank Condon principle, applications of Raman spectroscopy (Qualitative).

Lectures: 10

Text and Reference Books:

1. Elements of spectroscopy by S. L. Gupta and V. Kumar
2. Introduction to atomic spectra by H. E. White

3. Atomic and molecular Spectroscopy by Raj Kumar
4. Molecular Spectroscopy by C. B. Banwell

Bachelor (With Honour's) in Physics – Paper IIIrd

OR

Bachelor (Honour's with Research) in Physics – Paper IIIrd

Semester VII – Classical Mechanics

Total Lectures – 45

Unit – 1

Mechanics of a system of particles, Constraints and their classification, Degrees of freedom, Generalised coordinates, Principles of Virtual work, D' Alembert's principle and Lagranges equation, Generalised potential, Lagrangian for a charge paticle moving in an electromagnetic field (Gyroscopic force), Guage Invariance of the Lagrangian, Applications of Lagrangian formulation.

Lecture:-12

Unit – 2

Generalised momentum, Cyclic coordinates, Hamiltonian function H and conservation of energy (Jacobi's Integral), Hamiltons equations, Example on Hamiltonian dynamics, Hamilton's principle, Derivation of Lagranges equation from Hamilton's Principle, Principle of least action and other forms of principle.

Lecture:-12

Unit – 3

Reduction of two particles, Conservation theorem (First Integral of motion), Motion in a central force field, The Virial theorem, The inverse square law of force (Kepler's problem), General description of scattering cross section, Impact parameter, Scattering angle, Rutherford scattering.

Lecture:-10

Unit – 4

Canonical Transformation, Generating functions, Conditions for canonical Transformation, Examples of canonical transformations, Poisson's Brackets and their properties, Equations of Motion in terms of Poisson's bracket, Lagrange brackets, Relation between Lagrange and Poisson brackets, Liouville's theorem.

Lecture:-11

Text and Reference Books:

1. Classical Mechanics by H. Goldstien, C Poole and J. Safko
2. Classical Mechanics by N. C. Rana and P. S. Joag
3. Classical Mechanics by J. C. Upadhyaya

Bachelor (With Honour's) in Physics – Paper IVth

OR

Bachelor (Honour's with Research) in Physics – Paper IVth

Semester VII – Statistical Physics

Total Lectures – 45

Unit – 1

Phase space, microstates and macrostates. Micro-canonical, canonical and grand-canonical ensembles. Liouville's theorem and its significance, Partition function and distribution function for a microcanonical ensemble. Thermodynamic quantities: temperature, pressure, free energy and thermodynamic potential. Concept of chemical potential, dependence of thermodynamic quantities on number of particles. An ideal gas in microcanonical ensemble. Entropy of an ideal gas using microcanonical Ensemble, Gibb's paradox.

Lecture – 10

Unit – 2

Gibbs canonical distribution and partition function. The Maxwellian distribution. Free energy and partition function. Grand canonical distribution and partition function. Ideal gas in canonical and grand canonical ensemble. Energy fluctuations in canonical and concentration fluctuations in grand canonical ensemble. Boltzmann distribution. The Boltzmann distribution in classical statistics. Free energy and equation of state of an ideal gas. Chemical potential of a monatomic ideal gas.

Lecture - 11

Unit – 3

Postulates of quantum statistical mechanics, Energy states and energy levels, Macrostates and microstates, Thermodynamic probability, the Bose-Einstein statistics, Fermi-Dirac and Maxwell-Boltzmann statistics. The distribution function, the partition function and thermodynamic properties of Bose-einstein, Fermi-Dirac and Maxwell-Boltzmann systems. The statistical interpretation of entropy, the monatomic ideal gas, the distribution of molecular velocities. Ideal Fermi gas, Energy and pressure of Fermi gas, Degenerate electron gas, equation of state, degeneracy temperature, specific heat.

Lecture – 13

Unit – 4

Ideal Bose gas, Derivation of energy and pressure of Boson gas, Degenerate Bose gas, Bose-Einstein condensation, condensation temperature, specific heat, entropy and pressure, black body radiation and Planck's Radiation law, First- and second-order phase transitions.

Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

Lecture – 11

Text and Reference Books:

1. Statistical and Thermal Physics by F. Reif
2. Statistical Mechanics by K. Huang
3. Statistical Mechanics by R. K. Pathria
4. Statistical Mechanics by R. Kubo
5. Statistical Physics by Landau and Lifshitz
6. Statistical Mechanics and properties of matter: theory and applications by E.S.R. Gopal

Bachelor (With Honour's) in Physics

OR

Bachelor (Honour's with Research) in Physics

Semester VII

List of Practical

1. To determine the value of Planck's constant using photocell.
2. To determine the wavelengths of sodium D_1 and D_2 lines using spectrometer.
3. To study the Balmer lines of the hydrogen spectrum using spectrometer.
4. To study the Iodine spectrum using spectrometer.
5. To analyze the mercury spectrum using spectrometer.
6. To study the Zeeman effect.
7. To analyze the elliptically polarized light by using Babinet compensator.

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Bachelor (With Honour's) in Physics – Paper I^{st}

OR

Bachelor (Honour's with Research) in Physics – Paper I^{st}

Semester VIII – Advanced Mathematical Physics

Total Lectures – 45

UNIT 1:- Group and Theorems.

Definition of Group, Group table, Sub Group, Lagrange's theorem, Classes, Complexes, Conjugate subgroup, Cayley theorem, Group representation Unitarity theorem, Schur's lemma theorem, Equivanlence theorem, Unitary group, Point group.

Lecture: -10

UNIT 2:- Applications of Laplace Transform

Integral Transforms, Laplace Transform, First and second order shifting theorems, Inverse LT by partial function, LT of derivative and integral of a function, Fourier series, FS arbitrary period, Half-wave expansion, Partial sums, Fourier integral and transforms, FT of delta functions.

Lecture: - 11

UNIT 3 – Numerical Methods

Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions, Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative method, matrix inversion, Eigenvalues and eigen vectors of matrices.

Lecture: - 12

UNIT 4 – Complex Variable

Function of complex variable, Cauchy-Riemann conditions for analytic function, [Singular functions: Poles and branch points, order of singularity, branch cuts,] Cauchy's integral theorem, Laurent's series, Residues, Cauchy residue theorem, Evaluation of definite integrals..

Lecture: -12

Text and Reference Books:

1. Applied Mathematics for Engineers and Physicists by Pipes & Harvill.
2. Mathematical Physics by B.S. Rajput.
3. Mathematical Physics by B.D. Gupta.

Bachelor (With Honour's) in Physics – Paper IInd

OR

Bachelor (Honour's with Research) in Physics – Paper IInd

Semester VIII – Electrodynamics

Total Lectures – 45

UNIT 1 – Relativistic Electrodynamics:

Transformation of differential operator, Invariance of D' Alembertian Operator, Ninkowski Force, Geometrical interpretation of Lorentz Transformations of Space and Time, Transformation of electromagnetic potentials, Lorentz transformation of Electromagnetic potentials, Lorentz transformation of Electric and Magnetic fields.

Lecture – 12

UNIT 2 – Electrodynamics of a moving and radiating system:

Lienard – Wiechert Potentials, The electromagnetic fields from Lienard – Weichert Potentials of a moving charge, The electromagnetic Fields produced by a charge in uniform and accelerated motion, Reaction force of radiation, Radiated Power, Angular distribution of radiation due to accelerated charge, Bremsstrahlung Radiation.

Lecture – 10

UNIT 3 – Maxwell's Equation and Electromagnetic Waves:

Equation of Continuity, Maxwell's Postulate, Physical Interpretation of Maxwell's Postulate, Maxwell's equation and their empirical bases, Derivation of Maxwell's Equation, Physical significance of Maxwell's equation, Electromagnetic Energy and Poynting theorem, Poynting Vector, The wave equation, Plane electromagnetic waves in free space, Plane electromagnetic waves in isotropic and anisotropic non – conducting medium, Scalar and Vector Potentials.

Lecture – 11

UNIT 4 – Applications of Electromagnetic Waves:

Boundary conditions at the surface of discontinuity, Reflection and Refraction of electromagnetic waves at the interface of non – conducting medium, Fresnel's equation, Verification of Fresnel's equation, Scattering and it's parameters, Theory of Scattering of electromagnetic waves, Polarization of Scattered light.

Lecture – 12

Text and Reference Books:

- Classical Electrodynamics – J. D. Jackson, John Willey

2. Electrodynamics – D. J. Griffits, Prentice Hall of India, New Delhi.
3. Electrodynamics – Gupta Kumar, G. Singh.
4. Electromagnetic Theory and Electrodynamics – Satya Prakash

Bachelor (With Honour's) in Physics – Paper III[rd]

OR

Bachelor (Honour's with Research) in Physics – Paper III[rd]

Semester VIII – Nano-Science

Total Lectures – 45

Unit 1 – Introduction to Nanoscience

Background of Nanoscience and Nanotechnology, Definition of Nanoscience and Nanotechnology, Surface to volume ratio and its consequences, Quantum confinement and its consequences, size dependence of properties (electrical, optical, mechanical, magnetic and other physical and chemical properties like surface energy, melting point depression, reactivity and catalysis), Quantum dots, Quantum wires, and Quantum wells, Band Structure and Density of States at Nanoscale, Electronic structure from bulk to quantum dot.

Lecture:-10

Unit 2 – Synthesis of Nano-materials

Key issues in the synthesis of Nano-materials, Different approaches of synthesis, Top-down and Bottom-up approaches, UV-lithography, e-beam lithography, Ball milling, Physical vapour deposition, e-beam deposition, Sputtering, Pulsed Laser Deposition, Cluster beam deposition, Chemical vapour deposition, Electrodeposition, Co-precipitation technique, Sol-gel Technique and Solid- state reaction technique.

Lecture:-12

Unit 3 – Characterisation of Nano materials

X-ray diffractometer, Scherrer's formula, effect of strain on XRD peaks, UV-Vis single and dual beam spectrophotometer, shift in absorption spectra, Photoluminescence spectrometer, shift in photoluminescence peaks, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Scanning Tunnelling Microscope (STM) and Atomic Force Microscope (AFM), X-Ray Photoelectron Spectroscopy (XPS) and Raman spectroscopy.

Lecture:-12

Unit 4 – Applications of Nano-materials

Transistors, sensors, and flexible electronics, Nanofluids, antibacterial coatings, self-cleaning coatings, Nanotextiles, batteries, super capacitors, fuel cells and solar cells, hydrogen storage nanomedicine, and drug delivery: targeted drug delivery, quantum dot heterostructure lasers, all optical switching and optical data storage, other emerging areas and future trends in nanoscience and technology, Ethical considerations and potential risks associated with nanotechnology.

Lecture:-11

Text and Reference Books:

1. Nanostructures and Nano-materials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.

2. Introduction to Nanotechnology by Charles P. Poole, Jr. Frank J. Owens, John Wiley & Sons Inc. Publication.

3. Quantum Wells, Wires and Dots by Paul Harrison, John Wiley Sons Ltd.

4. Quantum Dot Heterostructures by D. Bimberg, M. Grundman, N.N. Lendenstov.

5. Introduction to Nanoscience and Nanotechnology by Hornyak G. L., Tibbals H. F., Dutta J., Moore J. J., CRC Press.

Bachelor (With Honour's) in Physics – Paper IVth

OR

Bachelor (Honour's with Research) in Physics – Paper IVth

Semester VIII – X-Rays and Laser Physics

Total Lectures: 45

UNIT 1 – X-Rays Fundamental:

X-Rays: Origin, production and properties, energy spectrum, Continuous and characteristics X-Ray spectra, Moseley's Law, Emission and Absorption of X-Ray spectra, Fine structure, theory and energy level diagram, relative intensities of X-ray lines.

Lectures: 13

UNIT 2 – X-Ray Spectroscopy

Detection of X-rays: photographic and electronic detectors, soft X-ray spectroscopy and valence band spectra, Qualitative idea of the techniques XPS, AES, EXAFS and XANES and their applications in material characterization.

Lectures: 10

UNIT 3 – Elements of Laser Spectroscopy:

Spontaneous and stimulated emission, Einstein's coefficients, Principle of Laser emission, Properties of Laser emission, Laser action, Injection Laser threshold current, Semiconductor Laser, Argon Laser, Liquid Laser, Dye Laser, and Free electron Laser.

Lectures: 11

UNIT 4 – Applications of Laser Spectroscopy

Laser induced fluorescence (LIF) and its applications, Qualitative idea of Laser Raman spectroscopy (SRS, SERS). Applications of SRS and SERS in material science and chemistry.

Lectures: 11

Text and Reference Books:

1. Elements of spectroscopy by S. L. Gupta and V. Kumar
2. Introduction to atomic spectra by H. E. White
3. Atomic and molecular Spectroscopy by Raj Kumar
4. Laser physics and applications by L. V. Tarasov
5. Laser Physics and Technology by P. K. Gupta and R. Khare

Bachelor (With Honour's) in Physics

OR

Bachelor (Honour's with Research) in Physics

Semester VIII

List of Practical

1. To determine the wavelength of a laser beam using plane diffraction grating.
2. To determine the angular spread of laser beam.
3. To study the B-H curve.
4. Synthesis of nanoparticles by chemical route.
5. To study the first and second order passive filters.
6. To study the first and second order active filters.
7. Analysis of the given XRD pattern of nanostructured substance.

PG Physics Course

Sem	Paper code	Nature	Title	Theory/practical /Research Project	Credit
IX	RB010901T	Compulsory 1	Quantum Physics	Theory	4
	RB010902T	Compulsory 2	Nuclear Physics-I	Theory	4
		Optional	**Optional (Specialization)**	Theory	-
	RB010903aT	Optional Paper 3(a)	Advanced Electronics-I		4 or
	RB010903bT	Optional Paper 3(b)	Condensed Matter Physics-I		4
	RB010904P	Compulsory 4	Specialization Lab	Practical	4
	RB010905R	Compulsory 5	Research Project (Allocation)	Research Project	-
X	RB011001T	Compulsory 1	Advanced Quantum Physics	Theory	4
	RB011002T	Compulsory 2	Nuclear Physics-II	Theory	4
		Optional	**Optional (Specialization)**	Theory	-
	RB011003aT	Optional Paper 3(a)	Advanced Electronics-II		4 or
	RB011003bT	Optional Paper 3(b)	Condensed Matter Physics-II		4
	RB011004P	Compulsory 4	Specialization Lab	Practical	4
	RB011005R	Compulsory 5	Research Project (Evaluation)	Research Project	8

M.Sc. Physics – Paper 1st
Semester IX – Quantum Physics

UNIT 1 **Total Lectures:- 45**

Linear operators, Null operator, Identity operator, Singular and Non-singular operator, Eigen functions and Eigen values orthogonal eigen functions, The operator formalism in quantum mechanics, Momentum operator, Hamiltonian operator, commutation in operators, Hermitian operator, Properties of Hermitian operator, Parity operator, Postulates of quantum mechanics, coordinate and momentum representation, superposition of eigen states, continuous spectrum, Equation of motion, Ehrenfest's theorem, simultaneous measurements and commuting operators, Schwartz inequality, Heisenberg uncertainty relation derived from operator, commutator algebra.

UNIT 2 **Lectures:- 12**

Angular momentum operator, Commutation relation for Lx, Ly and Lz, Ladder operators, Completeness of eigen functions, Dirac-delta function, bra and ket notation, Matrix representation of an operator, Unitary transformation, The Schrodinger equation for spherically symmetric potentials, Degeneracy, Hydrogen atom, Radial equation, Eigen value, Radial Probability.

UNIT 3 **Lectures:- 11**

Stationary perturbation theory, Non-degenerate case, First order perturbation, second order perturbation, Perturbation of an oscillator, Helium atom, Degenerate case, Removal of degeneracy in first and second order, First order Stark effect in hydrogen, Weak field Zeeman effect, The variational method, Expectation value of the energy, Ground state of Helium, Exchange degeneracy, Heitler-London theory of hydrogen molecule, W K B method and its applications.

UNIT 4 **Lectures:- 12**

Scattering cross-section, Relation between angles, energies, etc. in laboratory and centre of mass system of co-ordinates, Normalisation of incoming wave, Differential scattering cross-section, Partial waves and phase shifts, Born approximation and its validity condition, Study of scattering from a square well potential.

Lectures:- 10

Text and Reference Books :

1. Quantum Mechanics by Satya Prakash & C.K. Singh
2. Advance Quantum Mechanics by B.S. Rajput
3. Quantum Mechanics by L.I. Schiff

M.Sc. Physics – Paper 2nd
Semester IX – Nuclear Physics 1

Total Lectures:- 45

Unit-I

Theories of nuclear composition: Proton- electron theory, Proton-neutron theory; Nuclear shape and size: charge distribution, mass distribution; Nuclear Instability; Importance of binding energy; Nuclear density; Spin angular momentum; Nuclear spin (total angular momentum); Parity; Nuclear dipole and electric quadrupole moments; Isobaric spin concept.

Lectures:- 12

Unit-II

Properties and simple theory of deuteron in ground state; Magnetic dipole and quadrupole moments of deuteron; Scattering cross section; Neutron-proton scattering at low energy; S-wave effective range theory; Proton- proton scattering at low energy; Properties of nuclear forces (Spin dependence, Saturation properties, tensor component, charge symmetry and charge dependence); Exchange force model.

Lectures:- 12

Unit-III

Experimental evidences of Shell structure in nuclei; Extreme single particle shell model; Spin orbit interaction and prediction of magic numbers; Prediction of angular momentum, parity, magnetic moment and electric quadrupole moment; The limitations of the model.

Lectures:- 11

Unit-IV

Types of reactions and conservation laws; Energetics of nuclear reactions; Reaction cross section; Partial wave method of calculating cross section; Elementary idea of compound and direct reactions.

Lectures:- 10

Text and Reference Books:

1. Theory of Nuclear Structure by M.K. Pal (Affiliated east-West Press).
2. Introductory Nuclear Physics by Kenneth S. Krane (John Willy & Sons).
3. Nuclear Physics: An Introduction by W.E. Burcham, F. R. S. (Longmans).
4. Nuclear Physics by S. N. Ghoshal (S. Chand & Company LTD.).

M.Sc. Physics – Paper 3(a)
Semester IX – Advanced Electronics-I

Total Lecture - 45

Unit I: Integrated Circuits: An Overview

Classification and fabrication of ICs, Materials and processing , ideas of crystal growth, wafer preparation, oxidation & diffusion, photolithography and etching, connections & packing.

Lecture - 9

Unit II: Operational Amplifier: Basic & Application

Op-Amp: Characteristics, parameters, Inverting and Non-Inverting amplifiers, Op-Amp in Analog computation: Adder, Subtract, Integrator, Differentiator Voltage follower, Divider, log and anti-log amplifier.

Lecture - 8

Unit III: Op-Amp in Active Filters and Signal Translation

Active Filters: Low pass, High pass, Band pass, Band rejects filter (1st order only), Comparators, Wave shape generator, Schmitt trigger, Voltage Controlled Oscillator (VCO), Phase Locked Loop (PLL), A/D &D/A convertor, 555 timer.

Lecture - 14

Unit IV: Multi-Vibrator, Register & Memory

Multi-vibrator: Astable, Mono-stable and Bistable, Counters: Synchronous & Asynchronous, Ring & Mod, Serial and Parallel shift register, Semiconductor memory: RAM , ROM and EPROM.

Lecture - 14

Text and Reference Books:

1. Op-Amp and liner Integrated Circuits – R.A. Gayakward (PHI)
2. Op-Amp and liner Integrated Circuits – Coughlin and Driscall (PHI)
3. Integrated Electronics- Millman & Halkies (THL)
4. Principle of Electronics – V.K. Mehta (S Chand)
5. Digital Principles and Circuits- C.B. Agrawal (Himalaya pub.)
6. Modern Digital Electronics- R.P. Jain (Mc Graw Hill)

M.Sc. Physics-Paper 3(b)

Semester IX — Condensed Matter Physics-I

Total Lectures: - 45

UNIT 1 — Crystalline solids and Crystal symmetry

Crystalline solids, direct and reciprocal lattice, Bragg's law, x-rays diffraction, X-ray diffraction methods: the Laue, powder and rotating crystal methods. Determination of lattice parameters, Symmetry elements of crystals: rotation, reflection, translation, inversion, roto-inversion, roto-reflection. Point group and space group, symmetry and physical properties of solids.

Lectures: - 14

UNIT 2 — Defects and Imperfections in crystals:

Point defects, line defects, stacking faults, role of dislocations in crystal growth, influence of defects on the physical properties of solids, stress and strain fields, elastic energy of dislocation, dislocation in fcc, bcc, and hcp lattices.

Lectures: - 11

UNIT 3 — Lattice dynamics and optical properties of solids

Dispersion relation of diatomic lattice, optical phonons and dielectric constant, in-elastic neutron scattering, Debye-Waller factor, thermal expansion and thermal conductivity, Interaction of electrons and phonons with photons, polaritons, optical properties of metals, polarons.

Lectures: - 10

UNIT 4 — Electronic and quantum electronic properties of solids

Electrons in a periodic lattice, Bloch theorem, Kronig-Penney Model, Band theory of solids, classification of solids, effective mass, magneto-resistance, metal-insulator transition, Mott-insulator, quantum electronic transport, quantum and integral Hall effect.

Lectures: - 10

Text and Reference Books:

1 Introduction to solid state physics by Charles Kittle.
2 Solid state physics by S. O. Pillai
3 Introduction of Solids by L.V. Azaroff
4 Solid State Physics by N.W. Ashcroft and N.D. Mermin.
5 Crystallography Applied to Solid State Physics by A.R. Verma and O.N. Srivastava
6 Solid State Physics-Structure and Properties of Materials by M.A. Wahab
7. Elements of Solid State Physics by J. P. Srivastava

List of Practical in Advanced Electronics – I

Semester – IX

1. Logic Gates and their combination.
2. Half and Full Adder.
3. Half and Full Subtractor.
4. RS Flip Flop.
5. JK Flip Flop.
6. D – Latch.
7. Study of Op-Amp Characteristics.
8. Schmitt Trigger.

List of Practical Condensed matter Physics -I
For Semester IX

1. Measurement of lattice parameters and indexing of power photographs.
2. Interpretation of transmission Laue photography.
3. Determination of orientation of a crystal by back reflection Laue method.
4. Ratation/oscillation photogrphs and their interpretation.
5. To study the modulus of rigidity and internal friction in metals as a function of temperature.
6. To measure the cleavage step height of a crystal by multiple Fizeaue fringes.
7. To obtain multiple beam Fringers of equal chromatic order.
8. To determine magnetoresistance of a Bismuth crystal as a function of magnetic field.

M.Sc. Physics – Paper 1st
Semester X – Advanced Quantum Physics

UNIT 1 **Total Lectures:- 45**

Time dependent Perturbation Theory, First order perturbation, Harmonic perturbation Transition probabilities, Fermi Golden rule, Dipole approximation, Second order perturbation,

Lectures:- 11

UNIT 2

Physical meaning of identity, Distinguishability of identical particles, Symmetric and Antisymmetric wave functions, Construction from unsymmetrised function, Connection of spin and statistics, collision of identical particles with spin, Pauli Spin matrices.

Lectures:- 12

UNIT 3

Schrodinger relativistic equation for free particles (Klein-Gordan Equation), Dirac relativistic equation, Free particle equation, Properties of Dirac matrices, Free particles solutions, Electron spin, Magnetic moment, Dirac equation of a central field of force, Spin-Orbit coupling. Solution for hydrogen atom. Negative energy states.

Lectures:- 12

UNIT 4

Formulation in terms of transition probability, Matrix elements of the perturbation, Transition probability for absorption, Transition probability for emission, Einstein coefficients, Einstein transition probability for absorption and emission.

Lectures:- 10

Text and Reference Books :

1. Quantum Mechanics by Satya Prakash & C.K. Singh
2. Advance Quantum Mechanics by B.S. Rajput
3. Quantum Mechanics by L.I. Schiff

M.Sc. Physics – Paper 2nd
Semester X – Nuclear Physics II

Unit-I **Total Lectures:- 45**

Basic α- decay process & its systematic, Experimental information on α- decay (dependence of α-decay on mass number, energy-lifetime relationships, long range α-particles, fine structure of α- particles spectra), Theory of α- emission.

Lectures:- 11

Unit-II

Basic β- decay process; Energy released in β- decay; Shape of β- ray spectra; Neutrinos and antineutrinos; Fermi theory of β- decay; Kurie plots and the neutrino mass; Angular momentum and parity selection rule; Comparative half lives and forbidden decays.

Lectures:- 12.

Unit-III

Energetic of γ- decay, Classical electromagnetic radiations and their quantum mechanical approach, Angular momentum and parity selection rule, Life times for γ-emission, Zero-zero transition, nuclear isomerism, Internal conversion.

Lectures:- 10

Unit-IV

Fundamental interactions, Classification of elementary particles on the basis of interactions and their quantum numbers, Symmetry and classification of elementary particles, Gellmann-Nishijima formula, CPT invariance, CP violation in K- decay, Quark model, colored quarks and gluons.

Lectures:- 12

Text and Reference Books:

1. Introductory Nuclear Physics by Kenneth S. Krane (John Willy & Sons).
2. Introductory Nuclear Physics by Smauel S. M. Wong (Wily-VCH, Second Edition)
3. Nuclear and Particle Physics: An Introduction by Brian R Maritn (John Willy & Sons).
4. Nuclear Physics by S. N. Ghoshal (S. Chand & Company LTD).

M.Sc. Physics – Paper 3(a)
Semester X – Advanced Electronics-II

Total Lecture - 45

Unit I: Analog Communication

Amplitude Modulation, Modulation and Demodulation Techniques, Frequency Modulation: Narrow band and wide band, PLL as Frequency demodulator, Phase modulation, Equivalence between AM, FM & PM modulation.

Lecture - 8

Unit II: Digital Communication

Sampling and quantization, Pulse Code Modulation, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Differential Phase Shift Keying (DPSK), Frequency Division and Time Division multiplexing.

Lecture - 12

Unit III: Satellite and Radar Communication

Satellite orbit, Satellite frequencies, Synchronous Satellite, Satellite Communication, Transponders, Basic radar system, Pulsed radar, Moving target radar, CW radar, Radar cross-section, Radar display, PPI Duplexer radar antenna, Modern radar.

Lecture - 13

Unit IV: Microwave and Antenna System

Generation of microwave by Reflex Klystron and Semiconductor gun diode, Wave-guide and Cavity resonator, Microwave antenna, Microwave Detector: VSWR, Power and Dielectric measurement, Isolated, Directional Coupler, Magic Tee, Short electric doublets, Radiation from one pole and dipole aerials, Antenna Parameters, Antenna arrays, Folded dipole application, Yagi Antenna, Parabolic Reflectors.

Lecture - 13

Text and Reference Books:

1. Electronic Communication Systems by Geoge Kennedy, Brendas Davis, Srm Prasanna, McGraw Hill Education.
2. Hand Book of Electronics by S. L. Gupta, V. Kumar, Pragati Prakashan Meerut.
3. Microwave Electronics by Andrey D. Grigoriev, Vyacheslav A. Ivanov, Springer Publishers.

M.Sc. Physics-Paper 3(b)
Semester X — Condensed Matter Physics-II

Total Lectures: - 45

UNIT 1 — Magnetic Properties and superconductivity

Magnetism in materials: Dia, Para and Ferromagnetism, Weiss theory of ferromagnetism: spin waves, magnons, Domain and Bloch wall, Curie-Weiss law, Superconductivity, energy gap, critical temperature, persistent currents, Meissner effect, Cooper pairing due to phonons, BCS theory of Superconductivity, Ginzburg-Landau theory, DC Josephson effect, ac Josephson effect.

Lectures: - 15

UNIT 2 - Electron gas in solids

Electron gas in 1-D and 2-D systems, interacting electron gas: Hartee and Hartee-Fock approximations. Correlation energy, Screening, Plasma Oscillations. Strongly-interacting Fermi system. Elementary introduction to Landau's quasi-particle theory of a Fermi liquid.

Lectures: - 10

UNIT 3 - Disordered systems

Point defects: Shallow impurity of states in semiconductors. Localized lattice vibrational states in solids, vacancies, interstitials, and colour centres in ionic crystals. Disorder in condensed matter, substitutional, positional, and topographical disorder, short- and long-range order, atomic correlation function and structural descriptions of glasses and liquids, Anderson model for random systems and electron localization, mobility edge.

Lectures: - 12

UNIT 4 - Thin films

Thin film and ultrathin films, conditions for accurate determination of step height and film thickness (Fizeau fringes), Nucleation and growth of thin films, Film growth models, Electrical conductivity of thin films, comparing the behaviour of thin films from their bulk counterpart, Boltzmann transport equation for a thin film (for diffused scattering), expression for electrical conductivity for thin films.

Lectures: - 12

Text and Reference Books:

1. Introduction to solid state physics by Charles Kittle.
2. Principles of Condensed Matter Physics by P. M. Chaikin and T. C. Lubensky
3. Solid State Physics-Structure and Properties of Materials by M. A. Wahab
4. Physics of Surfaces and Interfaces by Harald Ibach
5. Solid state physics by S. O. Pillai
6. Elements of Solid State Physics, by J. P. Srivastava

List of Practical in Advanced Electronics – II

Semester – X

1. Amplitude Modulation and Demodulation.
2. Frequency Modulation and Demodulation.
3. Study of Analog to Digital Converter.
4. Study of Digital to Analog Converter.
5. Study of ASK, FSK and PSK.
6. Study of V–I Characteristics of Gun Diode.
7. Study of generation of Microwave and klystron tube.
8. Study of Multivibrator.
9. Study of 555 – timer.

List of Practical Condensed matter Physics –II
For Semester X

1. Conductivity of Germanium in Vander Pauw Geometry.
2. Magneto-resistance of Ge
3. Four-probe method
4. Hall effect
5. Study of Fluorescence matrials
6. Study of Ferromagnetic materials.
7. Study of Superconducting materials.
8. Measurement of magnetic susceptibility.