M.Sc. PHYSICS (I Semester): MATHEMATICAL PHYSICS

Unit 1. Polynomials- Legendre, Hermite and Laguerre polynomials and their generating functions. Recurrence relations and special properties of $P_n(x)$ as solution of Legendre
differential equation, Rodrigues formula, orthogonality of $P_n(x)$, associated Legendre polynomials (Introdution only).

Unit 2. Bessel function of first kind, generating function, recurrence relations, $J_n(x)$ as solution of Bessel differential equation, Expansion of $J_n(x)$ when n is half and odd integer, Integral representation.

Unit 3. Complex Variable: Function of a complex variable, Cauchy Riemann conditions, Cauchy's integral theorem (without proof), Cauchy's integral formula, Cauchy's Residue theorem, singular points and evaluation of definite integrals of the type

$\int_0^{2\pi} f(\sin\theta, \cos\theta)d\theta$, $\int_{-\infty}^{\infty} f(x)\, dx$, $\int_{-\infty}^{\infty} f(x)\, e^{iax}dx$

Unit 4. Integral Transforms: Laplace Transform, First and second shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of a function, Solution of initial value problems by using LT,

Unit 5. Fourier Series and Fourier Transform: Fourier series, Half range expansion, Arbitrary period, Fourier integral and transforms, FT of delta and Gaussian function.

Text and References Books

Mathematical method for Physics by G. Arfken

Advanced Engineering Mathematics by E.Kreyszig

Special Functions by E.D Rainville

Special Functions by W.W Bell

Functions of complex variable by R.V.Churchill

Mathematical Method for Physicists and Engineers by K.F.Reily, M.P.Hobson and S.J.Bence

M.Sc. PHYSICS (I Semester): CLASSICAL MECHANICS

Unit 1. Preliminaries: Newtonnian mechanics of one and many particle systems, Simple Pendulum with rigid support,Two connected masses with string passing over a pully, Virtual work,Rolling mass inside or outside a circular ring, Constraints; their classification, D'Alembert's principle, generalized coordinates.

Unit 2. Hamilton's principle: Derivation of Lagrange's equation from Hamilton's principle, advantages of variational principle formulation, Principle of least action.

Unit 3. Two body central force problem: Motion in a central force field, The virial theorem, The inverse square law of force, The motion in central force in the Kepler problem.

Unit 4. Hamiltonian equations of motion: Legendre transformations and Hamilton equations of motion, Cyclic coordinates and conservation theorem, Canonical transformation generating functions, Properties, Poisson bracket, Poisson theorem, Relation of Poisson brackets . Hamilton Jacobi method

Unit 5. Small oscillations: Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates.

Text and Reference Books

H. Goldstein : Classical Mechanics
N.C. Rana and P.S. Joag : Classical Mechanics
A. Sommerfiel : Mechanics
Perceival and D. Richards: Introdution to Dynamics

M.Sc. PHYSICS (I Semester): QUANTUM MECHANICS- I

Unit 1. Wave Mechanics: Dual nature of matter and radiation, Schrodinger equation, Principle of superposition, Motion of wave packets, Uncentainty principle, Fundamental postulates of wave mechanics, Eigenvalues and eigenvectors, Probabilistic interpretation, normalization of bound and continuum state wave functions, Expectation values of dynamical variables, Coordinate and momentum representation, Hermitian operator, Commutator algebra and uncertainty relation, Three dimensional potential well and Hydrogen atom.

Unit 2. Representation and Transformations: State vectors, Hilbert Space, Dirac notations, Dynamical and linear operators in matrix form, Linear harmonic oscillator in matrix formulation, Space and time displacements, Rotation generators, Transformations of dynamical variables, Symmetry and conservation laws.

Unit 3. Approximate Methods: Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method and its application for Helium atom. Stark effect, Dipole polarizability of ground state Hydrogen atom, Zeeman Effect.

Unit 4. Angular momentum: Commutation relations involving angular momentum operators, the eigenvalue spectrum, Matrix representation of **J** , Addition of angular momentum, Clebsch- Gordon coefficients, Spin angular momentum, Spin wave functions, Addition of spin and orbital angular momentum.

Unit 5. Identical Particles: Symmetric and anti- symmetric wave functions and construction from unsymmetrised wave functions, distinguishbility of identical particles, The exclusion principle.

Text and References Books

A text book of Quantum Mechanics by P.M. Mathews and K. Venkatesan
Introduction to Quantum Mechanics by E. Merzbacher
Quantum Mechanics by S. Gasiorowicz
Quantum Mechanics by L.I. Schiff
Modern Physics by S.P. Khare

M.Sc. PHYSICS (I Semester): ELECTRONIC DEVICES

Unit 1. Conduction Mechanism in Metals: Mobility and conductivity, Bound and free electrons, Enery distribution of electrons, Fermi level, The density of states, Thermionic emission.

Unit 2. Conduction Mechanism in Semiconductors: Direct and indirect semiconductors, charge carriers concentrations, Drift of carriers in electric and magnetic fields, Diffusion of carriers, The contact potential.

Unit 3. Semiconductor-diode characteristics: Qualitative theory of P-N junction, Space charge at a junction, Forward and reverse bias junctions, Reverse bias breakdown, Zener diode.

Unit 4 . Bipolar Junction Transistors: Transistor current components, CB, CE, CC configurations, Input output characteristics, Early Effect, Graphical analysis of the CE configuration, Transistor hybrid model, h parameters, Analysis of a Transistor amplifier circuit using h parameters, Measurement and graphical determination of h parameters, Hybrid π model, The r_e transistor model, Ebers-Moll model,Transistor biasing and thermal stabilization, The operating point, Bias stability.

Unit 5. Field Effect Transistors: Construction and characteristics of JFET, transfer characteristic, The FET small signal model, Measurement of g_m and r_d, JFET fixed bias, Self bias and voltage divider configurations, Use of FET as voltage controlled resistor, JFET source-follower (common-Drain) configuration, JFET Common – Gate configuration, Depletion and enhancement type MOSFETs.

Text and Reference Books

Solid State Electronic Devices by B.G. Streetman
Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
Integrated Electronics by J. Millman and C.C. Halkias
Introduction to Semiconductor Devices by M. S. Tyagi
Electronic Devices and Circuits by Balbir Kumar and S.B. Jain

M.Sc. PHYSICS (II Semester): QUANTUM MECHANICS- II

Unit 1. Time dependent Perturbation Theory : First order perturbation, Interation of an atom with electromagnetic field, Transition probabilities, Fermi Golden rule, Dipole approximation.

Unit 2. Induced and Spontaneous radiations: Einstein A and B coefficients, Induced and spontaneous emissions of radiations, their applications in the construction of gas and solid lasers.

Unit 3. Quantum Theory of Radiation: Classical radiation field, Fourier decomposition and radiation oscillators, Creation, annihilation and number operators, Photon states, Quantized radiation field, Basic matrix elements for emission and absorption, Spontaneous emission in the dipole approximation, Plank's radiation law.

Unit 4. Relativistic Equations: Klein-Gordon equation and its plane wave solution, Probility density in KG theory, Difficulties in KG equation, Dirac equation for a free electron, Dirac matrices and spinors, Plane wave solutions, Charge and current densities, Existence of spin and magnetic moment from Dirac equation of electron in an electromagnetic field.

Unit 5. Dirac Equation: Dirac equation for central field with spin orbit intraction, Energy levels of Hydrogen atom from the solution of Dirac equation, Covariant form of Dirac equation.

Text and Reference Books

Quantum Mechanics by L.I. Schiff
Modern Quantum Mechanics by J.J. Sakurai
A Text Book of Quantum Mechanics by P.M. Mathews and K.Venkatesan
Quantum Mechanics by A. P. Messiah

M.Sc. PHYSICS (II Semester): STATISTICAL MECHANICS

Unit 1. Foundation of Statistical Mechanics & Ensembles: Phase space, concept of Ensemble, Ensemble average, Liouville's theorem, equation of motion and Liouville's theorem, Canonical Ensemble, Microcanonical Ensemble, Grand Canonical Ensemble, partition functions.

Unit 2. Statistical Quantities: Calculation of statistical quantities, Energy and density fluctuations, Entropy of an ideal gas using microcanonical Ensemble, Gibb's paradox, Sackur-Tetrode equation.

Unit 3. Postulates of quantum statistical mechanics, Density matrix, Statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi- Dirac and Bose- Einstein Statistics, properties of ideal Bose and Fermi gases, Bose- Einstein condensation.

Unit 4. Cluster expansion for a classical gas, virial equation of state, ising model, mean-field theories of the ising model in three, two and one dimentions, Exact solutions in one-dimention. Landau theory of phase transition, critical indices, scale transformation and dimentional analysis.

Unit 5. Fluctuations: Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, fluctuation dissipation theorem, The Fokker-Plank equation.

Text and Reference Books

Statistical and Thermal Physics by F. Reif
Statistical Mechanics by K. Huang
Statistical Mechanics by R. K. Pathria
Statistical Mechanics by R. Kubo
Statistical Physics by Landau and Lifshitz
Statistical Mechanics and properties of matter, theory and application by E.S.R. Gopal

M.Sc.PHYSICS (II Semester): ATOMIC AND MOLECULAR PHYSICS

Atomic Physics:

Unit 1 . Quantum Mechanical Treatment of one-electron Atom, Spin-Orbit interaction and fine structure of hydrogen atom, Spectra of alkali elements. Singlet and triplet States of Helium,

Unit 2 . Many electron atoms: Central field approximation, Thomas-Fermi field, Atomic wave function, Hartree and Hartree –Fock approximations, Spectroscopic Terms: L S and J J coupling schemes for many electron atoms, wavefunctions and energies of multiplets., Electric dipole and Electric Quadrupole.

Molecular Physics:

Unit 3. Born - Oppenheimer approximation, Heitler-London theory of H_2, LACO treatment of H_2^+ and H_2 .Classification of Molecules,Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Selection rules , Nuclear spin and intensity alternation , Isotope effect, Classification of electronic states , Coupling of rotational and electronic motions, Electronic spectra: Franck-Condon principle.

Unit 4. Infrared Spectroscopy,Raman spectroscopy, Photoelectron Spectroscopy, Nuclear Magnetic Resonace , Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).

Spectroscopic Techniques:

Unit 5. General description and working of infra-red Spectrophotometer, Photoelectron Spectrometer, Simple Raman Spectrometer, NMR Spectrometer and ESR Spectrometer.

Text and Reference Books

Introduction to atomic spectra by H.E. White
Spectra of diatomic molecules by Herzberg
Atoms and molecules by M. Weissbluth
Quantum theory of Atomic Structure Vol I by Slater
Quantum theory of molecules and Solids by Slater
Fundamentals of molecular spectroscopy by C.B.Banwell
Introduction to molecular spectroscopy by G.M.Barrow
Molecular spectroscopy by Jeanne L.McHale
Molecular spectroscopy by J.M.Brown
Spectra of atoms and molecules by P.F. Bemath
Modern spectroscopy by J.M. Holias

M.Sc.PHYSICS (IISemester): ELECTRODYNAMICS & PLASMA PHYSICS

Unit 1. Electrostatics: Electrostatic field **E** due to a charge distribution, Values of div E curl E, scalar potential Φ, Poisson's and Laplace's equations, Electrostatic potential energy and energy density, Dielectrics, displacement vector **D ,** electrostatic energy in dielectric media, formal solution of boundary value problems with Green function; Methods of images, point charge near an infinite conducting plane, Point charge in the presence of grounded conducting sphere, Point charge in presence of charged insulated sphere, Conducting sphere in uniform electric field.

Unit 2. Magneticstatics: Magnetic induction **B** due to current distribution, Equation of continuity, div **B** and curl **B ,** Vector potential **A**, Macroscopic equations, Magnetization **M** and magnetic field **H.**

Unit 3. Time- Varying Fields: Faraday's law of induction, Energy in the magnetic field, Maxwell's displacement current, Maxwell's equations, Maxwell's equations in terms of vector and scalar potentials, Poyntings theorem, Relativistic properties of **E** and **H** and covariance of Maxwell's equations, Lienard- Wiechert potentials due to a point charge, Electric and magnetic fields produced by a charged particle in uniform and arbitrary motion, Power radiated by an accelerated charge, Larmor's formula and its relativistic generalization and angular distribution of radiation from a charged particle with co-linear velocity and acceleration, Synchrotron radiation.

Unit 4. Plane Electromagnetic Wave: Plane electromagnetic waves in a non-conducting medium, Linear and circular polarization, Reflection, Refraction of electromagnetic waves at a plain interface between dielectrics, Fresnel relation polarization by reflection and total internal reflection, Waves in a conducting medium.

Unit 5. Plasma: Definition of plasma ,Concept of temperature, Debye shielding, Criteria for plasma, Single-particle motions in **E** and **B** fields, Magnetic mirrors and plasma confinement, Plasma as fluid, the fluid equation of motion , The stress tensor, Equation of continuity and equation of state, Waves in plasmas, Plasma oscillations, Plasma frequency ω_p,Electron plasma waves, ion waves, Electron and ion oscillations perpendicular to **B**, Electromagnetic waves perpendicular to **B** and parallel to **B**, Cutoffs and resonances.

Kinetic theory and plasma, Boltzmann equation, Derivation of the equation of continuity and fluid equation of motion by taking moments of Boltzmann equation.

Text and Reference Books

Classical Electrodynamics by J.D. Jackson

Foundations of Electromagnetic theory by J.R. Reitz, F.J.Milford and R.W.Christy

Introduction to Electromagnetics by David J. Griffiths

Intriduction to Plasma Physics and Controlled Fusion, Vol-1: Plasma Physics by Francis F. Chen

Plasma Physics by S.N. Sen.

M.Sc. PHYSICS (III Semester): CONDENSED MATTER PHYSICS

Unit 1. Crystal Physics and Defects in Crystals:
Crystalline solids, unit cell and direct lattice, Bravais lattice in two dimensions (plane lattice) and three-dimensional (space lattice), Closed packed structures.

Unit 2. Interaction of X-rays with matter, Absorption of X-rays, X-ray diffraction, The Laue, powder and rotating crystal methods, The reciprocal lattice and its important properties and applications, Diffraction intensity, Atomic scattering factor, Geometrical structure factor.

Unit 3. Crystal imperfections: Point defects, line defects and planer (stacking) faults. Estimation of dislocation density from X-ray diffraction measurements. The observation of imperfections in crystals: electron microscopic techniques.

Unit 4. Electronics Properties of Solids:
Electrons in a periodic lattice: Bloch theorem, The Kronig-Penny Model, Effective mass of an electron, Tight-binding approximation, Cellular and pseudopotential methods,
Fermi surface: Fermi surface and Brillouin zones, Anomalous skin effect, Cyclotron resonance, de Hass van Alphen effect, Magnetoresistance, Hall effect in semiconductors
Superconductivity: Elements of BCS theory, Flux quantization, Meissner effect, Critical temperature, Persistent current.

Unit 5. Ferromagnetism: Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Ferromagnetic domains, The Bloch-wall, Spin waves and magnons, Curie- Weiss law for susceptibility, Ferri and antiferro-magnetic order.

Text and References Books

Verma and Srivastava: Crystallography for Solid State Physics
Azaroff: Introduction to Solids
Omar: Elementary Solid State Physics
Aschroff & Mermin: Solid State Physics
Kittel: Solid State Physics
Chaikin and Lubensky: Principles of Condenced Matter Physics

M. Sc. PHYSICS (III Semester): SPECIAL PAPER- I: ELECTRONICS

Unit 1. Operational Amplifier Basic and Application: Review of Feedback, Linear Circuit, Op-Amp Basic, Inverting and Non-inverting amplifiers, Unity follower, Summing amplifiers, Integrator, Differentiator, Op- Amp Specifications- DC Off-set parameter, Frequency parameters, Imperfection in Op- Amplifier application- multiple stage gain, Voltage summing and subtraction, Current controlled voltage ource, Voltage controlled current source, Rectifiers and Limiters, Comparators and Schmitt Triggers, Active filters.

Unit 2. Digital Logic Gates: Symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL, TTL, ECL, MOSFET, CMOS), Transistor- Transistor Logic (TTL), Single Input TTL Inverter (transfer characteristic), Multi- collector transistors, Propagation delays, Diode Logic, DTL NAND Gate (transfer characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation, MOSFET Logic- Review of MOSFET, MOSFET Inverter with active load, MOSFET NOR and NAND gates, Complementary MOS (CMOS)- CMOS inverter, CMOS NOR and NAND, Power dissipation in CMOS, Advantages/Disadvantages of CMOS.

Unit 3. Digital Electronics and Logic Gate: Binary, Octal, Hexadecimal number system, Base conversion system, Bipolar junction and Field Effect transistor as switches, Basic digital logic gates (OR, AND and NOT, NOR, NAND and Exclusive OR), XOR gate, Boolean laws and theorem, Sum of Product (SOP) and Peroduct of Sum (POS) method, Karnaugh map, pair, quad and octave, POS simplification, min-term, max-term.

Unit 4. Application of Digital Logic Gate: Half adder and Full adder circuit, multiplexers, demultiplexer, **Flip- Flop and Registers-** RS Flip Flop, D- Flip Flop, T- Flip Flop, JK- Flip Flop, JK Master- Slave Flip Flop, Astable, Monostable and Bi-stable multivibrator, types of registers, serial-in-serial out, serial-in-parallel out, parallel-in-serial out, parallel-in parallel out, **Counters and Convertors-** asynchronous and synchronous counter, Mod-3 and Mod-5 counters, shift counters, Digital-to Analog Converters-D/A converter, ladder network, A/D converters.

Unit 5. Microprocessor-Intel 8085 microprocessor architecture, interfacing devices, BUS timing, instruction set, simple illustrative program.

Text and Reference Books

Electronic Device and Circuit: R. Boylested and L. Nashdsky
Analysis and Design of Digital Integrated Circuit: Hodges, Jackson and Saleh
Digital Principles and Implementation: A.P. Malvino and D.P. Leach
Op- Amp and Linear Integrated Circuit: Ramakant A. Gayakwad

M. Sc. PHYSICS (III Semester): SPECIAL PAPER II: ELECTRONICS

Unit 1. Microwave Devices: Klystrons amplifiers,velocity modulation, Basic principles of two cavity klystrons, Multicavity clystron amplifier and Reflex klystron oscillator, Magnetrons, principles of operation of magnetrons and Travelling wave tube (TWT).
Transferred electron devices, Gun effect, Principles of operations, modes of operation, Read diode, IMPATT diode, and TRAPATT diode.

Unit 2. Amplitude Modulated Systems: Frequency translation, method of frequency translation, recovery of the base band signal, Amplitude modulation, Maximum allowed modulation, The square law demodulation, Spectrum of an amplitude modulated signal, Modulators and Balanced modulators, Single side band modulation, Methods of generating as SSB signal, Vestigial side band modulation, Multiplexing.

Unit 3. Frequency Modulated Systems: Angle modulation, Phase and frequency modulation, Relationship between phase and frequency modulation, Phase and frequency deviation, Spectrum of an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, FM generation, Parameter variation method, Armstrog system.

Unit 4. Transmission and Radiation of signals: Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart, Single and double Stub matching, Time domain reflectometry, Telephone lines and cables, Radio frequency lines.

Unit 5. Fiber optic communications: Principles of light transmission in a fiber, Propagation within a fiber, Effect of index profile on propagation, Modes of propagation, Single mode propagation, Losses in fibres, Dispersion, Fiber optic communication systems.

Text and Reference Books

Electronic Devices and circuit Theory by R. Boylested and L. Nashdsky
Principles of Communication Systems by H. Taub and Donald L. Schilling
Optoelectronics: Theory and Practice, Edited by Alien Chappal
Microwaves by K.L. Gupta
Electronic communications by Dennis Roddy and John Coolen

M. Sc. PHYSICS (III Semester): NUCLEAR AND PARTICLE PHYSICS

Unit 1. Introductry Concept of Nuclei: Nuclear angular momentum, Nuclear magnetic dipole moment and Electric quadruple moment, Parity quantum number, Statistics of nuclear particles, Isobaric spin concept, Systematic of stable nuclei.

Unit 2. Nuclear Disintegration: Simple theories of decay, Properties of neutrino, Non-conservation of parity and Wu's experiment in beta decay, Electron capture, Internal conversion.

Unit 3. Inter Nucleon Forces: Properties and simple theory of the deuteron ground state, Spin dependence and tensor component of nuclear forces, Nucleon- nucleon scattering at low energy, Charge- independence of nuclear forces, Many – nucleon systems and saturation of nuclear forces, Exchange forces, Elements of meson theory.

Unit 4. Nuclear Structure and Models: Fermi gas model, Experimental evidence for shell structure in nuclei, Basic assumption for shell model, Single- particle energy levels in central potential, Spin-orbit potential and prediction of magic numbers, Extreme single- particle model, Prediction of angular momenta, Parities and magnetic moment of nuclear ground states, Liquid drop model, Semi- empirical mass formula, Nuclear fission, The unified model.

Unit 5.Particle Physics: Properties and origin, Elementary particles, Properties, classification, type of interactions and conservation laws, Properties of mesons, Resonance particles, Strange particles and Strangeness quantum number, Simple ideas of group theory, Symmetry and conservation laws, CP and CPT invariance, Special symmetry groups SU (2) and SU (3) classification of hadrons, Quarks, Gell- Mann- Okubu mass formula.

Text and Reference Books

Nuclear Physics by Roy & Nigam
Introduction to nuclear Physics by H. Enge
Theoretical Nuclear Physics by J.M. Blatt and V.F. Weisskopf
Theoretical nuclear and Subnuclear Physics by J.D. Walecka
Particle Physics An introduction by M.Leon
Group Theory in Subnuclear Physics by F.I. Stancu
Introduction to Particle Physics by R. Ones.

M.Sc PHYSICS (IV SEMESTER): PHYSICS OF NONOMATERIALS

Unit 1 . Introduction to Nonostructure Materials: Nanoscience & nanotechnology , Size dependence of properties, Moor's law, Surface energy and Melting point (quasi melting) of nanoparticles,

Unit 2. **Band structure of solids**: Free electron theory (qualitative idea) and its features, Idea of band structure, insulators, semiconductors and conductors, Energy band gaps of semiconductors, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, Variation of density of states with energy and Size of crystal.

Unit 3. Quantum Size Effect: Quantum confinement, Nanomaterials structures, Two dimensional quantum system, Quantum well, Quantum wire and Quantum dot, Fabrication techniques.

Unit 4. Characterization techniques of Nanomaterials: Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Shift in photoluminescence peaks, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM), and Atomic Force Microscopy (AFM).

Unit 5. Synthesis of Nanomaterials: Key issue in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom up approaches, Cluster beam evaporation, Ball Milling, Chemical bath deposition with capping agent, Carbon nanotubes (CNT)- Synthesis, Properties and Applications.

Text and References Books

Nanostructures & Nanomaterials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.

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

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

Quantum Dot Hetrostructures, by D. Bimberg, M. Grundman, N.N. Ledenstov.

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

Carbon Nanotechnology by Liming Dai

Carbon Nanotubes: Properties and Applications by Michael J. O'. Connell.

M. Sc. PHYSICS (IV Semester): SPECIAL PAPER III ELECTRONICS

Unit 1. Digital communication: Pulse – Modulation systems, sampling theorem – Low – Pass and Band – Pass signals, PAM, Channel BW for a PAM signal . Natural sampling. Flat – top sampling. Signal recovery through Holding , Quantization of signals, Quantization error, Differential PCM, Delta Modulation, Adaptive Delta Modulation, CVSD .
Digital Modulation techniques : BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK

Unit 2. Mathematical representation of Noise: Sources of noise. Frequency domain representation of noise, effect of filtering on the probability density of Gaussian noise, spectral component of noise, effect of a filter on the power spectral density of noise. Superposition of noises. Mixing involving noise. Linear filtering. Noise Bandwidth, Quadrature components of noise, Power spectral density of $n_c(t)$, $n_s(t)$ and their time derivatives.

Unit 3. Data Transmission: Baseband signal receiver, probability of error . Optimum filter . White noise. Matched filter and probability of error. Coherent reception. Correlation, PSK, FSK, Non- coherent detection of FSK. Differential PSK, QPSK, calculation of error probability for BPSK, BFSK, and QPSK.

Unit 4. Noise in pulse – code and Delta – modulation system: PCM Transmission, Calculation of Quantization noise, Output – signal power, Effect of thermal noise in D M, Output signal – to – noise ratio in PCM, DM, Quantization noise in DM, Effect of thermal noise in Delta modulation , Output signal to noise ratio in DM .

Unit 5. Computer Communication Systems: Types of networks, Design features of a communication network, examples TYMNET, ARPANET, ISDN, LAN.
Mobile Radio and Satellites: Time division multiple Access (TDMA), Frequency Division Multiple Access (FDMA), ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA) Poisson distribution, Protocols, Cellular communications, Mobile communication via Satellites, Bandwidth consideration in INTERNET

Text and Reference Books

Principles of Communication Systems, second Edition by Taub and Schilling Communication Systems, third edition, by Simon Haykin

M.Sc. Physics (IV- Semester):SPECIAL PAPER –IV- ELECTRONICS

Unit 1. Materials for Integrated Circuits

Classification of IC, CMOS Process Overview , Electronic grade silicon , Crystal growth ,Czeehralski and float zone crystal growing methods, Silicon shaping lapping , Polishing and wafer preparation,

Unit 2. Hot Processes-I: Oxidation and Diffusion

Oxidation of silicon, oxide deposition by thermal dry oxidation and wet oxidation method Diffusion Process, Diffusion Coefficient, Fick's 1^{st} and 2^{nd} Laws of Diffusion, Vacancy –Impurity interactions, Dopants and Dopant Sources , Doping by Diffusion, ion implantation, Diffusion Process Control, Diffusion Systems, Implantation Technology, Selective Implantation, Junction depth, Channeling, Lattice Damage, Annealing ,Dopant Diffusion and Related Operations: Equipment for Diffusion and Related Operations.

Unit 3. Thin Films: Metals and Nonmetals

Vacuum Science and Technology, Evaporation theory and electron beam evaporation, evaporation system, idea of DC and R.F. sputtering system, Physical vapor deposition methods, Design construction of vacuum coating units, Chemicals Vapor Deposition, Reactors for Chemical Vapor Deposition, CVD Applications, Epitaxy methods for thin film deposition, Vapor-Phase Epitaxy,

Unit 4. Photolithography, Photoresist Processing and Etching

Wafer Cleaning methods, Wafer Preparation method: Vapor HMDS Treatment for adhesion improvement of photoresist, photoresist coating methods, soft backing of photo resist, post exposure backing of photo resist, Negative photoresist, Positive photoresist, Contrast and sensitivity of photoresist, Chemical Modulus Transfer Function (CMTF) of Photoresist, Resist Exposure (single, bi-layer and multi level photoresist exposure) and Resist Development, Hard Baking and Resist curing, Photolithographic Process Control.

Photolithography: An Overview, lithography, Raleigh criterion for resolution, Photolithography source, Resolution and numerical aperture, Photolithographic methods: Contact, proximity and projection and their resolution limit, Photo mask and mask Alignment, Limitations of optical lithography, Concept of phase-shift mask, Idea of electron beam lithography, Electron optics, Idea of an X-ray lithography and x-ray mask, Wet chemical dry etching for material removal, Reactive plasma etching, Ion milling,

Unit 5. Interconnections and Contacts and Packaging and Yield

Ohmic Contact Formation, Contact Resistance, Electromigration, Diffused Interconnections, Polysilicon Interconnections, Buried Contacts, Butted Contacts, Silicides, Multilayer Contacts, Liftoff Process, Multilevel Metallization.

Testing, Die Sepration, Die Attachment, Wire Bonding, Packages, Flip-Chip Process, Tape-Automated-Bonding Process, Yield, Uniform and Nonuniform Defect Densities.

Text and Refernece Books:

Integrated Electronics- Milliman and Taub
Microelectronics –Milliman and Gros
Thin Film Phenomena- K.L. Chopra
Hand Book of Thin Film- Marshel and Glang
VLSI Technology- S.M. Sze.

M.Sc. PHYS. (IV SEM.) COMPUTATIONAL METHODS AND PROGRAMMING

Unit 1. Computational methods: Methods for determination of zeros of linear and nonlinear algebraic equations and transcendental equations, Bisection method, Muller's method, Quotient-difference method, Newton-Raphson method
Solution of simultaneous linear equations, consistency of a system of linear equation, Gaussian elimination, LU decomposition method, matrix inversion, Jacobi iterative method, Gauss-Seidel method, convergence of Gauss-Seidel method

Unit 2. Diagonalization of matrices, Eigen values and eigenvectors of matrices, Power and Jacobi method.
Finite differences, Newton's formula for interpolation, Gauss, Stirling, Bessel's, Everett's formulae, Divided differences, Newton's general interpolation formula, Lagrange's interpolation formula.

Unit 3. Numerical differentiation, Numerical integration, Trapezoidal rule, Simpson 1/3 and 3/8 rules, Boole's and waddles rules, Newton-Cote's formula, Euler- Maclaurin formula, Gauss quadrature formula.
Method of Least square curve fitting, straight line and quadratic equation fitting, curve fitting of curves $y = ax^b$, $y = ae^{bx}$, $xy^a = b$ and $y = ab^x$, curve fitting by sum of exponentials, data fitting with cubic splines.

Unit 4. Numerical solution of ordinary differential equations, Euler, Picard and Runge-Kutta methods, Predictor and corrector method, elementary ideas of solutions of partial differential equations, solution of Laplace equation

Unit 5. Programming: elementary information about digital computer principles, compilers, interpreters and operating systems, Fortran programming, flow charts, integer and floating point, arithmetic expressions, built in functions, executable and non executable statements, IF statements, GO TO statements, DO loop and implied DO loop, simple computer programmes.

Text and References Books

Introductory Methods of Numerical analysis by S.S. Shastri
Numerical Analysis by Rajaraman

Numerical Methods by E. Balagurusamy
Fortran Programming by Rajaraman
Numerical methods for scientific & Eng. Computatioans by Jain, Iyengar

CH. CHARAN SINGH UNIVERSITY, MEERUT

DEPARTMENT OF PHYSICS

SYLLABUS

FOR M.Sc. (PHYSICS)

ELECTRONICS SPECIALIZATION

(REGULAR)

W.e.f.

ACADEMIC SESSION 2010-2011 AND ONWARD