SYLLABI FOR M.SC. PHYSICS I – IV Semesters

M.Sc. Physics I & II Semester 2008 -09

Ist Semester

Paper	Title	Marks
Paper-I	Mathematical Physics	80
	Internal Assessment	20
Paper-II	Classical Mechanics	80
	Internal Assessment	20
Paper-III	Quantum Mechanics I	80
	Internal Assessment	20
Paper-IV	Electronic Devices	80
	Internal Assessment	20

IInd Semester

Paper-V	Statistical Mechanics	80
	Internal Assessment	20
Paper-VI	Quantum Mechanics II	80
	Internal Assessment	20
Paper-VII	Nuclear and Particle Physics	80
	Internal Assessment	20
Paper-VIII	Atomic and Molecular Physics	80
	Internal Assessment	20
Paper-IX	Practicals	200
Paper-X	Practicals	200

M.Sc. Physics III & IV Semester 2009 -10

IIIrd Semester

Paper-X1	Computational methods and Programming	80
	Internal Assessment	20
Paper-XII	Special Paper from Group A	80
	Internal Assessment	20
Paper-XIII	Elective Paper	80
	Internal Assessment	20
Paper-XIV	Special Paper from Group B	80
	Internal Assessment	20

IVth Semester

Paper-XV	Electro dynamics and Wave Propagation	80
	Internal Assessment	20
Paper-XVI	Condensed Matter Physics	80
	Internal Assessment	20
Paper-XVII	Special Paper from Group C	80
	Internal Assessment	20
Paper-XVIII	Special Paper from Group D	80
	Internal Assessment	20
Paper XIX A	Practicals	100
Paper XIX B	Practicals	100
Paper XX	Practicals	200

Note: Break up of internal assessment marks:

Two theory papers : 10 marks (5 marks each)
Attendance : 5 marks
Assignment/term paper: 5 marks
& presentation

Total : 20 marks

NOTE:

The M.Sc. Physics programme will be of four semesters (two years) duration. The theory examination will be held at the end of each semester. There will be four theory papers in each semester. The two practical laboratory courses (Paper IX and X) will run at the same time in semester I and II. Similarly the two practical laboratory courses (Paper XIX A&B and XX) will run simultaneously in semester III and IV. The practical examination will be held at the end of semester II and IV. No elective/special paper shall be offered unless the number of students, opting for particular paper is equal to ten or more. Elective papers/Special papers will be offered according to the availability of the teachers in the department.

The distribution of percentage marks in practical papers (IX, X, XIX & XX) will be as follows:

Experiment	60%
Viva	20%
Seminar	10%
Laboratory Report	10%
Total	100%

Elective papers (One of the following will be offered by the Department depending on the availability of expertise:

El.1	Quantum Electrodynamics
EI.2	Physics of Liquid Crystals
El.3	Science and Technology of solar hydrogen and other renewable energies
El.4	Reactor Physics
El.5	Numerical Methods and Programming
El.6	Physics of Laser and Laser applications
El.7	Structure, Spectra and Properties of Bio-Moleculars
El.8	Diagram Techniques
El.9	Physics of Electronic Devices & Fabrication of IC and Systems
El.10	Atmospheric Science
El.11	Plasma Physics
El.12	Quantum Many-body Physics
El..13	Non-linear dynamics
El.14	Environmental Physics
El.15	Physics of Nano-materials
EL16	Solid State Electronics

Special Papers: (The students must choose one special paper each from group A, B, C and D)

Group A

A1	Condensed matter Physics –I
A2	Digital Electronics
A3	Nuclear and Particle Physics I
A4	Atomic and Molecular Physics-I
A5	Informatics I

Group B

B1	Condensed Matter Physics – II
B2	Electronics I
B3	Nuclear and Particles Physics II
B4	Atomic and Molecular Physics II
B5	Informatics II

Group C

C1	Condensed Matter Physics III
C2	Electronics II
C3	Nuclear and Particle Physics III
C4	Atomic and Molecular Physics III
C5	Informatics III

Group D

D1	Condensed Matter Physics IV
D2	Electronics III
D3	Nuclear and Particle Physics IV
D4	Atomic & Molecular Physics IV
D5	Informatics

M.SC Physics I Semester Paper I
MATHEMATICAL PHYSICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Vector spaces and Matrices

Definition of a linear vector space, Linear independence, basis and dimension, scalar Product, Orthonormal basis, Gram-Schmidt Orthogonalization process, Linear operators, Matrices, Orthogonal,Unitary and Hermitian matrices, Eigenvalues and eigenvectors of matrices, Matrix diagonalization.

Unit II Differential equations

Second order linear differential equation with variable coefficients, ordinary point, singular point, series solution around an ordinary point, series solution around a regular singular point; the method of Frobenius, Wronskian and getting a second solution, Solution of Legendre's equation, Solution of Bessel's equation, Solution of Laguarre and Hermite's equations.

Unit III Special Functions

Definition of special functions, Generating functions for Bessel function of integral order $J_n(x)$, Recurrence relations, Integral representation; Legendre polynomials $P_n(x)$, Generating functions for $P_n(x)$, Recurrence relations; Hermite Polynomials, Generating functions, Rodrigue's formula for Hermite polynomials; Laguerre polynomials, Generating function and Recurrence relations.

Unit IV Integral Transforms

Integral transform, Laplace transform, some simple properties of Laplace transforms such as first and second shifting property, Inverse Laplace Transform by partial fractions method, Laplace transform of derivatives, Laplace Transform of integrals, Fourier series, Evaluation of coefficients of Fourier series Cosine and Sine series, Fourier Transforms, Fourier sine Transforms, Fourier cosine Transforms.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Mathematical Physics by P.K. Chattopadhyay (T)
Mathematical Physics by B.S.Rajput
Matrices and Tensors for Physicists, by A W Joshi
Mathematical Physics by Mathews and Walkers
Mathematics for Physicists by Mary L Boas

M.SC Physics
Classical Mechanics

I Semester -Paper II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Survey of Elementary Principles and Lagragian Formulation.

Newtonian mechanics of one and many particle systems; conservation laws, constraints, their classification; D' Alembert's principle, Lagrange's equations; dissipative forces generalized coordinates and momenta; integrals of motion; symmetries of space and time and their connection with conservation laws; invariance under Galilian transformation.

Unit II Moving coordinate systems and Motion in a central force field.

Rotating frames; intertial forces; terrestrial applications of coriolis force.Central force; definition and characteristics; two body problem; closure and stability of circular orbits; general analysis of orbits; Kepler's laws and equations; artificial satellites; Rutherford scattering.

Unit III Variational Principle, Equation of motion and Hamilton-Jacobi Equation.

Principle of least action; derivation of equations of motion; variation and end points; Hamilton's principle and characteristic functions; Hamilton-Jacobi equation.

Unit IV Small Oscillations and Canonical Transformations

Canonical transformation; generating functions, properties of Poisson bracket, angular momentum Poisson brackets; small oscillations; normal modes and coordinates.

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Text and Reference Books :

Classical Mechanics by N C Rana and P S Joag (Tata Mcgraw Hill, 1991)
Classical Mechanics by H Goldstein (Addison Wesley, 1980)
Mechanics by A Sommerfeld (Academic Press, 1952)
Introduction to Dynamics by I perceival and D Richards (Cambridge Univ. Press, 1982)

M.SC Physics I Semester Paper III
Quantum Mechanics -I

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Quantum Mechanics-I

Unit I General formalism of Quantum Mechanics: States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Commutation rule and the uncertainty relation; Simultaneous eigenstates of commuting operators; The unitary transformation; Dirac delta function; Relation between kets and wave functions; Matrix representation of operators; Solution of linear harmonic oscillator problem by operator methods.
Unit II Angular momentum operator: Angular momentum operators and their representation in spherical polar co-ordinates; Eigenvalues and eigenvectors of L^2, spherical harmonics; Commutation relations among L_x L_y L_z ; Rotational symmetry and conservation of angular momentum; Eigenvalues of J^2 and J_z and their matrix representation; Pauli spin matrices; Addition of angular momentum.
Unit III Solution of Schrodinger equation for three dimensional problems: The three dimensional harmonic oscillator in both cartesian and spherical polar coordinates, eigenvalues eigenfunctions and the degeneracy of the states; Solution of the hydrogen atom problem, the eigenvalues eigenfunctions and the degeneracy.
Unit IV Perturbation Theory : Time independent perturbation theory; Non degenerate case, the energies and wave functions in first order the energy in second order; Anharmonic perturbations of the form λx^3 and λx^4 ; Degenerate perturbation theory; Stark effect of the first excited state of hydrogen.

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Text and Reference Books:

Quantum Mechanics by Ghatak and Loknathan
Quantum Mechanics by Powell and Craseman
Quantum Mechanics by S. Gasiorowicz
Quantum Mechanics by A.P.Messiah
Modern Quantum Mechanics by J.J.Sakurai
Quantum Mechanics by L.I.Schiff
Quantum Mechanics by Mathews and Venkatesan

M.SC Physics I Semester Paper IV
Electronic Devices

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Transistors Bipolar junction Transistor(BJT) Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Transistor ratings, The Ebers-Moll model, Field Effect Transistors: Junction Field Effect Transistor(JFET) , Metal Oxide Semiconductor Field Effect Transistor (MOSFET) FET Parameters.

Unit II Integrated circuits and Their Fabrications

Types of Integrated Circuits, Analog and Digital Integrated Circuits, Semiconductor Fabrication : Planar Technology, Fabrication of Monolithic, Integrated Circuits, Monolithic Passive and Active Circuit components, Typical IC Low Frequency Amplifier, New Technology Trends.

Unit III Photoelectirc and other Electronic Devices

Zener Diode, Power Diode, Photodiode, Varactor Diode, Light Emitting Diode (LED), Solar Cell, Transistor Register, Piezo-electric Crystals, Diode Lasers, Condition for Laser Action, Optical Gain, Memory Devices: Transistor Register, Random Access Memory, Read Only Memory.

Unit IV Negative Resistance Devices

Tunnel Diode, Backward Diode, Unijunction Transistor, p-n-p-n devices, p-n-p-n characteristics Thyristor, Silicon Controlled switch, SCS Characteristics, L Addition four Layer Devices. Basic Circuit Principles for NR Switching Circuits: Monostable, Bystable and Astable Operations.

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Text and Reference Books :

Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)
Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons
Measurement, Instrumentation and Experimental Design in Physics and Engineering by M.Sayer and A. Mansingh, Prentice Hall, India (2000)
Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.
Semiconductor Electronics by A.K.Sharma ,New Age International Publisher(1996)
Laser and Non-linear optics by B.B.Laud. ,Wiley Eastern Limited (1985)
Pulse, Digital and Switching Waveforms by Jacob Millman and Herbert Taub ,
Mc Graw Hill Book Company (1965)

M.SC Physics II Semester Paper V
Statistical Mechanics

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours .

Unit I Phase space, Ensembles, Liouville theorem, conservation of extension, Equation of motion, Equal a priori probability, Statistical equilibrium, Microcanonical ensemble, Quantization of phase space, classical limit, symmetry of wave functions effect of symmetry on counting various distributions using micro canonical ensemble.
Unit II Entropy of an ideal gas, Gibbs paradox, Sackur-Tetrode equation, Entropy of a system in contact with a reservoir, Ideal gas in a canonical ensemble, Grand canonical ensemble, Ideal gas in Grand Canonical ensemble, Comparison of various ensembles. Quantum distribution using other ensembles.
Unit III Transition from classical statistical mechanics to quantum statistical mechanics, Indistinguishability and quantum statistics, identical particles and symmetry requirements, Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics. Bose Einstein Condensation, Thermal properties of B.E. gas, liquid Helium, Energy and pressure of F-D gas, Electrons in metals, Thermionic Emission.
Unit IV Cluster expansion for a classical gas, virial equation of state, Van der Waals gas, Phase transition of second kind. Ising Model, Bragg Williams Approximation, Fowler Guggenheim Approximation, Ising Model in one and two dimensions, fluctuations in ensembles, Energy fluctuation in quantum statistics, Concentration fluctuation in quantum statistics, One dimensional random walk, Brownian motion.

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Text and Reference Books
Statistical Mechanics by K Huang
Statistical Mechanics by B.K. Aggarwal and M.Eisner
Statistical Mechanics by R.K. Patharia
Statistical Mechanics by Donalad A Mc Quarrie
Elementary Statistical Mechanics by Gupta and Kumar
Statistical Mechanics R Kubo
Statistical Physics Landau and Lifshitz

M.SC Physics II Semester Paper VI
Quantum Mechanics –II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Variational methods: Ground state of Helium by both variational and perturbation methods; The hydrogen molecule; WKB approximation; Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.

Unit II Semiclassical theory of radiation: Transition probability for absorption and induced emission ; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients.

Unit III Collision in 3D and scattering: Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well poetential; Complex potential and absorption; The Born approximation.

Unit IV Idential particles: The principle of indistinguishibility**;** Symmetric and antisymmetric wave functions; Spin and statistics of identical particles; The Slatter determinant; The Pauli exclusion principle; Spin states of a two electron system; States of the helium atom; Collision of identical particles.

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Text and Reference Books:

Quantum Mechanics by Ghatak and Loknathan
Quantum Mechanics by Powell and Crassman
Quantum Mechanics by S.Gasiorowicz
Quantum Mechanics by A.P.Messiah
Modern Quantum Mechanics by J.J. Sakurai
Quantum Mechanics by L.I..Schiff
Quantum Mechanics by Mathews and Venkatensan.

<u>M.Sc Physics II Semester Paper VII</u>
Nuclear and Particle Physics

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

<u>Unit I Two nucleon problem and nuclear forces:</u>

The deuteron : binding energy, dipole moment quadrupole moment and the evidence of non-central (Tensor) force, spin dependence of nuclear force. Nucleon-nucleon scattering ; s-wave effective range theory, charge independence and charge symmetry of nuclear forces, iso-spin formalism.

<u>Unit II Nuclear Models :</u>

Liquid drop model ,stability of nuclei, fission ; evidence of shell structure, the shell model spin parity and magnetic moment in extreme single particle model, evidence of collective excitations, collective vibration of a spherical liquid drop.

<u>Unit III Nuclear decays and nuclear reactions :</u>

Alpha, Beta and Gamma decays, Selections rules, Fermi's theory of beta decay, selection rules, comparative half lines, Kurie plot Fermi and Gamow -Teller Transitions; parity non-conservation in beta decay. Reaction cross section, compound nuclear reactions and direct reactions, the optical model, Breit-Winger resonance formula for l=0.

<u>Unit IV Elementary Particle :</u>

Basic interactions in nature : Gravitational Electromagnetic, weak and strong, classification of elementary particles, Leptons, Hadrons, Mesons, Baryons. Conservation Laws for Elementary Particles. Baryon, Lepton and Muon number, Strangeness and Hypercharge, Gelleman - Nishijima formula. Quark model, SU (2) and SU (3) Symmetries Parities of subatomic particles, charge conjugation, Time reversal.

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<u>Text and Reference Books :</u>

A.Bohr and B.R. Mottelson, Nuclear Structure, Vol. 1(1969) and Vol. 2 (1975) , Benjamin, Reading A, 1975
Kenneth S. Kiane, Introductory Nuclear Physics, Wiley, New York, 1988
Ghoshal,S.N Atomic and Nuclear Physics Vol. 2.
P.H. Perkins, Introduction to High Energy Physics, Addison-Wesley, London, 1982
A Preston and A Bhaduri : Nuclear Physics
H. Frauenfelder and E. Henley : Subatomic Physics

M.SC Physics II Semester Paper VIII
Atomic and Molecular Physics

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I One Electron systems and Pauli principle.

Quantum states of one electron atoms , atomic orbitals , Hydrogen spectrum , Pauli principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra. Spectra of two electron systems, equivalent and non equivalent electrons.

Unit II The influence of external fields, Two electron system Hyperfine structure and Line broadening: Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems , interaction energy in LS and jj coupling, Hyperfine structure (magnetic and electric, only qualitative).

Unit III Diatomic molecules and their rotational spectra :

Types of molecules, Diatomic linear symmetric top , asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator , energy levels and spectra of non-rigid rotor , intensity of rotational lines.

Unit IV Vibrational and Rotational Vibration spectra of Diatomic molecules :

Vibrational energy of diatomic molecule , Diatomic molecules as a simple harmonic oscillator , Energy levels and spectrum , Morse potential energy curve , Molecules as vibrating rotator , vibration spectrum of diatomic molecules , PQR Branches.

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Text and Reference Books :

Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
Introduction to Atomic spectra by H.E. White
Fundementals of molecular spectroscopy by C.B. Banwell
Spectroscopy Vol I and II by Walker and Straughen
Introduction to Molecular spectroscopy by G. M. Barrow
Spectra of diatomic molecules by Herzberg
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 (I & II Semester) : LABORATORY/ PRACTICAL COURSE

PAPER IX

Max Marks:200
Time: 4 hrs

1.Design/study of a Regulated Power Supply.
2.Design of a Common Emitter Transistor Amplifier.
3.Experiment on Bias Stability.
4.Negative Feedback (voltage series/shunt and current series/shunt)
5.Astable, Monostable and Bistable Multivibrater.
6.Characteristics and applications of Silicon Controller Rectifier.
7.Testing goodness of fit of poison distribution to cosmic ray bursts by chi-square test.
8.Determination of Half Life of 'In'.
9.Deterrmination of range of Beta-rays from Ra and Cs.
10.X-ray diffraction by Telexometer.
11.Determination of Ionization Potential of Lithium.
12.Determination of e/m of electron by Normal Zeeman Effects using Febry Perot Etalon.
13..Determination of Dissociation Energy of Iodine (1) Molecule by photography the absorption bands of I in the visible region.
(a) Measurement of Wavelength of He-Ne Laser light using ruler.
(b) Measurement of thickness of thin wire with laser
14.Study of Rectifiers and filter circuits.
15.Flashing of quenching of Neo gas.
16.Study of Network theorems.
17.Frequency variation in oscillagtors.
18.Frequency response of RC coupled Amplifier.
19. Temperature effect on a transistor amplifier.
20. e/m of electron by Helical method.

Setting of new experiments will form tutorial for this lab. Course.

M.Sc (Physics) (I & II Semester) : LABORATORY/PRACTICAL COURSE

Paper X

Max Marks: 200
Time: 4 hrs.

1.Experiments on FET and MOSFET characterization and application as an amplifier.
2.Experiment on Uni-junction Transistor and its application.
3.Digital I : Basic Logic Gates, TTL, NAND and NOR.
4.Digital II : Combinational Logic.
5.Flip-Flops.
6.Operational Amplifier(741)
7.Differential Amplifier.
8.Measurement of resistivity of a semiconductor by four probe method at different temperatures and Determination of band gap.
9.Determination of Lande's factor of DPPH using Electron - Spin resonance (E.S.R.) Spectrometer.
10.Measurement of Hall coefficient of given semiconductor : Identification of type of semiconductor and estimation of charge carrier concentration.
11.To study the fluorescence spectrum of DCM dye and to determine kthe quantum yield of fluorescence maxima and full width at hall maxima for this dye using monochromator.
12.To study Faraday effect using He-Ne Laser.
13.Experiments on Prism/Grating spectrometer.
14.Characteristics of Photovoltic Cell
15.Energy band gap of Ge Crystal.
16.Hall effect
17.Dielectric constant of Liquids.
18.Magnetic susceptibility by Gauy's method.
19.B.H. curve.
20.Experiments on G.M. counter

Setting of new experiments will form tutorial for this lab. Course.

M.SC Physics Semester - III Paper XI
Computation Methods and Programming

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Computational Methods

Unit I Numerical Integration, Differentiation , Roots of Eqns. and Curve Fitting.

Numerical Integration : Newton-cotes formulae : Trapojoidal rule, Simpson's 1/3 rule, error estimates in Trapejoidal rule and Simpson 1/3 rule using Richardson defferred limit approach ; Gauss-Legender quadrature method; Monte carlo (mean sampling) method for single, double and tripple integrals.

Numerical Differentiation: Taylor Series method; Generalized numerical diffrerentiation: truncation errors.

Roots of Linear, Non-linear Algebraic and Transcendental Eqns. : Newton - Raphson methods; convergence of solutions.

Curve Fitting : Principle of least square; Linear regression ; Polynomial regression; Exponetial and Geometric regression.

Unit II Interpolation, Solution of Simultaneous Linear Eqns., Eigen values and Eigen vectors.

Interpolation: Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and backward interpolation; Interpolation with unequally spaced points : Lagrangian interpolation.

Solution of Simultaneous Linear Equations : Gaussian Elimination method, Pivioting; Gauss- Jordan elimination method; Matrix inversion.

Eigen values and Eigen vectors : Jacobi's method for symmetric matrix.

Unit III Numerical Solution of First and Second Order Differential Eqns:

Numertical Solution of First Order Differential Eqns: First order Taylor Series method; Euler's method; Runge Kutta methods; Predictor corrector method; Elementary ideas of solutions of partial differential eqns.

Numerical Solutions of Second Order Differential Eqns: Initial and boundary value problems : shooting methods

Programming

UNIT IV Computer basics, Operating system and FORTRAN 77 :

Computer basics and operating system : Elementary information about digital computer principles; basic ideas of operating system, DOS and its use (using various commands of DOS); Compilers; interpretors; Directory structure; File operators.

Introduction to FORTRAN 77

Data types: Integer and Floating point arithmatic; Fortran variables; Real and Interger variables; Input and Output statements; Formates; Expressions; Built in functions; Executable and non-executable statements; Control statements; Go To statement; Arithmatic IF and logical IF statements; Flow charts; Truncation errors, Round off errors; Propagation of errors.

Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables; Subprogrammes: Function and SUBROUTINE; Double precision; Complex numbers; Common statement; New features of FORTRAN 90.

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Text and Reference Books

Sastry : Introductory methods of Numerical Analysis.
Rajaraman: Numerical Analysis.
Ram Kumar : Programming with FORTRAN 77
Press, Teukolsky, Vellering and Flannery : numerical Recipes in FORTRAN.
Desai: FORTRAN programming and Numerical methods.
Dorn and Mc Cracken : Numerical Methods with FORTRAN IV case studies.
Mathew : Numerical methods for Mathematics, Science and Engineering.
Jain, Iyngar and Jain: Numerical methods for Scientific and Engineering Computation"
Gould and Tobochnik : An Introduction to Computer Simulation methods part I and Part II.
Mc Calla : Introduction to Numerical methods and Fortran programming.
Verma, Ahluwalia and Sharma : Computation Physics : An Introduction.

M.Sc Physics Semester - III Paper XII (Option A1)
CONDENSED MATTER PHYSICS –I

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1 : Lattice Dynamics

Interatomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Optical phonons and dielectric constants. Inelastic neutron scattering. Mossbauer effect. Debye - Waller factor. Anharmonicity, thermal expansion and thermal conductivity.

Unit II : Optical Properties of Solids

Interaction of electrons and phonons with photons. Direct and indirect transitions. Absorption in insulators, Polaritons, one phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

Unit III : Electron-Phonon Interaction

Interaction of electrons with acoustic and optical phonons, polarons. Superconductivity: manifestations of energy gap. Cooper pairing due to phonons, BCS theory of superconductivity.

Unit IV : Superconductivity

Ginzsburg - Landau theory and application to Josephson effect : d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference. Vortices and type II superconductors, high temperature superconductivity (elementary).

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Text and Reference Books :

Madelung Introduction to Solid State Theory
Callaway : Quantum Theory of Solid State
Huang : Theoretical Solid State Physics
Kittel : Quantum Theory of Solids

M.Sc. Physics Semester -III Special Paper- XII (Option A2)
Digital Electronics

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I : NUMBER SYSTEMS
Binary numbers, Octal numbers, Hexadecimal numbers, Inter-conversions of numbers. Binary addition, subtraction, multiplication, signed numbers, 1's complement, 2's complement, 2's complement subtraction, Hexadecimal addition, subtraction, BCD code, Gray code, conversion from binary to Gray code and Gray code to binary code.

Unit II : DIGITAL ELECTRONICS
Positive and negative logic designations, OR gate, AND gate, NOT gate, NAND gate, NOR gate, XOR gate, Circuits and Boolean identities associated with gates, Boolean algebra-DeMorgans Laws, Sum of products and product of sums expressions, Minterm, Maxterm, deriving SOP and POS expressions from truth tables.

Unit III : COMBINATIONAL AND SEQUENTIAL LOGIC
Binary adders, half adders, full adders, decoders, multiplexer, demultiplexer, encoders, ROM and applications, Digital comparator, Parity checker and generator, Flip-Flops- RS, JK, master slave JK, T-type and D-type flip flops, Shift-register and applications, Asynchronous counters and applications.

Unit IV : MOS TECHNOLOGY AND DIGITAL CIRCUITS
Metal oxide semiconductor field effect transistors, enhancement mode transistor, depletion mode transistor, p-channel and n-channel devices, MOS invertors- static inverter, dynamic inverter, two phase inverter, MOS NAND gates, NOR gates, complementary MOSFET technology, CMOS inverter, CMOS NOR gates and NAND gates, MOS shift register and RAM

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Text and Reference books:

1. Integrated Electronics by J. Millman and C.C. Halkias (Tata McGraw Hill)
2. Digital Electronics by William Gothmann (Parentice Hall of India)
3. Digital logic by J. M.Yarbrough (Thomson Publication)

M.Sc Physics Semester- III Paper XII (Option A3)

NUCLEAR AND PARTICLE PHYSICS- I

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1 :

Nucleon - Nucleon interaction and Hadron Structure : Phenomenological Nucleon - Nucleon potentials - Meson theory - Derivation of Yukawa interaction - Electromagnetic properties of deuteron - Polarisation in nucleon - nucleon scattering - Scattering matrix - Probing charge distribution with electron - Form factors - Proton form factors - Deep inelastic electron - proton scattering - Bjokren scaling and partons - Quarks within the proton - Gluons as mediators of strong interaction.

Unit II :

Particle Phenomenology : Pion _ Nucleon scattering - Isospin analysis - Phase shifts - Resonance and their quantum numbers - Production and formation experiments Relativistic kinematics and invariants - Mandelstam variables - Phase space - Decay of one particle into three particles - Dalitz plot.

Unit III

Lonizing radiations : Ionization and transport phenomena in gases - Avalanche multiplication Detector Properties : Detection - Energy measurement - Position measurement Time measurement.

Gas Counters : Ionization chambers, - Proportional counters - Multiwire porportional counters - Geiger - Muller counters - Neutron detectors.

Solid State Detectors : Semiconductor detectors - Integrating solid state devices - Surface barrier detectors.

Unit IV

Scintillation counters : Organic and inorganic scintillators - Theory, characteristics and detection efficiency.

High Energy Particle Detectors : General principles - Nuclear emulsions - Cloud chambers - Bubble chambers - Cerenkov counter.

Nuclear Electronics : Analog and digital pulses - Signal pulses - Transient effects in an R-C circuit - pulse shaping- linear amplifiers - Pulse height discriminators - Single channel analyser - Multichannel analyser.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

G.E.Brown and A.D. Jackson, Nucleon - Nucleon Interaction, North - Holland, Amsterdam, 1976

S. de Benedetti, Nuclear interaction, John wiley and Sons, New York, 1964.

P. Marmier and E. Sheldon, Physics of Nuclei and Particles, Vol. I & II Academic Press, New York 1970.

H.A. Enge, Introduction to Nuclear Physics, Addison - Wesley, 1975.

S.S. Kapoor and V.S. Ramamurthy, Nuclear Radiation Detectors, Wiley - Eafstern, New Delhi, 1986.

W.H. Tait, Radiation Detection, Butterworths, London 1980.

W.J. Price ,Nuclear Radiation Detection, Mc Graw Hill, New York, 1964.

M.Sc Physics Semester- III Paper XII (Option A4)

Theory Marks: 80
Internal Assessment : 20
Time : 3 Hrs.

Atomic and Molecular Physics - I

Unit 1

Raman effect - quantum theory - molecular polarisability pure rotational Raman spectra of diatomic molecules - vibration rotation Raman Spectrum of diatomic molecules. Intensity alternation in Raman spectra of diatomic molecules.

Unit II

Electronic spectra of diatomic molecules, Born Oppenheimer approximation - vibrational coarse structure of electronic bands -progression and sequences, intensity of electronic bands - Frank Condon principle. Dissociation and pre-dissociation energy .

Unit III

Rotational fine structure of electronic bands. Experimental set up for Raman spectroscopy - application of IR and Raman spectroscopy in the structure determination of simple molecules.

Unit IV

The origin of X-Rays, X-Ray emission spectra, Dependence of position of Emission lines on the atomic number, X-Ray emission (Doublet) spectra, Satellites, Continuous X-ray Emission, X-Ray Absorption spectra.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
Introduction to Atomic spectra--H.E. White (T)
Fundamentals of molecular spectroscopy-- C.B. Banwell
Spectroscopy Vol I , II and III -- Walker and Straughen
Introduction to Molecular spectroscopy -- G. M. Barrow
Spectra of diatomic molecules-- Herzberg
Molecular spectroscopy -- Jeanne L McHale
Molecular spectroscopy-- J M Brown
Spectra of atoms and molecules-- P.F. Bemath
Modern spectroscopy--J M Holkas

M.Sc Physics Semester- III Paper XII (Option A5)
Informatics –I

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1 : Uses of Computer networks, network for companies , Network for people, social Issues, local Area Networks, Metropolitan Area, Networks, Wide area Networks, Wireless Networks, Internetworks, Network software, Protocol Hierarchies, Design Issues for layers, interfaces and services connection oriented and connectionless service, service and primitives, Relationship of services to protocols, The OSI Reference Model The TCP/IP Reference Model, Comparison of OSI AND TCP Reference Models. Data communication Services SMDS, x.25 Networks, Frame relay, Broadband ISDN & ATM..

Unit II : Network layer design issues, service provided to Transport layer, Internal organization of Network layer, Routing Algorithms, The optimality principle, Shortest path routing ,Flooding, Flow control and Buffering, The Internet, Internetworking, How networks differ, concatenated virtual circuits, connectionless internetworking, Tunneling Internet routing, IP Protocol, IP Addresses, Internet Transport Protocols (TCP AND UDP), The TCP Service model, TCP Protocol, UDP, Wireless TCP AND UDP, Domain name system (DNS) DNS Name space, Resource records, Name Servers, Electronic Mail, Architecture and Services.

Unit III : The telephone system, structure of the Telephone system. The local loop, Trunks and Multiplexing, Frequency Division multiplexing, Time division multiplexing, circuit switching, Packet switching, clock synchronization, centralized network access control, decentralized network access control, distributed network access control.

Unit IV : Geosynchronous satellites, Low orbit satellites, Satellite communication, Satellite Networks, Polling, ALDHA, FDM, TDM, CDMA, Fibre cables, Fibre optic Networks, Fibre distributed data interface, Fast Ethernet, High performance parallel interface, Fibre channel.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

Andrews S. Tanenbaum by Computer Networks PHI 2001
Computer Networks by William Stalling PHI.
Data communication by Reid and Bartskor
Data Networks by Gallanger
Data communication by William Stalling

M.SC Physics Semester - III Paper XIII (Option EL 1)
(QUANTUM ELECTRODYNAMICS)

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I

Dirac equation, properties of Dirac matrices. Projection operators, Traces. Feynman's theory of positron.

Unit II

Second quantization of Klein Gordon Field, Creation and Annihiliation operators, Commutation relations. Quantisation of electromagnetic field, creation and Annihilation operators, Commutation relations. Fock space representation.

Unit III

Interacting fields, Dirac (interaction) Picture , S-Matrix and its expansion. Ordering theorems, Feynman graph and Feynman rules.

Unit IV

Application to some problems like Rutherford scattering and Compton scattering, calculation of cross sections using Feynman graphs.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition therewill be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Bjorken & Drell : Relativistic Quantum Fields
Muirhead : The Physics of Elementary Particles
Schweber, Bethe and Hoffmann: Mesons and Fields
Sakural : Advanced Quantum Mechanics
Mandal : Introduction to Field Theory
Lee : Particle Physics and introduction to Field Theory.

M.SC Physics Semester - III Paper XIII (Option EL 2)
PHYSICS OF LIQUID CRYSTALS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Classification of Liquid Crystals

Symmetry, Structure and classification of liquid Crystals, Polymorphism in thermotropics, Reentrant phenomena in liquid crystals, Blue phases, Polymer liquid crystals, Distribution functions and order parameters, macroscopic and microscopic order parameters. Measurement of order parameters, magentic resonance, electron spin resonance, Raman Scattering and X-ray diffraction.

Unit II Theories of Liquid Crystalline Phase Transitions

Nature of phase transitions and critical phenomena in liquid crystals, hard particle, Maier - Saupe and Van der Waals theories for nematic - isotropic and nematic smetic A transitions; Landau theory : Essential ingradients, application to nematic isotropic, nematic-smetic A transitions and transitions involving smectic phases.

Unit III Continuum theory

Curvature elasticity in nematic and smectic A phases, distortions due to magnetic and electric Fields, magnetic Coherence length, Freedericksz transition, field - induced cholesteric-nematic transition.

Dynamical Properties of Nematics :The equations of nematodynamics, Laminar flow, molecular mortions.

Unit IV Optical porperties of Cholesterics

Optical properties of an ideal helix, agents influencing the pitch, liquid crystal displays.

Ferroelectic Liquid Crystals : The properties of smectic C, continuum description, smectic C smectic A transition, applications.

Discotic Liquid Crystals : Symmetry and structure, mean-field description of discotic liquid crystals, continuum description Lyotropic liquid crystals and biological membrane. Applications of liquid crystals.

> **Note** : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Chandrashekhar : Liquid Crystals
Vertogen & de Jeu : Thermotropic Liquid Crystals: Fundamentals
De Gennes & Prost : The Physics of Liquid Crystals
Introduction to liquid crystals : Physics and Chemistry (1977, Taylor and Francis)
Elston & Sambles : The Optics of Thermotropic Liquid Crystal
Collyer, Liquid Crystal Polymers : From Structures to Applications
Goodby et al: Ferroelectric liquid Crystals : Principles, Properties & Applications.

M.SC Physics Semester - III Paper XIII (Option EL 3)

Science and Technology of solar Cells, Hydrogen and other Renewable Energies.

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Solar Cells. 1

Elements of solar cells operation, semiconductors, light absorption and carrier generation, carrier recombination, pn junction, short circuit current, efficiency, factors affecting the conversion efficiency , Bandgap Energy, Temperature, Recombination Life Time, Light Intensity, Doping Density, Surface Recombination Velocities, Series Resistance.

Unit 2 Solar Cells - 2

Thin film and other unconventional cell materials, Copper Indium Selenide/Cadium Sulphide solar Cells, Indium Phosphide Solar Cells, Tin Oxide and Indium Tin Oxide, Polymer-semiconductor Schottky Barrier Cells, Organic Solar Cells, Loss Mechanisms, Multiple Cell system : spectrum splitting and cascade cells, thermocouple voltaic system, photo electrolytic cell, satellite power system.

Unit 3 Hydrogen Energy, Production and Utilizaztion

Relevance in relation to depletion of fossile fuels and environmental considerations, solar Hydrogen Energy system, Solar Hydrogen production ,direct thermal, thermochemical, electrolytic, photolytic, use of Hydrogen as a fuel, Use in vehicular transport, hydrogen for electricity generation, Fuel cells and other uses.

Unit 4. Other Renewable Clean Energies

Elements of Solar thermal energy, Wind energy and Ocean thermal energy conversion

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference books:

Solar Cells by Chenming kHu and R.M. White (McGraw Hill 1983)
Solar Energy Engineering ed by A.A.A. Sayigh (Academic Press)
Photoelectrochemical solar cells by Chandra
Hydrogen as an Energy Carrier -Technologies, Systems Economy by Winter and Nitch (Eds)
Solar cell devices - Physics by Fonash
Fundamentals of Solar Cells Photovoltaic Solar Energy by Fahrenbruch and Bube

M.SC Physics Semester -III Paper XIII (Option EL 4)
REACTOR PHYSICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Interaction of Neutrons with Matter in Bulk
Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium , extrapolation length and diffusion length - the albedo concept.

Unit II Moderation of Neutron
Mechanics of elastic scattering, average logarithmic energy decrement, slowing down power and moderating ratio of a medium. Fermi's age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length, Fermi age.

Unit III Theory of Homogeneous Bare Thermal Reactor
Critical equation, material and geometric bucklings, Neutron balance in a thermal reactor, four factor formula, typical calculations of critical size and composition in simple cases.
Homogeneous Natural Uranium Reactors : Advantages and disadvantages of heterogeneous assemblies, various types of reactors and a brief discussion of their design features.

Unit IV Problems of Reactor Control and Maintenance
Role of delayed neutrons, Inhour formula, temperature effects, fission product poisoning, use of coolants and control rods
Power Reactors : Fast breeder reactors, dual purpose reactors, concept of fusion reactors.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :
Glasstone & Edlund : : The elements of Nuclear Reactor theory
Murray : Introductions of Nuclear Engineering
The problems in the Text and Reference Books will form tutorial course.

M.SC Physics Semester - III Paper XIII (Option EL 5)
NUMERICAL METHODS AND PROGRAMMING

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Numerical Methods
Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions.
Solutions of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, matrix inversion

Unit II Eigenvalues and eigenvectors of matrices, Power and Jacobi Methood.
Finite differences, interpolation with equally spaced and unevenly spaced points. Curve fitting, Polynomial least squares and cubic Spline fitting.
Numerical differentiation and integration, Newton-Cotes formulae, error estimates, Gauss method.

Unit III Monte Carlo methods and numerical solution of differential equations : Random variate, Monte Carlo evaluation of integrals, Methods of importance sampling, Random walk and Metropolis method.
Numerical solutions of ordinary differential equations, Eeuler and Runge -Kutta methods, Predictor and corrector methods, Elementary ideas of solutions of partial differential equations.

Unit IV Fortran Programming
Digital Computer Principles, Compilers, Interpreters, Operating Systems, Fortran programming Flow charts, Integer and Floating Point Arithmetic, Expressions, built in functions, executable and non-executable statements, assignment, control and input-output elements, Subroutines and functions, Operation with files.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books
Sastry : Introductory Methods of Numerical Analysis.
Rajaraman Numerical Analysis
Rajaraman : Fortran Programming
Vetterming, Teukolsky, Press and Flannery : Numerical Recipes
The Problems given in the Text and Reference Books will form tutorial course.

M.SC Physics Semester -III Paper XIII (Option EL 6)
Physics of Laser and Laser Applications

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Laser characteristics : Spontaneous and Stimulated Emission, Absorption, Laser Idea, Pumping Schemes, Properties of Laser Beams : Monochromativity, Coherence, Directionality, Brightness, Radiation Trapping Superradiance, Superfluorescence, Amplified Spontaneous Emission, Non-radiative delay.
Unit II Pumping process: Optical pumping and pumping efficiency, Electrical pumping and pumping efficiency. Passive Optical Resonators, Rate Equations, Four-level Laser, Three-level Laser, Methods of Q-switching : Electro optical shutter, mechanical shutter, Acousto - optic Q-switches, Mode locking.
Unit III
Ruby Laser, Nd-Yag Laser, N_2 Laser, Dye-Laser, Semiconductor Laser.
Univ IV Multiphoton photo-electric effects, Two-photon, Three-photon and Multiphoton Processes Raman Scattering,Stimulated Raman Effect.Introduction to Applications of Lasers : Physics, Chemistry, Biology, Medicine, Material working ,optical communication, Thermonuclear Fusion, Holography, Military etc.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books
Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
Svelto : Lasers
Yariv Optical Electronics
Demtroder: Laser Spectroscopy
Letekhov : Non-Linear Spectroscopy
Principles of Lasers by Svelto
Lasers and Non-linear Optics by B.B. Laud.

M.SC Physics III Semester Paper XIII Paper IV (Option EL 7)
STRUCTURE, SPECTRA AND PROPERTIES OF BIOMOLECULES

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Structural Aspects of Biomolecules

Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary structure of Proteins, Structure of Polysaccharides.

Unit II Theoretical Techniques and Their Applications to Biomolecules

Hard sphere Approximation, Ramachandran Plot, Potential Energy Surfaces, Outline of Molecular Mechanics Method, Brief Ideas about Semi-empirical and Ab Initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their Uses.

Unit III Spoectroscopic Techniques and Their Application to Biomolecules

Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR Spectroscopy, Photoacoustic Spectroscopy, Photo-biological Aspects of Nucleic Acids.

Unit IV Structure - Function Relationship and Modeling

Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model.

> **Note** : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Srinivasan & Pattabhi,: Structural Aspects of Biomolecules
Govil & Hosur : Conformations of Biological Molecules
Price : Basic Molecular Biology
Pullman : Quantum Mechanics of Molecular Conformations'
Lehninger: Biochemistry
Mehler & Cordes : Biological Chemistry
Smith and Hanawalt : Molecular Photobiology, Inactivation & Recovery

M.SC Physics III Semester Paper XIII (Option EL 8)
DIAGRAM TECHNIQUES

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Formalism of Second Quantization
Quantum mechanical many body problem, boson and fermion systems, Creation and Annihilation operators, Commutation Relations, Vacuum state. The Hamiltonian in terms of creation and annihilation operators and its matrix elements for the simple cases of one - and two particle systems.

Unit II Time Dependent Operators
Schrodinger, Heisenberg and Interaction picture ,Time development operators (TDO), its properties and equation of motion, The integral equation for TDO and formal solution by iterative method, Dyson chronological operator, S-matrix expansion, Universality of S-matrix , Transition matrix, The adiabatic hypothesis and correspondence with usual perturbation theory.

Unit III Introduction to Graph
Creation and destruction operator in the interaction picture, Particle and hole operators. Reduction of chronological products. Normal product. Contraction of operators and Wick's theorem. Graphical representation of the expansion. First order graphs, Higher order graphs. The interaction term and ground state energy. Evaluation of the contributions of various graphs to the perturbation series, Linked and unlinked diagrams.

Unit IV Introduction to Green's Function
Differential equations and their Green's Functions. Examples of time independent Schrodinger equation. Resolvent operators. The single particle Green's function. Physical interpretation, Fourier transform of the Green's functions. Lehmann Representation and Kramer-Kronig relationship. Analytic properties and physical meaning of the poles, Relation between Green's function and the properties of the ground state. Its relation with elementary excitations. Concept of quasi particles.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :
Raimes: Many Electron Theory
Mandl : Introduction to Quantum Field theory
Abrikosov : Quantum Field Theoretical Methods in Statistical Physics
Fretter & Walecha : Quantum Theory of Many particle Systems
March, Young & Sampantha : The Many Body problems in Quantum Mechanics
Mattuch : Feynman Daigram Techniques.

M.SC Physics III Semester Paper XIII (Option EL 9)

PHYSICS OF ELECTRONIC DEVICES & FABRICATION OF INTEGRATED CIRCUITS AND SYSTEMS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Semconductor Materials

Energy Bands, Instrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors. Degenrate and compensated semiconductors. Elemental (Si) and compound semconductors (GaAs). Replacement of group III element and Group V elements to get tertiary alloys such as $Al_xGa_{(1-x)}As$ or $GaP_yAs_{(1-y)}$ and quaternary $In_xGa_{(1-x)}P_yAs_{(1-y)}$ alloys and their important properties such as band gap and refractive index changes with x and y. Doping of Si (Group III (n) and Group V (p) compounds and GaAs (Group II (P), IV (n.p.) and VI (n compounds). Diffusion of Impurities - Thermal Diffusion, Constant Surface Concentration, Constant Total Dopant Diffusion, Ion Implantation.

Unit II Carrier Transport in Semiconductors :

Carrier Drift under low and high fields in (Si and GaAs), saturation of drift velocity, High field effects in two valley semiconductors. Carrier Diffusion, Carrier injection, Generation Recombination Processes - Direct, Indirect bandgap semiconductors, Minority Carrier Life Time, Drift and Diffusion of Minority Carriers (Haynes-Shockley Experiment) Determination of; Conductivity (a) four probe and (b) Van der Paw techniques. Hall coefficient, Minority Carrier Life Time. Junction Devices : (i) p-n junction, effect of indirect and surface recombination currents on the forward biased diffusion current, p-n junction diodes - rectifiers (high frequency limit), (ii) Metal - semiconductor (Schottky Junction) : Energy band diagram, current flow mechanisms in forward and reverse bias, effect of interface states. Applications of Schottky diodes, (iii) Metal Oxide - Semiconductor (MOS) diodes. Energy band diagram, depletion and inversion layer. High and low frequency Capacitance Voltage (C-V) characteristics. Smearing of C-V curve, flat band shift. Application of MOS diode.

Unit III Transistors

JFET, BJT, MOSFET and MESFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions. High Frequency Limits.

Microwave Devices

Tunnel diode, transfer electron devices (Gunn diode). Avalanche Transit time devices (Read, Impatt diodes, and parametric devices)

Photonic Devices

Radiative and non-radiative transitions. Optical Absorption. Bulk and Thin film Photo - conductive devices (LDR) diode photodetectors, Solar cell - (Open circuit voltage and short circuit current, fill factor), LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), diode lasers (conditions for population inversion, in active region, light confinement factor. Optical gain and thershold current for lasing, Fabry - Perrot Cavity Length for lasing and the separation between modes).

Unit IV OVER VIEW AND BASIC PRINCIPLES OF THE FOLLOWING

Memory Devices

Static and dydnamic random access memories SRAM and DRAM CMOS and NMOS, non-volatile - NMOS, magnetic optical and ferroelectric memories, charge coupled devices (CCD).

Other Electric Devices

Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferroelectric Liquid Crystals and Polymeric materials for these devices. Piezoelectric, Electrostrictive and magneto strictive Effects, Important materials exhibiting these properties, and their applications in sensors and actuator devices. Acoustic Delay lines, piezoelectric resonators and filters. High frequency piezoelectric devices- Surface Acoustic Wave Devices. Pyroelectric effect. Inorganic oxide and Polymer pyroelectric materials and their applications.

Fabrication of Integrated Devices

Thin film Deposition Techniques: Vacuum pumps and gauges - pumping speed, throughout. Effective conductance control. Chemical vapor Deposition (CVD), MOCVD, PEMOCVD (Plasma enhanced chemical vapor deposition). Physical vapor Deposition : Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering and Laser Ablation.

Lithography, Etching and Micro-machining of Silicon, Fabrication of integrated Circuits and Integrated Micro - Electro - Mechanical - Systems (MEMS)

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

The Physics of semiconductor Devices by D.A. Eraser, Oxford Physics Series (1986)
Semiconductor Devices - Physics and Technology, by SM Sze Wiley (1985)
Introduction to semiconductor devices, M.S . Tyagi, John Wiley & Sons
Measurement, Instrumentation and Experimental Design in Physics and Engineering by M. Sayer and A. Mansingh, Prentice Hall, India (2000)
Thin film phenomena by K.L.Chopra
The material science of thin films, Milton S. Ohring
Optical electronics by Ajoy Ghatak and K. Thyagarajan. Cambridge Univ. Press
Material Science for Engineers by James F. Shackleford, Prentice Hall
Deposition techniques for films and coating, R.F. Bunshah (Noyes publications)
Solid State electronics, Ben G. Streetman

M.SC Physics III Semester Paper XIII (Option EL 10)

ATMOSPHERIC SCIENCE

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Physical Meteorology : Atmospheric composition, laws of thermodynamics of the atmosphere. Adiabatic process, potential temperature . The Clausis Clapyeron equation, laws of black body radiation, solar and terrestrial radiation, Albedo, Green house effect, Heat balance of earth-atmosphere system.

.**Dynamic Meterology :** Fundamental forces, non-inertial reference frames and apparent forces, structure of static atmosphere. Momentum, continuity and energy equations, Thermodynamics of the dry atmosphere, elementary applications of the basic equations. The circulation theorem, vorticity, potential vorticity, vorticity and potential vorticity equations.

Unit II Monsoon Dynamics

Wind, temperature and pressure distribution over India in the lower, middle and upper atmosphere during pre, post and mid-monsoon season. Monsoon circulation in the meridonal (Y-Z) and Zonal (X-Y) planes, energy cycle of monsoon. Dynamics of monsoon depressions and easterly waves . Intra seasonal and interannual variability of monsoon. Quasi-bi weekly and 30-60 day oscillations. ENSO and dynamical mechanism for their existence.

Unit III Numerical Methods for atmospheric Models

Filtering of sound and gravity waves, filtered forecast equations, basic concepts of quasi-geostrophic and primitive equation models, one level and multi-level models. Basic concepts of initialization and objective analysis for wave equation, advection equation and diffusion equation.

Atmospheric Pollution : Role of meteorology on atmospheric pollution, Atmospheric boundary layer, air stability, local wind structure, Ekman spiral, turbulence boundary layer scaling.

Residence time and reaction rates of pollutants, sulphur compounds, nitrogen compounds carbon compounds, organic compounds, aerosols, toxic gases and radio active particles trace gases.

Unit IV Atmospheric Instrumentation Systems

Ground based instruments for the measurement of Temperature, Pressure, Humidity, Wind and Rainfall Rate.

Air borne instruments - Radisonde, Rawinsonde, Rockestsonde-satellite instrumentation (space borne instruments)

Radar Meteorology : Basic meteorology-radar principles and technology - radar signal processing and display - weather radar-observation of tropical cyclones, use of weather radar in aviation, clear air radars-observation of clear air phenomena-other radar systems and applications.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

The Atmosphere by Fredrick K.Lutgens and Edward J.Tarbuk (for chapter I and VI)
Dynamic Meteorology by Holton, J.R. 3rd edition, Academic Press N.Yf.(1992). The Physics of Monsoons, By R.K.Keshvamurthy and M.Shankar Rao, Allied Publishers, 1992 (for kchapter 3)
Numerical Weather Prediction, by G.J.Haltiner and R.T.Villians, John Wiley and sons, 1980 (for chapter 4)
Principles of Air pollution meteorology by Tom Lyons and Prillscott, CBS publishers & Distributors (P) Ltd.
Radar Meterology by Henry Saugageot.

M.SC Physics III Semester Paper XIII (Option EL 11)
PLASMA PHYSICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I

Introduction to the Plasma State, elementary concepts and definitions of temperature and other plasma parameters, occurrence and importance of plasma for various applications.
Production of Plasma in the laboratory. Physics of glow discharge, electron emission, ionization breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of a discharge.
Plasma diagnostics : Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts.

Unit II

Single particle orbit theory : Drifts of charged particles under the effect of different combinations of electric and magnetic fields. Crossed electric and magnetic fields. Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves.
Fluid description of plasmas : distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximation commonly used in one fluid equations and simplified one fluid and MHD equations.

Unit III

Waves in fluid plasmas : dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion-acoustic waves, Alfven waves, Magnetosonic waves.
Stability of fluid plasma : The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, Plasma supported against gravity by magnetic field, energy principle.
Kinetic description of plasma : microscopic equations for may body systems : Statistical equations for a many body system, Vlasov equation and its properties, drift kinetic equation and its properties.

Unit IV

Waves in Vlasov Plasma : Vlasov equation and its Linearization, solutions of linearised Vlasov equation, theories of Langumuir waves, Landau damping, Ion Acoustic waves, Drift waves in magnetized plasmas.
Non-linear plasma theories : Non linear electrostatic waves, solitons, shocks, non linear Landau Damping.
Thermonuclear fusion : Status, problems and technological requirements.
Applications of cold low pressure and thermal plasmas.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

<u>Text and Reference Books :</u>

Introduction to Plasma Physics, FF Chen.
Principles of Plasma Physics, Krall and Trievelpiece
Introduction to Plasma Theory, DR Nicholson
The Plasma State, JL Shohet
Introduction to Plasma Physics, M.Uman
Principles of Plasma Diagnostic, IH Hutchinson
Plasma Diagnostic Techniques, RH, Huddelstone and SL Leonard

M.SC Physics III Semester Paper XIII (Option EL 12)

QUANTUM MANY BODY PHYSICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Formation of Second Quanization

Wavefunctions for identical particles, Symmetrized basis for Ferrions and Bosons, one particles & two particle operators and their matrix elements in symmetrized basis. Number space representations of the basis, creation and annihilation operators, commutation relations, Representation of operators in terms of creation and annihilation operators. Equation of motion for operators in number space.

Unit II Simple Applications

Electron gas: Hartree Fock approximation, ground state energy and single particle energy in paramagnetic and Ferromagnetic states. Role of exchange term, Ground state of Interacting Bosons, Bose-Einstein Condensate, Spectrum of elementary excitations, Superfuidity.

Unit III Green's Functions and Linear Response Theory

One particle and two particle Green's functions, Ground State energy and Linear response in terms of Green's functions, Analytic properties of Green's functions. Equations of Motion for Green's function.

Unit IV Perturbation Theory

Interaction representation, Gell-Mann-Low Theorem for Ground State Energy, Perturbation Expansion for Green's functions, Wick's theorem, diagrammatic representation, Dyson's equation, self energy, Polarization.

Application to Interacting Fermi Gas : Dilute Fermi gas, Landau Theory, Screening of Coulomb interaction, random phase approximation for electron gas.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Raimes: Many Electron Theory
Mandl : Introduction to Quantum Field theory
Abrikosov : Quantum Field Theoretical Methods in Statistical Physics
Fretter & Walecha : Quantum Theory of Many particle Systems
March, Young & Sampantha : The Many Body problems in Quantum Mechanics
Mattuch : Feynman Daigram Techniques.

M.SC Physics III Semester Paper XIII (Option EL 13)

NONLINEAR DYNAMICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Introduction to Dynamical Systems

Physics of nonlinear systems, dynamical equations and constants of motion, phase space, fixed points, stability analysis, bifurcations and their classifications, Poincare section and iterative maps.

Unit II Dissipative Systems

One - dimensional noninvertible maps, simple and strange attractors, iterative maps, period doubling and universality, intermittency, invariant measure, Lyapunov exponents, higher-dimensional systems, Henon map, Lorenz equation. Fractal geometry, generalized dimensions, examples of fractals.

Unit III Hamiltonian Systems

Integrability, Liouville's theorem, action - angle variables, introduction to perturbation techniques, KAM theorem, area preserving maps, concepts of chaos and stochasticity.

Unit IV Advanced Topics

One selection from quantum chaos, cellular automata and coupled map lattices, solitons and completely integrable systems, turbulence.

> **Note** : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Percival and D. Richards : Introduction to Dynamics
E.A. Jackson : Nonlinear Dynamics I & II
R.L.Devaney : Introduction to Dynamical System
Hao Bai-lin: Chaos
A.J. Lichtenberg and M.A. Lieberman : Regular and Stochastic Motion
M.C. Gutzwiller : Chaos in Classical and Quantum Mechanics
E. Off. M.Tabor

M.SC Physics III Semester Paper XIII (Option EL 14)

ENVIRONMENTAL PHYSICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Essentials of Environmental Physics

Structure and thermodynamics of the atmosphere. Composition of air. Greenhouse effect Transport of matter, energy and momentum in nature. Stratification and stability of atmosphere. Laws of motion, hydrostatic equilibrium. General circulation of the tropics. Elements of weather and climate of India.

Unit II Solar and Terrestrial Radiation

Physics of radiation. Interaction of light with matter. Rayleigh and Mie scattering. Laws of radiation (Kirchoffs law, Planck's law, Wien's displacement law, etc.), Solar and terrestrial spectra. UV radiation. Ozone depletion problem. IR absorption energy balance of the earth atmosphere suystem.

Unit III Environmental Pollution and Degradation

Elementary fluid dynamics. Diffusion, turbulence and turbulent diffusion. Factors governing air, water and noise pollution. Air and water quality standards. Waste disposal. Heat island effect. Land and see breeze. Puffs and plumes. Gaseous and particulate matters. Wet and dry deposition.

Unit IV Environmental Changes and Remote Sensing

Energy source and combustion processes Renewable sources of energy. Solar energy, wind energy, bioenergy, hydropower, fuel cells, nuclear energy. Forestry and bioenergy.

1. **Global and Regional Climate**

Elements of weather and climate. Stability and vertical motion of air. Horizontal motion of air and water. Pressure gradient forces. Viscous forces. Inertia forces. Reynolds number. Enhanced Greenhouse Effect. Energy balance ,a zero dimensional Greenhouse model, Global climate models.

> **Note** : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

Egbert Boeker & Rienk Van Groundelle : Environmental Physics (John Wiley).
J.T. Hougtion : The Physics of Atmosphere (Cambridge University Press 1977).
J. Twidell and J. Weir, Reneable Energy Resources (Elbs, 1988).
Sol Wieder. An introduction to Solar Energy for Scientists and Engineers (John Wiley, 1982)
R.N. Keshavamurthy and M. Shanker Rao : The Physics of Monsoons (Allied Publishers, 1992).
G.J. Haltiner and R.T. Williams : Numerical Weather Prediction (John Wiley , 1980)

M.SC Physics III Semester Paper XIII (Option EL 15)
PHYSICS OF NANOMATERIALS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I

Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, insulators and semiconductors, Density of states in bands, Variation of density of states with energy, Variation of density of states and band gap with size of crystal.

Unit II

Electron confinement in infinitely deep square well, confinement in two and one dimensional well, Idea of quantum well structure, Quantum dots, Quantum wires.

Unit III

Determination of particle size, Increase in width of XRD peaks of nanoparticles, Shift in photoluminescence peaks, Variations in Raman spectra of nanomaterials.

Unit IV

Different methods of preparation of nanomaterials, Bottom up : Cluster beam evaporation, Ion beam deposition, Chemical bath deposition with capping techniques and Top down : Ball Milling.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Nanotechnology Molecularly designed matrials by Gan -Moog Chow, Kenneth E. Gonsalves, American Chemical Society
Quantum dot heterostructures by D. Bimerg, M. Grundmann and N.N. Ledenstov, John Wiley & Sons, 1988.
Nano technology : :molecular speculations on global abundance by B.C. Crandall, MIT Press 1996.
Physics of low dimensional semiconductors by John H. Davies, Cambridge Univ. Press 1997.
Physics of Semiconductors nano structures by K.P. Jain, Narosa 1997.
Nano fabrication and bio system : Integrating materials science engineering science and biology by Harvey C. Hoch, Harold G. Craighead and Lynn Jelinskii, Cambridge Univ. Press 1996.
Nano particles and nano structured films ; Preparation characterization and applications Ed. J.H. Fendler, John Wiley & Sons 1998.

M.SC Physics III Semester Paper XIII (Option EL 16)
SOLID STATE ELECTRONICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1 **SEMICONDUCTOR MATERIALS**

Energy bands, Metals, Semiconductors and Insulators, Direct and Indirect bands, Variation of energy bands with alloy composition, Electrons and Holes, Effective mass, Intrinsic material, Extrinsic material, The Fermi Level, Electron and Hole concentration at equilibrium, Temperature dependence of carrier concentrations, Compensation and space charge neutrality. Conductivity and Mobility, Effect of Temperature and Doping on mobility. Hall Effect, Invariance of Fermi level.

Unit 2 CARRIER TRANSPORT IN SEMICONDUCTORS

Optical absorption and Luminescence, Carrier lifetime and Photoconductivity: Direct recombination of electrons and holes, Indirect recombination; Trapping, Steady state carrier generation, quasi Fermi levels. Photoconductivity Diffusion of Carrier, Diffusion and Drift of Carrier, Diffusion and recombination, diffusion length, Hayens Shockley experiment, gradient in quasi Fermi level.

Unit 3 **INTEGRATED CIRCUITS- FABRICATION AND CHARACTERISTICS**

Integrated circuit technology, basic integrated circuits, epitaxial growth, masking and etching- photolithography, Diffusion of impurities, monolithic transistor, monolithic diodes, integrated resistors, integrated capacitors, metal semiconductor contacts, Schottky diodes and transistors, Thin film deposition techniques , Chemical vapour deposition, Physical vapour deposition, Thermal evaporation.

Unit 4 **MICROWAVE DEVICES**

Resonant Cavity, Klystrons and Magnetron – velocity modulation, basic principle of two cavity klystron and reflex klystron, principle of operation of magnetron, Hot electrons, Transferred electron devices, Gunn effect, principle of operation, Modes of Operation, Read diode, Impatt diode, trapatt diode.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books:

Integrated Electronics by J.Millman and C.C.Halkias (Tata-McGraw Hill)
Solid State Electronic Devices by Ben G.Streetman (PHI)
Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication)
Linear Integrated Circuits by D.Roy Choudhury and Shail Jain (Wiley Eastern Ltd)
Physical Model for Semiconductor Devices by J.E.Carrol

M.Sc Physics Semester III Paper XIV (Option B1)
CONDENSED MATTER PHYSICS -II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit1: Crystal Physics

External symmetry elements of crystals. Concepts of point groups. Influence of symmetry on Physical properties : Electrical conductivity. Space groups, derivation of equivalent point position (with examples from triclinic and monoclinic systems), experimental determination of space group. Principle of powder diffraction method, interpretation of powder photographs.

Unit II : X-Ray Crystallography

analytical indexing: Ito's method. Accurate determination of lattice parameters - least-square method. Applications of powder method. Oscillation and Buerger's precession methods.; Determination of relative structure amplitudes from measured intensities (Lorentz and polarization factors), Fourier representation of electron density. The phase problem, Patterson function.

Unit III : Exotic Solids

Structure and symmetries of liquids, liquid crystals and amorphous solids. Aperiodic solids and quasicrystals; Fibonaccy sequence, Penrose lattices and their extension to 3-dimensions. Special carbon solids; fullerenes and tubules ; formation and characterization of fullerenes and tubules. Single wall and multi-wall carbon tubules. Electronic properties of tubules. Carbon nanotubule based electronic based electronic devices.

Unit IV : Nano Structural Materials

Definition and properties of nanostructured materials. Methods of synthesis of nanostructured materials. Special experimeental techniques for characterization nanostructured materials. Quantum size effect and its applications.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Azaroff : X-ray Crystallography
Weertman & Weertman : Elementary Dislocation Theory
Verma & Srivastava : Crystallography for Solid State Physics
Kittel : Solid State Physics
Azaroff & Buerger : The Powder Method
Buerger: Crystal Structure Analysis
M.Ali Omar: Elementary Solid State Physics
The Physics of Quasicrystals, Eds. Steinhardt and Ostulond
Handbook of Nanostructured Materials and Nanotechnology (Vol. 1 to 4). Ed. Hari Singh Nalwa

M.Sc Physics Semester III Paper XIV (Option B2)
ELECTRONICS -I

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

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, Differential PCM, Delta Modulation, Adaptive Delta modulation, CVSD.

Digital Modulation Techniques ; BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK

Unit II

Mathematical Representation of Noise: Frequency domain representation of nose, Effect of filtering on the probabiulity 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 nc(t), ns(t) and their time derivatives.

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 III :

Noise in pulse-code and Delta-modulation systems : PCM transmission, Calculation of Quantization noise, output - signal power. Effect of thermal noise, output signal - to - noise ratio in PCM, DM, Quantization noise in DM output signal power, DM output - signal - to quantization - noise ratio. Effect of thermal noise in Delta modulation, output signal to noise ratio in DM.

Unit IV

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.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Taub and Schilling, Principles of Communication Systems, Second Edition, TMH, 1994.
Simon Haykin, Communication Systems, Third Edition, John Wiley & Sons, Inc. 1994.

M.Sc Physics Semester III Paper XIV (Option B3)

NUCLEAR AND PARTICLE PHYSICS - II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1 :

Nuclear Reactions : Elementary approach to potential scattering theory - S-wave neutron scattering in the compound nuclear reaction model - Derivation and discussion of Breit - Wigner resonance formula - Single level single channel R-matrix (R-function) theory - Statistical model of compound nuclear reaction - pre-equilibrium reactions - Discussion of direct reactions - Ground state of deuteron - Magnetic moment - Quadrupole moment - S and D admixtures - Plane wave theory of deuteron - Stripping in zero range approximation - Spectroscopic factor and determination of nuclear level properties - Single nucleon transfer reactions.

Unit II

Theory of average cross sections - Properties of optical potentials - Heavy - ion collisions- Features of medium and low energy heavy- ion elastic scattering - Diffraction models - Nuclear fission and extended liquid drop model.

Nuclear Energy : The fission process - neutrons released in the fission process Cross sections - The fission reactions - Fusion - Thermonuclear reactions - Energy production in stars.

Unit III

Historical Developments : Different types of accelerators - Layout and components of accelerators - Accelerator applications.

Transverse Motion : Hamiltonian for Particle motion in accelerators - Hamiltonian in Frenet - Serret coordinate system - Magnetic field in Frenet - Serret coordinate system - Equation of betatron motion - Particle motion in dipole and quadrupole magnets - Linear betatron motion : Transfer matrix and stability of betatron motion - Courant - Snyder invariant and emittance - Stability of betatron motion - Sympletic condition - Effect of space - charge force on betatron motion.

Unit IV

Synchrotron Motion : Longitudinal equation of motion - The synchrotron Hamiltonian - The synchrotron mapping equation - Evolution of synchrotron phase space ellipse.

Linear Accelerators : Historical milestones - Fundamental properties of accelerating structures - Particle acceleration by EM waves - Longitudinal particle dynamics in Linac - Transverse beam dynamics in a Linac.

Principle and Design Details of Accelerators : Basic principle and design details jof accelerators viz electrostatic, electrodynamic with special emphasis on microtron, pelletron and cyclotron - Synchrotron radiation sources - Spectrum of the emitted radiation and their application.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Satchler, Introduction to Nuclear Reactions
H.A. Enge, Introduction to Nuclear Physics, Addison - Wesley, 1975.
B.L. Cohen, Concepts of Nuclear Physics, Tata Mc Graw Hill, New Delhi 1978.
P.Marmier and E. Sheldon, Physics of Nuclei and Particles, Vol. I & II Academic Press, 1969.
S.Y. Lee, Accelerator Physics, World Scientific, Siungapore, 1999.
J.J. Livingood, Principles of Cyclic Particle Accelerators, D. Van Nostrand Co., 1961.
J.P. Blewett, Particle Accelerators, McGraw - Hill Book Co.
S.P. Kapitza and V.N. Melekhin, The Microtron, Harwood Academic Publishers.
W.Scharf, Particle Accelerators and Their Uses, Harwood Academic Publishers.
I.M. Kapchinsky, Theory of Resonance Linear Accelerators, Harwood Academic Publishers.
P. Lapostole and A. Septier, Linear Accelerators, North Holland.

M.Sc Physics Semester III Paper XIV (Option B4)

Atomic and Molecular Physics - II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

NMR

NMR, The principle of NMR, NMR spectrometer, Types of NMR, Types of nuclei viewed from the stand point of NMR, High Resolution and Broad line NMR, Relaxation mechanisms, chemical shift; spin-spin coupling. Applications of NMR spectroscopy.

Mossbauer Spectroscopy

Mossbauer Spectrometer, Isomer nuclear transition, Resonance fluorescence, Mossbauer effect, Mossbauer nuclei, Isomer shift, quadrupole splitting, Magnetic hyperfine structure. Applications of Mossbauer spectroscopy.

Unit II

ESR spectrometer, substances which can be studied by ESR, Resonance condition. Description of ESR by Precession, Relaxation mechanisms, Features of ESR spectra (a) the g factor (b) Fine structure (c) hyperfine structure (d) ligand hyperfine structure. Applications of ESR

Unit III

Spontaneous and stimulated emission, Absorption, Einstein coefficients. The laser idea, properties of laser beams, Rate equations, methods of obtaining population inversions, laser resonator;

Unit IV

Nd: YAG Laser, CO_2 laser, Nitrogen laser, Dye laser, Laser Applications: Holography material processing fusion reaction, laser isotope separation.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
Quantum electronics - A. Yariv
Introduction to non-linear laser spectroscopy - M.D. Levenson
Molecular spectra and Molecular structure II and III -Herzberg

M.Sc Physics Semester III Paper XIV (Option B 5)
INFORMATICS (DATA COMMUNICATION) -II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Multiplexing (FDM, TDM), Switching paradigms (circuit, packet and cell switching), Propagation Delay, Clock Synchronization, Network access control (centralized, decentralized, distributed).

Unit II

Overview of Satellite Communication, Broadcast Channel and Optical Fibre Communication System, Power and Energy spectra, Distortionless Transmission, Signal distortion over a Channel.

Unit III

Multimedia techniques of data compression, voice, video, Mbone and interactive video-on-demand over the internet Mobile computing.

Unit IV

Fundamentals of Network Management (NM), Need for NM, Elements of NM system (Manager, Agent and a protocol, SNMP), Functional areas of NM defined by ISO Fault Management, Configuration Management, Performance Management, Security Management, Accounting Management, NM standards, TMN, Web based NM (Introduction), case studies : HP Open - View, IBM Net-view, SUN Solaris Enterprise manager.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Data communication by Reid and Bartskor
Data Networks by Gallager
Data communication by William Stalling
Communication networks by Leon-Garicia and Widjaja
Introduction to communication systems by S. Haykins
Analog and Digital Communication by S.Haykins
Multimedia Networking by Bohdan O Szuprowicz , McGraw - Hill Singapore, 1995 (ISE)
Internetworking Technologies Handbook by Marilee Ford et al, Cisco Press 1997.
Using SET for Secure Electronic Commerce by Grady N. Drew, PTRPrentice Hall, 1998.
Advanced Data Communications and Networking by N. Buchanan , Chapman & Hall, London, 1997.
IP Multicasting. The Complete Guide to Interactive Corporate Networks by Dave Kotur, John Wiley & Sons New York, 1998.
Computer Networks by William Stalling, PHI Computer Networks by S. Keshav. Addison

M.Sc Physics IV Semester Paper XV
Electrodynamics and wave propagation

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours .

Unit I Electrodynamics in four-vector notation : Review of four-vector and Lorentz transformation in four dimensional space; Conservation of charge and four current density; Electromagnetic field tensor in four dimensions and Maxwell's equations; Lorentz invariants of electromagnetic fields; Dual field tensor; Transformation of electric and magnetic field vectors; Covariance of force equation.
Unit II Simple radiating systems: Field and radiation of a localized source; Oscillating electric dipole; Centre fed linear antenna; Lienard-Wiechert potential ; Electric and magnetic fields due to a uniformly moving charge and accelerated charge; Linear and circular acceleration and angular distribution of power radiated.
Unit III Radiative reaction : Radiative reaction force; Scattering and absorption of radiation; Thompson scattering and Rayleigh scattering; Normal and anomalous dispersion; Ionoshere; Propagation of electromagnetic wave through ionosphere; Reflection of electromagnetic waves by ionosphere; Motion of charged particles in uniform **E** and **B** fields; Time varying fields.
Unit IV Wave guides and Transmission lines : Fields at the surface of and within a conductor; Wave guides; Modes in a rectangular wave guide; Attenuation in wave guides; Dielectric wave guides; Circuit representation of parallel plate transmission lines; Transmission line equations and their solutions; Characteristic impedance and propagation coefficient; Low loss radio frequency and UHF transmission lines.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

Classical Electrodynamics by J.D. Jackson
Introduction to Electrodynamics by D.J. Griffiths
Electromagnetic by B.B. Laud
Classical Electricity and Magnetism by Panofsky and Phillips
Fundamentals of Electromagnetics by M.A. Wazed Miah

M.Sc Physics IV Semester Paper XVI
CONDENSED MATTER PHYSICS

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I Crystal Physics and Crystal Diffraction

Crystalline solids, lattice, the basis, lattice translation, vectors, direct lattice, two and three dimensional Bravais lattice, conventional units cells of FCC, BCC, Nacl, CsCl, Diamond and cubic ZnS, primitive lattice cell of FCC, BCC and HCP; closed packed structures: packing fraction of simple cubic, bcc, fcc, hcp and diamond structures.

Interaction of x-rays with matter, absorption of x-rays, elastic scattering from a perfect lattice, the reciprical lattice and its application to diffraction techniques Ewald's construction, the Laue, powder and rotating crystal methods, atomic form factor, crystal structure fractor and intensity of diffraction maxima. Crystal structure factors of bcc, fcc, monatomic diamond lattice, polyatomic CuZn.

Unit II Lattice Vibration and Defects in Crystals

Vibration of one dimensional mono- and diotonic- chains, phonon momentum, density of normal modes in one and three dimensions, quantization of lattice vibrations, measurement of phonon dispersion using inelastic neutron scattering.

Point defects, line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, the observation of imperfection in crystals, x-rays and electron microscopic techniques.

Unit III Electronic Properties of Solids and Energy Bands.

Electron in periodic lattice, block theorem kronig-penny model and band theory, classification of solids, effective mass, weak-binding method and its application to linear lattice, tight-binding method and its application to cubic bcc and fcc crystals, concepts of holes, Fermi surface : construction of Fermi surface in two- dimension, de Hass van alfen effect, cyclotron resonance, magnetoresistanc.

Unit IV Ferromagnetism, Anti-ferromagnetism and Superconductivity

Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and magnons, Curie-weiss law for susceptibility. Ferri and Anti Ferro-magnetic order. Domains and Block wall energy.

Occurrence of supercunductivity, Messner effect, Type-I and Type-II superconductors, Heat capacity, Energy gap, Isoptope effect, London equation, Coherence length, Postulates of BCS theory of superconductivity, BCS ground state, Persistent current. High temperature oxide super conductors (introduction and discovery)

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books:

Verma and Srivastava : Crystallography for Solid State Physics
Azaroff : Introduction to Solids
Omar : Elementary Solid State Physics
Aschroft & Mermin : Solid State Physics
Kittel : Solid State Physics
Chaikin and Lubensky : Principles of Condensed Matter Physics
H. M. Rosenberg : The solid State.

M.Sc Physics Semester IV Paper XVII (Option C1)

CONDENSED MATTER PHYSICS - III

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Interacting electron gas: Hartree and Hartree - Fock approximation, correlation energy. Screening, Plasma oscillations. Dielectric function of an electron gas in random phase approximation. Limiting cases and Friedel oscillation.

Unit II

Strongly-interacting Fermi system. Elementary introduction to Landau's quasi - particle theory of a Fermi liquid. Strongly correlated electron gas. Elementary ideas regarding surface states, metallic surface and surface reconstruction.

Unit III

Point-defects : Shallow impurity states in semiconductors. Localized lattice vibrational states in solids. Vacancies, interstitials and colour centres in ionic crystals.
Disorder in concensed matter, substitutional, positional and topographical disorder, Short and long range order. Atomic correlation function and structural descriptions of glasses and liquids.

Unit IV

Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Madelung : Introduction to Solid State Theory
Callaway : Quantum Theory of Solid State
Huang : Theoretical Solid State Physics
Kittel : Quantum Theory of Solids

M.Sc Physics Semester IV Paper XVII (Option C2)

Electronics -2

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I

External Photoelectric Effect detector: Vacuum photodiode, photo-multipliers, microchannels, Internal Photoelectric Effect detectors: pn junction photodiode, solar cell (open circuit voltage, short circuit current, fill factor), pin photodiode, avalanche photodiode, phototransistor, Light emitting diode.

Unit II

Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, linear demodulation of AM waves, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation: PAM, PTM, PWM, PPM, PCM(in brief)

Unit III

Differential amplifier, CMRR, circuit configuration, emitter coupled supplied with constant current, transfer characteristics, block diagram of Op. Amp. Off-set currents and voltages, PSRR, Slew rate, universal balancing techniques, Inverting and non-inverting amplifier, basic applications- summing, scaling, current to voltage and voltage to current signal conversion, differential dc amplifier, voltage follower, bridge amplifier, AC-coupled amplifier.

Unit IV

Integration, differentiation, analog computation, Butterworth active filter circuits, logarithmic amplifier, antilogarithmic amplifier, sample and hold circuits, digital to analog conversion – ladder and weighted resistor types, analog to digital conversion- counter type, AC/DC converters, comparators, regenerative comparator (Schemitt trigger), Square wave generator, pulse generator, triangle wave generator.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference books:

Integrated Electronics by J. Millman and C.C.Halkias (Tata-McGraw Hill)
Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
Electronics communication Systems by George Kennedy and Bernard George (McGraw Hill).
Linear Integrated Circuits by D.Roy Choudhury and Shail Jain (Wiley Eastern Ltd)
Solid State Electronic Devices by Ben G. Streetman ((Parentice Hall of India)
Semiconductor Optoelectronic devices by Pallab Bhattacharya (Parentice Hall of India)

M.Sc Physics Semester IV Paper XVII (Option C3)

NUCLEAR AND PARTICLE PHYSICS-III

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Single particle Shell Model : Determinantal wave functions of the nucleus - single particle operator and their expectation values.

Extended Single Particle Model : Classification of shells - Senirotiy and reduced I - spin - Configuration mixing - Pairing force theory - Gap equation and ground state properties - idea of quasi particles - Simple description of two - Particle shell model spectroscopy.

Unit II

Collective Model of Nucleus : Deformable liquid drop and nuclear fission - Shell effects on liquid drop energy - Collective vibrations and excited states - Permanent deformation and collective rotations - Energy levels - Electromagnetic properties of even - even odd - A deformed nuclei Nilson model and equilibrium deformation - Behaviour of nuclei at high spin - Back bending.

Unit III

Introduction : Fundamentals of nuclear fission - Fission fuels - Neutron chain reaction - Multiplication factor - Condition for criticality - Breeding phenomena - Different types of reactors - Fusion - Nuclear fusion in stars.

The Diffusion of Neutrons : Neutron current density - The equation of continuity - Fick's law - The diffusion equation - Boundary conditions - Measurement of diffusion parameters.

Neutron Moderation : Moderation without absorption - Enrgy loss in elastic collisions - Collision and slowing - Down densities - Moderation - Space dependent slowing down - Fermi's age theory - Moderation with absorption - NR and NRIM approximations - Temperature effects on resonance absorption.

Unit IV

Criticality : Criticality of an infinite homogeneous reactor - The one - region finite thermal reactor - The critical equation - Optimum reactor shapes - Multiregion Reactors - One group and two group methods of calculation of criticality - Reflector savings - critical reactor parameters and their experimental determination.

Reactor Kinetics : Infinite reactor with and withoutn delayed neutrons - The Stable period - Reactivity and its determination - The prompt jump and prompt critical condition - Changes in reactivity - Temperature coefficients - Fuel depletion effects.
Reactor Control : Control - rod worth - One Control rod - Modified one group and two - group theories.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

<u>Text and Reference Books :</u>

M.A. Preston and R.K. Bhaduri, Structure of the Nucleus, Addison Wesley, 1975.
R.R. Roy and B.P. Nigam, Nuclear Physics, Wiley - Eastern Ltd. 1983.
M.K. Pal, Theory of Nuclear structure, Affiliated East West Madras, 1982.,
P.Marmier and E. Sheldon, Physics of Nuclei and Particles, Vol. II. Academic Press, New York:1971
H.A. Enge, Introduction to Nuclear Physics, Addison Wesley, 1975.
J.R.Lamarsh, Introduction to Nuclear Reactor Theory, Addison Wesley, 1966.
P.F. Zweifel, Reactor Physics, Mc-Graw Hill Kogakusha Ltd. Kokyo, 1973.
S. Glasstone and M C Ediund, The Elements of Nuclear Reactor Theory, Van Nostrand Co., 1953.
A.M. Weinberg and E.P. Wigner, The Physical Theory of Neutrton Chain Reactors, University of Chicago Press, 1958.

M.Sc Physics Semester IV Paper XVII (Option C4)
ATOMIC AND MOLECULAR PHYSICS -II

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Time dependence in quantum mechanics - Time dependent perturbation theory - Rale expression for emission - perturbation theory calculation of polarisability - Quantum mechanical expression for emission rate.

Unit II

Time correlation function and spectral Fourier transform pair- Properties of time correlation function and spectral time shape-Fluctuation dissipation theorem - Rotational correlation function and pure rotational spectra - Re orientational spectroscopy of liquids.

Unit III

Two photon absorption spectroscopy - Selection rules - Expression for TPA cross section photo acoustic spectroscopy -PAS in gaseous medium - Roseneweig and Greshow theory - Thermally thin thick samples.

Unit IV

Typical experimental setup - Application in spectroscopy - Stimulated Raman Scattering - Quantum mechanical treatment - Raman oscillation parametric instabilities -Electromagnetic theory of SRS.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

Quantum electron A.- Yariv
Introduction to non linear laser spectroscopy - M.D. Levenson
Photoacoustics and its application - Roseneweig
Molecular spectroscopy - Jeane L McHale
Molecular quantum mechanics - P.W. Alkins & R.S. Friedman
Structural methods in inorganic chemistry - E.A.V. Ebsworth, D.W.H.Rankin & S. Cradock.

M.Sc Physics Semester IV Paper XVII (Option C5) INFORMATICS -III (MATERIALS AND DATA COMMUNICATION)

Max. Marks : 80
Internal Assessment :20
Time : 3 Hrs.

Unit I

Semiconductor Quantum structures, Heterostructures, Mismatch Heterostuctures, Coherently Strained Structures, Partially Relaxed Strained Layer Structures, Methods of Formation of Hetrostructures, some of the examples of heterostructures.

Unit II

Bandgap engineering, Strained Layer Epitaxy, Light emitting Diodes, Etched Well surface emitting LED, Continuous operation lasers, Heteroquantum Lasers, CW Heteroquantum Laser, Stripe Geometry.

Unit III

Fourier series and transforms and their appilcations to data communication.
Introduction to Probability and Random Variables. Introduction to Information Theory and Queuing Theory.
Introduction and Evolution of Telecommunication, Fundamentals of electronic communication: Wired, Wireless, Satellite and optical Fibre, Analog/digital, Serial/parellel, Simplex/half and full duplex, Syncronous/Asynchronous, Bit/baud rates, Parity and error control (CRC,LRC,ARQ etc.), Signal to Noise Ratio.

Unit IV

Transmission types, codes, modes, speed and throughput. Modulation types, techniques and standards. Base band carrier communication, Detection, Interference, Noise signals and their charecterization, Phase Locked Loops.

Modems, Transmission media (guided and unguided), Common Interface standards.

Note : The syllabus is divided into **four units**. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be **two** questions from each unit and the student is to answer one questions from each unit.

Text and Reference Books :

Data communication by Reid and Bartskor
Data Networks by Gallager
Data Communication by William Stalling
Communication networks by Leon- Garcia and Widjaja
Introduction to communication systems by S. Haykins
Analog and Digital Communication by S. Haykins

M.Sc Physics Semester IV Paper XVIII (Option D1)
CONDENSED MATTER PHYSICS- IV

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Mechanics of plastic deformation in solids, Stress and strain fields of screw and edge dislocations. Elastic energy of dislocations. Forces between dislocations, stress needed to operate Frank-Read source, dislocations in fcc, hcp and bcc lattices. Partial dislocations and stacking faults in close - packed structures.

Unit II

Experimental methods of observing dislocations and stacking faults. Electron microscopy : kinematical theory of diffraction contrast and lattice imaging.

Unit III

Study of surface topography by multiple-beam interferometry, Conditions for accurate determination of step height and film thicknesses (Fizeau fringes). Elementary concepts of surface crystallography. Scanning, tunnelling and atomic force microscopy.

Unit IV

Electrical conductivity of thin films, differences of behaviour of thin films from bulk, Boltzmann transport equation for a thin film (for diffused scattering), expression for electrical conductivity for thin film.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :v

Azaroff: X-ray Crystallography
Weertman & Weertman : Elementary Dislocation Theory
Vermeer & Srivastava : Crystallography for Solid State Physics
Kittel : Solid State Physics
Azaroff & Buerger : The Powder Method
Buerger : Crystal Structure Analysis
Thomas : Transmission electron Microscopy
Tolansky : Multiple Beam interferometry
Heavens : Thin Films
Chopra : Physics of Thin Films
Hirsh et. Al : Electron Microscopy of Thin Crystals
Henry et al. : The Interpretation of X-ray Diffraction photographs.

M.Sc Physics Semester IV Paper XVIII (Option D2)

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Electronics - III

Unit I

Micrioprocessors and Architecture : Internal Microprocessor Architecture, Real mode and protected modes of memory addressing, memory paging.

Addressing modes : Data addressing modes. Program memory addressing modes, Stack memory addressing modes.

Instruction Set : Data movement instructions, Arithmetic and Logic instructions, Program control instructions. Assembler details.

Unit II

Programming the Microprocessor : Modular programming, using the keyboard and video display, Data conversions, Disk files, Example programms.

Hardware Specifications : Pin outs and the Pin functions, clock generator (8284A), Bus buffering and Latching, Bus timing. Ready and wait state, Minimum mode versus maximum mode.

Unit III

Memory interface, Memory devices, Addresses decoding, 8088 and 80188 (8-bit) memory interface, 8086, 80186, 80286 and 80386 (16-bit) memory interface, 80386 DX and 80486 (32-bit) memory interface, Dynamic RAM.

Basic I/O Interface : Introduction to I/O interface, I/O port address decoding 8255, 8279, 8254, 16550, ADC and DAC (excluding multiplexed display & keyboard display using 8255)

Unit IV

Interrupts : Basic interrupt processing, Hardware interrupts. Expanding the interrupt structure, 8259A PIC.

Direct Memory Access : Basic DMA operation, 8237 DMA controller, Shared Bus operation, Disk memory systems, Video displays.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Barry B.Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro processor architrecture, programming and interfacing "Fourth Edition, PHI, 1999.

Douglas V. Hall, "Microprocessors and Interfacing, Programming and Hardware", second edition, McGraw Hill International Edition, 1992.

Muhammad Ali Maxidi and Janice Gillispie Mazidi, "The 80x86 IBM and Compatible Computers (Volumes I & II). Second edition, Prentice - Hall, International, 1998.

M.Sc Physics Semester IV Paper XVIII (Option D3)
NUCLEAR AND PARTICLE PHYSICS - IV

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Strong interactions and symmetries : uses of Symmetry - Space time and internal symmetries - Lie groups generators and Lie algebra - Casimir operators - SU(2) irreducible representation - Weight diagram - Diagonal generators - SU(3) generators - U and V spin - Raising and lowering operators - Root diagram - Weight diagram - Multiplets of SU (n) - Baryons and meson multiplets - Symmetry breaking - Gell - Mann Okubo mass formula - Charm, bottom and top quarks and higher symmetry - Bag model for hadrons.

Unit II

Weak and and Electromagnetic interactions : Invariance of Dirac equation - Bilinear covariants - Properties of gamma matrices - Leptonic, semileptonic and nonleptonic weak decays - Selection rules for leptons - Current - current interaction and V-A theory - Universality - Abelian and non-Abelian gauge invariance - Spontaneous symmetry breaking and Higgs mechanism - Standard model for electro weak unification.

Unit III

Perturbative QCD I : Colour gauge invariance and QCD Lagrangian - Deep inelastic scattering : The GLAP equations - an alternative approach to the GLAP equations - Common parameterizations of the distribution functions - Structure Functions ,The spin - dependent structure functions and the MIT bag model.

Unit IV

Perturbative QCD II : The Drell - Yan process - Small x Physics and the Gribov - Levin -Ryskin equation.

Nonperturbative QCD : QCD sum rules - The ground state of QCD - Equation of state of a quark gluon plasma - Hadronization phase transition.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

F. Halzen and A.D. Martin, Quarks and Leptons, John - Wiley & Sons, New York, 1984.
G. Kane, Modern Elementary Particle Physics, Addison - Wesley, 1987.
D.B. Lichtenberg, Unitary Symmetry and Elementary Particles, 2nd Edition, Academic Press, 1978.
R.K. Bhaduri, Models of Nucleon, Addison - Wesley, Reading, MA 1988.
J McL Emmerson, Symmetry Principles in Particle Physics, Clarendon Press, Oxford, 1972.
M. Leon, An introduction to Particle physics, Academic Press, New York, 1973.
I.J.R. Aitchison and A.J.G.Hey , Gauge Theories of Particle Physics , Adam Hilger, Bristol, 1989.
D.H. Perkins, Introduction to High Energy Physics, Addison- Wesley, London, 1982.
W. Greiner and A. Schafer, Quantum Chromodynamics, Springer, Berlin, 1993.
D.H. Parkins, Introduction to High Energy Physics, Addison - Wesley, London, IV Edition, 2000.
F.J.Yndurain, Quantum Chromodynamics - An introduction to the Theory of Quarks and Gluons, Springer - Verlag, New York., 1983.

M.Sc Physics Semester IV Paper XVIII (Option D4)
ATOMIC AND MOLECULAR PHYSICS -IV

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit I

Vibronic interaction, Herzberg Teller theory, Fluorescence spectroscopy, Kasha's rule, Quantum yield, Non-radiative transition, Jablonski diagram.

Unit II

Time resolved fluorescence and determination of excited state lifetime.
Light detectors, Single photon counting technique, Phase sensitive detectors

Unit III

Laser optogalvanic spectroscopy, Matrix isolation spectroscopy, Fourier transform spectroscopy, Laser cooling.

Unit IV

Molecular symmetry and group theory, Matrix representation of symmetry elements of a point group reducible and irreducible representations, character tables specially for C_{2v} and C_{3v} point groups, Normal coordinates and normal modes, Application of group theory to molecular vibrations.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text Books and References :

JM Hollas, High Resolution Spectroscopy
Cotton ,Chemical Application of group theory
Herzberg, Molecular spectra and Molecular structure II & III
Demtroder, Laser spectroscopy and Instrumentation
King, Molecular Spectroscopy
Lakowicz, Principles, Fluorescence Spectroscopy.

M.Sc Physics Semester IV Paper XVIII (Option D5)

INOFRMATICS (C++ & INTERNETWORKING TECHNOLOGY)

Theory Marks:80
Internal Assessment Marks:20
Time : 3 Hours

Unit 1

Introduction to UNIX/LINUX, Conceptual frame work of Computer languages, Introduction to C/C_{++} : constants, variables, data types, declaration of variables, user defined declaration, operators, heirarchy of arithmatic operators, expressions and statements; Control statements: if, switch, conditional operator, goto, if ---- else.

Unit II

Decision making and looping statements : while, do --- while, for; built in functions and programme structure, strings; input and output statement; pointers and arrays; subprograms; function overloading recursion; file access.

Unit III

Object oriented concepts; classes, objects, incapsulation and inheritence, reuse and extension of classes, inheritance and polymorphism; virtual functions and virtual classes; friend functions and friend classes. Case studies and applications using some object oriented programming languages.

Unit IV

Introduction to web enabling technologies and languages: Introduction to HTML, HTML Page Formatting Basics, Tables and Frames, Web Page Forms, Introduction to JAVA, Basic difference between C++ and JAVA.

Note : The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

Timothy Bold : An Introduction to Object Oriented Programming 2nd Edition, Addison - Wesley 1997.
Balgurisamy E: Object Oriented Programming with C_{++} ,Tata McGraw Hill, 2000.
Chandra B: Object Oriented programming using C+ +, Narosa, New Delhi, 2002.
Rajaram R: Object Oriented programming and C+ +, New Age, New Delhi, 1999.
Mcgrath Mike: HTML 4, Dreamtech Press, New Delhi, 2001.
Merger David: HTML, Tata Mc Graw Hill, New Delhi, 2002.
Kamthane Ashok N.: Object Oriented Programming with ANSI & TURBO C++, Pearson

M.Sc Physics Laboratory / Practical Course III & IV Semester

Paper XIX Part A **General**

Max Marks: 100
Time: 4 hrs

1. To study the frequency variation in R-C phase shift. Oscillator, Colpitt Oscillator and Hartley Oscillator.
2. To determine the e/m for electron by Helical method.
3. To calibrate the prism/grating spectrometer with mecury vapour lamps and hence to find the Cauchy's constant.
4. To study the characteristics of a photovoltaic cell)p-n) junction solar cell.
5. To determine the band gap energy for the Ge crystal.
6. To study the Hall effect and to determine the Hall co-efficient for a Ge Crystal.
7. To measure the dielectric constant of unknown liquid.
8. To determine the magnetic susceptibility of NiSO4, FeSO4, CoSO4 by Gauy's method.
9. To study the B-H curve for a given sample using CRO.
10. To determine the plate characteristics of G.M. Counter and to find out the absorption coefficient foil absober using B-Delay source.
11. Multivibrator
12. Digital Ckt. Logic gate.
13. Active and Passive Filters.
14. Lattice dynamic Kit
15. E.S.R. of DPPH
16. He-Ne Layer
17. Push Pull amplifier
18. Chopper Amplifier.

To write computer programs and execute for the following:-

19 Matrix multiplication for two or more matrices
20 To arrange numbers in ascending /descending orders
21 To make a list of prime numbers between 1 and 100
22 To find the H.C.F. of three numbers.
23 To find the sum of some special infinite series

Note At least ten of the above experiments must be set up. The student has to perform One experiment from Part-A in the examination.

M.Sc. Physics III & IV Semester Laboratory/Practical Course

Paper XIX Part B **COMPUTER EXPERIMENTS**

Maz Marks: 100
Time: 4 hrs

1 Computer Graphics
2 (a) Numerical Integration
(b) Least square fitting
(c) Numerical solutions of equations (single veriable)
(d) Interpolation
(e) Numerical solution of simultaneous linear algebraic equations
(f) Numerical differentiation
(g) Matrix inversion
(h) Matrix eigen values.
(i) Numerical solution of ordinary differential equation
(j) Numerical Solution of second order ordinary differential equations

Note: The student has to perform one experiment from part B.

M.Sc. Physics III & IV Semester Laboratory/Practical Course

ELECTRONICS

Paper XX

Max Marks: 200
Time: 4 hrs

1. Pulse Amplitude Modulation/Demodulation
2. Pulse position/Pulse width Modulation/Demodulation
3. FSK Modulation Demodulation using Timer/PLL
4. Microwave characterization and Measurement
5. PLL circuits and applications
6. Fibre Optics communication
7. Design/Study of Active & Passive filters
8. BCD to Seven Segment display
9. A/D and D/A conversion
10. Experiments using various types of memory elements
11. Addition, subtraction, multiplication & division using 8085/8086.
12. Wave form generation and storage oscilloscope.
13. Frequency, Voltage, Temperature measurements.
14. Motor Speed control, Temperature control using 8086.
15. Trouble shooting using signature analyzer
16. Assembler language programming on PC
17. Experiments based on Computer Aided design.
18. Op. Amp.
19. Push-Pull Amp.
20. Chopper Amplifier
21. Coupling Methods in Amplifiers.
22. Digital Comporator
23. Analog Comparator
24. Integrating & Differentiating Ckt.
25. Binary Module, Cascade Counter, Shift Register.
26. Logic gates.

M.Sc. Physics III & IV Semester Laboratory/Practical Course
Condensed Matter Physics

Paper XX

Max Marks: 200
Time: 4 hrs

1. Measurement of lattice parameters and indenning of powder photographs.
2. Interpretation of transmission Lauc photographs.
3. Determination of orientation a/c crystal by back reflection lane method.
4. Rotation/Oscillation photographs and their interpretation.
5. To study the modulus of rigidity and internal friction in metals as a function of temperature
6. To measure the clearage step height of crystal by Multiple Fizeane fringes.
7. To obtain multiple beak fringes of equal chromatic order. To determine crystal step height and study berefringence.
8. To determine magnetoresistance of a Bismuth crystal as a function of magnetic field.
9. To study hysterisis in the electrical polarization of a TGS crystal and measure the Curie temperature.
10. To measure the dislocation density of a crystal by etching.
11. To study lattice dynamics simulation.
12. To study magnetic susceptibility.
13. To study B-H curve.
14. To determine the barch of Ge material
15. To study temperature effect on transistor amplifier.
16. To study dielectric properties of liquids & Solids
17. To study ESR spectrum
18. To study Hall effect and to determine Hall coefficient.
19. To study electrical resistivity of Semiconductors by four probe method.

Setting of new experiments will form tutorial for this lab. Course.

M.Sc. Physics III & IV Semester Laboratory/Practical Course

Paper XX

Max Marks: 200
Time: 4 hrs

ATOMIC AND MOLECULAR PHYSICS

1. Study of line spectra on photographed plates/films and calculation of plate factor.
2. Verification of Hartman's dispersion formula.
3. Study of sharp and diffuse series of potassium atom and calculation of spin orbit interaction constant.
4. Determination of metallic element in a given inorganic salt.
5. To record the spectrum of CN violet bands and to perform vibrational analysis.
6. To record the visible bands of ALO and to perform vibrational analysis.
7. To photograph and analyse the reddish glow discharge in air under moderate pressure.
8. To photograph the analyse the whitish glow discharge in air under reduced pressure.
9. To perform vibrational analysis of a band system of N2.
10. To perform vibrational analysis of band system of C2
11. To photograph and analyse the line spectrum of Calcium atom.
12. To record/analyse the fluorescence spectrum of a sample.
13. To record/analyse the Raman spectrum of a sample.
14. Study of Hyperfine structure of the green line of mercury.
15. To photograph the (O, O) band of CuH and to perform rotational analysis.
16. Flashing & quenching in Neon Gas.
17. E/m of electron.
18. Experiments on Prism/Grating Spectrometer.
19. Wavelength of laser light.
20. Faraday effect with laser.
21. Michelson interferometer.
22. Analysis of ESR Spectra of transition metals.
23. Analysis of H-atom spectra in minerals.
24. Measurements of dielectric constant.
25. E.S.R. of DPPH.

Setting of new experiments will be tutorial for this lab. Course.

M.Sc. Physics III & IV Semester Laboratory/Practical Course

Paper XX

Max Marks: 200
Time: 4 hrs

NUCLEAR AND PARTICLE PHYSICS

1. To determine the operating voltage, slope kof the plateau and dead time of a G.M. Counter.
2. Features analysis using G.M. Counter.
3. To determine the operating voltage of a photomultiplier tube and to find the photopeak efficiency of a NaI (II) crystal of given dimensions for gamma rays of different energies.
4. To determine the energy resolution of a NaL (TI) detector and to show that it is independent of the gain of the amplifier.
5. To calibrate a gamma ray spectrometer and to determine the energy of a given gamma ray source.
6. To determine the mass attenuation coefficient of a gamma rays in given medium.
7. To study the Compton scattering using gamma rays of suitable energy.
8. To study the various models in a multichannel analyser and to calculate the energy resolution, energy of gamma ray.
9. To determine the beta ray spectrum of Cs-137 source and to calculate the binding energy of K-shell electron of Cs 137.
10. To study the Rutherford scattering using aluminium as scatter and Am-241 as a source.
11. To measure the efficiency and energy resolution of a HP Ge detector.
12. Alpha spectroscopy with surface barrier detector - Energy analysis of an unknown gamma source.
13. Determination of the range and energy of alpha particle using spark counter.
14. The proportional counter and low energy X-ray measurements.
15. X-ray fluorescence with a proportional counter.
16. Neutron activation analysis.
17. Gamma-gamma coincidence studies.
18. Identification of particles by visual range in nuclear emulsion.
19. Construction and testing of a single channel analyser circuit.
20. Decoding and display of the outputs from the IC 7490.