MASTER OF SCIENCE (PHYSICS) – FIRST SEMESTER

First Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Classical Mechanics	5	100
2	Quantum Mechanics - I	5	100
3	Electronics Devices	5	100
4	Mathematical Physics	5	100
5	General Laboratory-I	4	100
Total		**24**	

Subject Name: CLASSICAL MECHANICS

Unit 1: Preliminaries; Newtonian mechanics of one and many particle systems; conservation laws, work-energy theorem; open systems (with variable mass).Constraints; their classification; D'Alembert's principle' generalized coordinates.

Unit 2: Lagrange's equations; gyroscopic forces; dissipative systems; Jacobi integral ;gauge invariance; generalized coordinates and momenta; integrals of motion; symmetries of space and time with conservation laws; invariance under Galilean transformations.

Unit 3: Rotating frames; inertial forces; terrestrial and astronomical 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 equation; artificial satellites; Rutherford scattering.

Unit 4: Principle of least action; derivation of equations of motion; variation and end points; Hamilton's principle and characteristic functions; Hamilton-Jacobi equation. Canonical transformation; generating functions; Properties; group property; examples; infinitesimal generators; Poisson bracket; Poisson theorems; angular momentum PBs; small oscillations; normal modes and coordinates.

Recommended Texts:

1. Classical Mechanics, by N C Rana and P S Joag (Tata McGraw-Hili,1991)
2. Classical Mechanics, by H Goldstein(AddisonWesley,1980)
3. Mechanics, by A Sommerfeld (AcademicPress,1952)
4. Introduction to Dynamics, by I Perceival and D Richards(CambridgeUniv.Press.1982).

Subject Name: QUANTUM MECHANICS- I

Unit 1: Why QM? Revision ;Inadequacy of classical mechanics; Schrodinger equation; Continuity equation; Ehrenfest theorem; Admissible wave functions; Stationary states.

Unit 2: One-dimensional problems, wells and barriers; Harmonic oscillator by Schrodinger equation and by operator method.

Unit3: Uncertainty relation of x and p, States with minimum uncertainty product; General formalism of wave mechanics; Commutation relations; Representation of states and dynamical variables; Completeness of eigen-functions; Dirac delta function; bra and ket notation; Matrix representation of an operator; Unitary transformation.

Unit 4: Angular momentum in QM; Central force problem: Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom.

Unit 5: Time-independent perturbation theory; Non-degenerate and degenerate cases; Applications such as Stark effect.

Recommended Texts:

1. Quantum Mechanics, LI Schiff,(McGraw-Hili)
2. Quantum Physics, S Gasiorowicz, (Wiley)0
3. Quantum Mechanics, B Craseman and J0 Powell, (Addison Wesley)
4. Quantum Mechanics AP Messiah,
5. Modem Quantum Mechanics JJ Sakurai,
6. Quantum Mechanics, Mathewsand Venkatesan

Subject Name: ELECTRONICS DEVICES

Unit 1: Transistors: JEET, BJT, MOSFET and MESFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions .High Frequency limits.

Unit 2: Microwave Devices: Tunnel diode, transfer electron devices (Gunn diode) Avalanche Transit time devices, Impatt diodes and parametric devices.

Unit 3: Photonic Devices: Radioactive and non-radioactive transitions. Optical Absorption, Bulk and Thin film Photoconductive devices (LOR), diode photo detectors, 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 laser(conditions for population inversion, inactive region, light confinement factor. Optical gain and threshold current for lasing, Fabry-Perrot Cavity Length for lasing and the separation.

Unit 4: Memory Devices: Static and dynamic random access memories S RAM and D RAM, CMOS and NMOS, non-volatile - NMOS, magnetic, optical and ferroelectric memories, charge coupled devices (CCD).

Unit 5: Other Electronic Devices: Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferro electric, Liquid Crystal and Polymeric materials for these devices. Piezoelectric, Electro strictive 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.

Recommended Texts:

1. Semiconductor Devices – Physics and Technology, by S M Sze Wiley(1985)
2. Introduction to semiconductor devices, M.S .Tyagi, John Wiley &Sons
3. Measurement, Instrumentation and Experimental Design in Physics and Engineering by M.Sayerand A. Mansingh Prentice Hall, India(2000)
4. Optical electronic by Ajoy Ghatak and K. Thyagarajan Cambridge Univ. Press

Subject Name: MATHEMATICALPHYSICS

Unit 1: Vector Spaces and Matrices

Linear independence: Bases; Dimensionality; Inner product; Linear transformations; Matrices; Inverse; Orthogonal and unitary matrices; Independent elements of a matrix; Eigen values and Eigen vectors; Diagonalization; Complete orthonormal sets of functions.

Unit 2: Differential Equations and Special Functions

Second order linear ODEs with variable coefficients ;Solution by series expansion; Legendre ,Bessel, Hermite and Lagaurre equations; Physical applications ;Generating functions ;recursion relations.

Unit 3: Integral Transforms

Laplace transform; First and second shifting theorems ;Inverse LT by partial fractions;~T of derivative and integral of a function; Fourier series; FS or arbitrary period; Half-wave expansions; Partial sums ;Fourier integral and transforms; FT of delta function

Recommended Texts:

1. Mathematical Methods for Physics ,by G Arfken
2. Matrices and Tensors for Physicists, by A W Joshi
3. Advanced Engineering Mathematics ,by E Kreyszig
4. Special Functions ,by E D Rainville
5. Special Functions, by W W Bell
6. Mathematical Method for Physicists and Engineers ,by K F Reily, M P Hobson and S J Bence
7. Mathematics for Physicists ,by Mary L Boas

Subject Name: GENERAL LABORATORY- I

1. To study dielectric constant using parallel plate capacitor.
2. To determine Planck's Constant using Photo cell.
3. To study the characteristics of PNP and NPN transistor's.
4. To calculate the hysteresis loss by tracing a B-H curve.
5. Measurement of hall coefficient of given semiconductor and estimation of charge carrier concentration.

6. Measurement of resistivity of a semiconductor by four probe method at different temperature.
7. Measurement of wavelength of He-Ne laser light using ruler and diffraction grating.
8. To find the refractive index of different liquid using Refracto-meter.
9. To determine the wavelength of spectral lines using plane transmission grating.
10. To determine the wavelength of sodium light by Newtons ring method.
11. To determine the specific resistance of a given wire using Carrey Foster's bridge.
12. To determine refractive index of a glass slab using a travelling microscope
13. To determine the time period of a Simple pendulum for its different length (l) and acceleration due to gravity.

MASTER OF SCIENCE (PHYSICS) – SECOND SEMESTER

Second Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Quantum Mechanics - II	5	100
2	Statistical Mechanics	5	100
3	Electrodynamics and Plasma Physics	5	100
4	Atomic and Molecular Physics	5	100
5	General Laboratory-II	4	100
Total		**24**	

Subject Name: QUANTUM MECHANICS II

Unit 1: Variational method; WKB approximation; Time-dependent perturbation theory; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximations.

Unit 2: Collision in 3-D and scattering; Laboratory and CM reference frames; Scattering amplitude; differential scattering cross section and total scattering cross section; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption.

Unit 3: Identical particles; Symmetric and anti-symmetric wave functions; Collision of identical particles; Spin angular momentum; Spin functions for a many-electron system.

Unit 4: Semi-classical theory of radiation; Transition probability for absorption and induced emission; Electric dipole and forbidden transitions; Selection rules.

Recommended Texts

1. L. I. Schiff, Quantum Mechanics(McGraw-Hill)
2. S. Gasiorowicz, Quantum Physics(Wiley)
3. B.CrasemanandJ.0. Powell, Quantum Mechanics (Addison Wesley)
4. A.P.Messiah, Quantum Mechanics
5. J.J.Sakurai, Modem Quantum Mechanics
6. Mathews and Venkatesan, Quantum Mechanics

Subject Name: STATISTICAL MECHANICS

Unit 1: Foundations of statistical mechanics; specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.

Unit 2: Micro canonical ensemble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy and density fluctuations.

Unit 3: Density matrix, statistics of ensemble's, statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi-Dirac and Bose Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

Unit 4: Cluster expansion for a classical gas, Virial equation of state, Ising model, mean-field theories of the Ising model in three, two and one dimensions Exact solutions in one- dimension.

Unit 5: Landau theory of phase transition, critical indices, scale transformation and dimensional analysis. Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, fluctuation dissipation theorem. The Fokker-Planck equation.

Recommended Texts

1. Statistical and Thermal Physics, by FReif
2. Statistical Mechanics, by K Huang
3. Statistical Mechanics, RK Pathria
4. Statistical Mechanics, R.Kubo
5. Statistical Physics, Landau and Lifshitz

Subject Name: ELECTRODYNAMICS AND PLASMA PHYSICS

Unit 1: Review of Four-Vector and Lorentz Transformation in Four-Dimensional Space, Electromagnetic Field Tensor in Four Dimensions and Maxwell's Equations, Dual Field Tensor, Wave Equation for Vector and Scalar Potential and Solution Retarded Potential and Lienard-Wiechert Potential, Electric and Magnetic fields due to a Uniformly Moving Charge and an Accelerated Charge, Linear and Circular Acceleration and Angular Distribution of Power Radiated, Bremsstrahlung, Synchrotron Radiation and Cerenkov Radiation, Reaction Force of Radiation.

Unit 2: Motion of charged Particles in Electromagnetic Field: Uniform E and B Fields, Non-uniform Fields, Diffusion Across Magnetic Fields, Time Varying E and B Fields, Adiabatic Invariants: First, Second and Third Adiabatic Invariants.

Unit 3: Elementary Concepts: Derivation of moment Equations from Boltzmann Equation, Plasma Oscillations, Debye Shielding, Plasma Parameters, Magneto plasma, Plasma Confinement.

Unit 4: Hydro-dynamical Description of Plasma: Fundamental equations. Hydro-magnetic Waves: Magneto sonic and Alfven Waves.

Unit 5: Wave Phenomena in Magneto plasma: Polarization, Phase Velocity, Group Velocity, Cut- offs, Resonance for Electromagnetic Wave Propagating Parallel and Perpendicular to the Magnetic Field, Proportion at Finite Angle and CMA Diagram, Appleton-Hartee Formula and Propagation through Ionosphere and Magnetosphere: Helicon, Whistler, Faraday Rotation.

Recommended Texts

1. Panofsky & Phillips: Classical Electricity and Magnetism
2. Bittencourt: Plasma Physics
3. Chen: Plasma Physics
4. Jackson: Classical Electrodynamics

Subject Name: ATOMIC AND MOLECULAR PHYSICS

Unit 1: Quantum states of one electron atoms, Atomic orbital's, Hydrogen spectrum-Pauli's principle, Spectra of alkali elements, Spin orbit interaction and fine structure in alkali Spectra, Equivalent and non-equivalent electrons,

Unit 2: Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems, interaction energy in LS and JJ Coupling, Hyperfine structure (qualitative)-Line broadening mechanisms(general ideas)

Unit 3: Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotor, Energy levels and spectra of non-rigid rotor, intensity of rotational lines, Stark modulated microwave spectrometer (qualitative).

Unit 4: Vibrational energy of diatomic molecule, Diatomic molecule as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, Vibration spectrum of diatomic molecule, PQR branches IR spectrometer(qualitative).

Recommended Texts

1. Introduction to Atomic spectra, H.E. white(T)
2. Fundamentals of molecular spectroscopy, C.B. Banwell (T)
3. Introduction to Molecular spectroscopy, G.M. Barrow
4. Spectra of diatomic molecules, Herzberg
5. Molecular spectroscopy, Jeanne L Mc Hale
6. Molecular spectroscopy, J.M. Brown
7. Spectra of atoms and molecules, P.F. Bemath
8. Modern spectroscopy, J.M. Holias

Subject Name: GENERAL LABORATORY- II

1. Experiment on FET and MOSFET characterization and application as an amplifier.
2. Experiment on Uni-Junction Transistor and its application.
3. Flip-Flops
4. Measurement of resistivity of a semiconductor by four probe method at different temperatures and determination of band gap.
5. Determination of Lande's factor of DPPH using Electron-Spin Resonance(E.S.R.) Spectrometer.

6. Measurement of Hall coefficient of given semiconductor: Identification of type of semiconductor and estimation of charge carrier concentration.
7. To study the fluorescence spectrum of DCM dye and to determine the quantum yield of fluorescence maxima and full width at half maxima for this dye using monochromator.
8. To study Faraday Effect using He-Ne Laser.

MASTER OF SCIENCE (PHYSICS) – THIRD SEMESTER

Third Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Condensed Matter Physics	5	100
2	Nuclear and Practical Physics	5	100
3	**Any One** Special Paper-I Condensed Matter Physics Special Paper-I Advanced Electronics	5	100
4	**Any One** Special Paper-II Condensed Matter Physics Special Paper-II Advanced Electronics	5	100
5	**Any One** Optics Laboratory Computational Method and Programme Laboratory	4	100
	Total	**24**	

Subject Name: CONDENCED MATTER PHYSICS

Crystal Physics and Defects in Crystals:

Unit 1: Crystalline solids, unit cells and direct lattice, two and three dimensional Bravais lattices, closed packed structures.

Unit 2: Interaction of X-rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods, crystal structure factor and intensity of diffraction maxima. Extinctions due to lattice centering.

Unit 3: Point defects, line defects and planer (stacking) faults. The role of dislocations in plastic deformation and crystal growth. The observation of imperfect ions in crystals, X-ray and electron microscopic techniques.

Electronic Properties of Solids:

Unit 4: Electronsin a periodic lattice: Bloch theorem, band theory, classification of solids, effective mass. Tight-bonding, cellular and pseudo-potential methods. Fermi surface, de Hass von Alfen effect, cyclotron resonance, magneto-resistance, quantum Hall effect. Superconductivity: critical temperature, persistent current, Meissner effect.

Unit 5: Weiss theory of ferromagnetism. Heisenberg model and molecular field theory. Spin waves and magnons. Curie-Weiss law for susceptibility, Ferri- andanti-ferromagnetic order. Domains and Bloch-wallenergy.

Recommended Texts

1. Crystallography for Solid State Physics, Verma and Srivastava
2. Introduction to Solids, Azaroff
3. Elementary Solid State Physics, Omar
4. SolidState Physics, Aschroft & Mermin, Solid State Physics, Kittel
5. Principles of Condensed Matter Physics, Chaikin and Lubensky

Subject Name: NUCLEAR AND PARTICLE PHYSICS

Unit 1: Nuclear Interactions and Nuclear Reactions

Nucleon –nucleon interaction -Exchange forces and tensor forces -Meson theory of nuclear forces - Nucleon -nucleon scattering - Effective range theory -Spin dependence of nuclear forces -Charge independence and charge symmetry of nuclear forces –Iso spin formalism - Yukawa interaction. Direct and compound nuclear reaction mechanisms -Cross sections in terms of partial wave amplitudes - Compound nucleus -Scattering matrix -Reciprocity theorem -Breit-Wigner one- level formula Resonance scattering.

Unit 2: Nuclear Models

Liquid drop model -Bohr -Wheeler theory of fission -Experimental evidence for shell effects – Shell model -Spin-Orbit coupling -Magic numbers -Angular momenta and parities of nuclear ground states - Qualitative discussion and estimates of transition rates-Magnetic moments and Schmidt lines-Collective model of Bohrand Mottelson.

Unit 3: Nuclear Decay

Beta decay - Fermi theory of beta decay - Shape of the beta spectrum -Total decay rate- Angular momentum and parity selection rules-Comparative half-lives-Allowed and forbidden transitions - Selection rules - Parity violation - Two-component theory of neutrino decay - Detection and properties of neutrino -Gamma decay -Multipole transitions in nuclei -Angular momentum and parity selection rules-Internal conversion -Nuclear isomerism.

Unit 4: Elementary Particle Physics

Types of interaction between elementary particles - Hadrons and leptons - Symmetry and conservation laws -Elementary' ideas of CP and CPT invariance -Classification of hadrons – Lie algebra, SU(2) -SU(3) multiplets -Quark model -Gell -Mann -Okubo mass formula for octetand decuplet hadrons -Charm, bottom and top quarks.

Recommended Texts

1. Bohr and B.R. Mottelson, Nuclear Structure, Vol. 1(1969) and Vo1.2, Benjamin, Reading, A, 1975.
2. Kenneth, S. Kiane, Introductory Nuclear Physics, Wiley, New York, 1988.
3. Ghoshal, Atomic and Nuclear Physics Vol.2.P.H.Perkins,
4. Introduction to High Energy Physics, Addison-Wesley, London, 1982.
5. S.de Benedetti, Nuclear Interaction, John Wiley & Sons, New York, 1964.

6. M.K. Pal, Theory of Nuclear Structure, Affiliated East-West, Madras, 1982.
7. Y.R. Waghmare, Introductory Nuclear Physics, Oxford-IBH, Bombay, 1981.
8. J.M. Longo, Elementary Particles, MeGraw -Hill, New York, 1971.
9. R.D. Evans, Atomic Nucleus, MeGraw Hill, New York, 1955.
10. Kaplan, Nuclear Physics, 2nd Ed., Narosa, Madras, 1989.
11. B.L. Cohen, Concepts of Nuclear Physics, TMGH, Bombay, 1971.
12. R.R. Royand B. P. Nigam, Nuclear Physics, Wiley-Eastern Ltd., 1983.

Subject Name: SPECIAL PAPER I (CONDENSED MATTER PHYSICS)

Unit 1: Lattice Dynamics and Optical Properties of Solids

Inter atomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Optical phonons and dielectric constants. Inelastic neutron scattering. Mossbauer Effect. Debye Waller factor. An - harmonicity, thermal expansion and thermal conductivity. Interaction of electrons andphonons with photons. Direct and indirect transitions. Absorption in insulators, Polaritons, one- phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

Unit 2: 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, Ginzsburg. Landau theory and application to Josephson effect: d-e Josephson effect, a-c Josephson effect, macroscopic quantum interference. Vortices and type II superconductors, high temperature superconductivity (elementary).

Recommended Texts

1. Madelung: Introduction to Solid State Theory
2. Callaway: Quantum Theory of Solid State
3. Huang: Theoretical Solid State Physics
4. Kittel: Quantum Theory of Solids

Subject Name: SPECIAL PAPER I (ADVANCED ELECTRONICS)

UNIT 1: Operational Amplifiers

Differential amplifier -circuit configurations –dual input, balanced output differential amplifier –DC analysis – AC analysis, inverting and non- inverting inputs CMRR – constant current bias level translator .Block diagram of a typical Op – Amp- analysis. Open loop configuration inverting and non – inverting amplifiers. Op – amp with negative feedback –voltage series feedback –effect of feedback on closed loop gain input persistence output resistance bandwidth and output offset voltage –voltage follower. Practical op – amp input offset voltage –input bias current –input offset current, total output offset voltage, CMRR frequency response. DC and AC amplifier summing scaling and averaging amplifiers instrumentation amplifier, integrator and differentiator. Oscillator's principles – oscillators types – frequency stability –

response – the phase shift oscillator. Wein bridge oscillator – LC tunable oscillators – Multivibrators – monostable and astable – comparators – square wave and triangle wave generators. Oscillators principles – types – frequency stability – the phase oscillator. Wein bridge – LC tunable oscillators – Monostable Astable – comparators – square wave and triangle wave enerators. Voltage regulators – fixed regulators – adjustable voltage regulators switching regulators.

UNIT 2: Communication Electronics

Amplitude modulation – Generation of AM waves – Demodulation of AM waves – DSBSC modulation. Generation of DSBSC waves, Coherent detection of DSBSC waves, SSB modulation, Generation and detection of SSB waves. Vestigial side band modulation. Frequency Division multiplexing (FDM).

Digital Electronics

1. Combinational Logic

   The transistor as a switch, OR, AND and NOT gates -NOR and NAND gates Boolean algebra - Demorgan's theorems - Exclusive OR gate, Decoder/ Demultiplexer Data selector / multiplexer - Encoder.

2. Sequential Logic

   Flip-Flops: AI-bitmemory -The RSFlip-Flop, JKFlip-Flop-JK master slave Flip-Flops- TFlip-Flop -DFlip-Flop -Shift registers -synchronous and asynchronous counters - cascade counters.

UNIT 3: Microprocessors

Introduction tomicro computers -memory -input/output -Interfacing devices 8085 CPU-Architecture - BUS timings - Demultiplexing the address bus generating control signals - Instruction set - addressing modes - Illustrative programmes - writing assembly language programmes looping, counting and indexing - counters and timing delays -stack and subroutine.

Recommended Texts:

1. "Electronic Devices and circuit theory" by Robert Boylested and Louis Nashdsky PHI,New Delhi - 110001,1991
2. "OP-Amps & Linear integrated circuits,"by Ramakanth A.Gayakwad PHI, Second Edition, 1991
3. "Digital principles and Applications "by A.P. Malvino and Donald P.Laach, Tata Megraw –Hill company. New Delhi, 1993
4. "Microprocessor Architecture, programming and Applications with 8085/8086 by Ramesh S.Gaonkar, Wiley -Eastern Ltd., 1987 (forunitv)

Subject Name: SPECIAL PAPER II (CONDENSED MATTER PHYSICS)

UNIT1: Crystal Physics and X-ray Crystallography

External symmetry elements of crystals. Concept of point groups. Influence of symmetry on physical properties: Electrical conductivity. Space groups, derivation of equivalent point positions (with examples from triclinic and monoclinic systems), and experimental determination of space group. Principle of powder diffraction method, interpretation of powder photographs, 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 2: Exotic Solids

Structure and symmetries of liquids, liquid crystals and amorphous solids. A periodic solids and quasi crystals; Fibonaccy sequence, Penrose lattices and their extension to 3-dimensions. Special carbon solids; fullerenes and tubules; formation and characterization off ullerenes and tubules. Single wall and multi-wall carbon tubules. Electronic properties of tubules. Carbon- nanotubule based electronic based electronic devices. Definition and properties of nanostructured materials. Methods of synthesis of nanostructured materials. Special experimental techniques for characterization of nanostructured materials. Quantum size effect and its applications.

Recommended Texts:

1. Azaroff: X-ray Crystallography
2. Weertman & Weertman: Elementary Dislocation Theory
3. Verma & Srivastava: Crystallography for Solid State Physics
4. Kittel: Solid State Physics
5. Azaroll & Buerger: The Powder Method
6. Buerger: Crystal Structure Analysis
7. M.Ali Omar: Elementary Solid State Physics
8. The Physics of Quasi - crystals, Eds. Steinhardt and Ostulond
9. Handbook of Nanostructured Materials and Nanotechnology (Vol. 1to4).Ed.HariSingh Nafwa.

Subject Name: SPECIAL PAPER II (ADVANCED ELECTRONICS)

UNIT 1: Analog and Digital Systems

Analog computation, active filters, comparators, logarithmic and anti-logarithmic amplifiers, sample and hold amplifiers, waveform generators. Square and triangular wave generators, pulse generator. Read-only Memory (ROM) and applications. Random Access Memory (RAM) and applications. Digital to –analog converters, ladder and weighted resistor types Analog to digital converters – counter type, successive approximation and dual slope converters, Applications of DACs and ADCs.

Optoelectronics

Photodetectors: Photo detectors with external photo effect, photo detectors with internal photo effect, photoconductors andphotoresistors, junction photodetectors. Circuits with Light Emitting Diodes, Diode tester. Polarity and voltage tester, measuring instruments with LED indication. LED, Numeric and alphanumeric display units. Semiconductor switches and potential isolation, The phototransistor as a switch in the opto - couplers, steady state performance, dynamic performance, use of opto - couplers.

UNIT 2: Microwave Devices

Klystrons, Magnetrons and Travelling Wave Tubes, Velocity modulation, Basic principles of two cavity Klystrons and Reflex Klystrons, principles of operation of magnetrons. Helix Travelling Wave Tubes, Wave Modes. Transferred electron devices, Gunn Effect, Principles of operation. Modes of operation, Read diode, IMPATT diode, TRAPATT

Microwave Communications

Advantages and disadvantages of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, fading sources, detectors, components, antennas used in MW communication systems.

Radar Systems

Radar block diagram an operation, radar frequencies, pulse considerations. Radar range equation, derivation of radar range equation, minimum detectable signal, receiver noise, signal to noise ratio, Integration of radar pulses. Radar cross section. Pulse repetition frequency. Antenna parameters, system Losses and Propagation losses. Radar transmitters, receivers. Antennas, Displays.

Satellite Communications

Satellite communications: orbital satellites, geostationary satellites, orbital patterns, look angles, orbital spacing, satellite systems. Link modules.

Text and Reference Books

1. "Microelectronics" by Jacob Millman, Megraw-hillinternational Book Co.. New Delhi, 1990
2. "Optoelectronics: Theory and Practice", Edited by Alien chappal. Me GrawHili Book Co., New York.
3. "Microwaves" by K.L. Gupta, Wiley Eastern Ltd., New Delhi, 1983
4. "Advanced Electronics Communications Systems" by Wayne Tomasi., Phi.Edn.

Subject Name: OPTICS LABORATORY

1. To calibrate a spectrometer with spectral lines of known wave length and hence determine the wavelength of the spectral line emitted by the source.
2. Determination of wavelength of sodium light by Michelson interferometer.
3. Adjust and focus the given spectrometer using Schuster's method and then determine the refractive index of material of the prism.
4. To study the V-I characteristics of a p-n diode.
5. Digital: Basic Logic Gates, TTL, NAND and NOR.
6. Operational Amplifier (741)
7. Differential Amplifier.
8. To verify Stefan's law by electrical method.
9. To draw the characteristics of a zener diode and find the breakdown voltage and to study the zener diode as a voltage regulator under-

   a) Input variation

   b) Load variation
10. To study various logic gates and verify the truth tables and fabricate a half adder
11. To study design and study of a full adder circuit using logic gates.
12. To determine the lines per centimetre of the given diffraction grating using given known wavelength and hence to determine the wavelength of the given unknown radiation.

MASTER OF SCIENCE (PHYSICS) – FOURTH SEMESTER

Fourth Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Computational Method and Programming	5	100
2	**Any One** Elective Paper - Physics in Liquid Crystal Elective Paper - Environmental Physics Elective Paper - Atmospheric Physics	5	100
3	**Any One** Special Paper -III Condensed Matter Physics Special Paper -III Advanced Electronics	5	100
4	**Any One** Special Paper -III Condensed Matter Physics Special Paper -III Advanced Electronics	5	100
5	Project	4	100
Total		**24**	

Subject Name: COMPUTATIONAL METHODS AND PROGRAMMING

Computational Method

Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, Convergence of solutions. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, matrix inversion. Eigen values and eigen vectors of matrices, Power and Jacobi Method. Finite differences, interpolation with equally spaced and unevenly spaced points. Curvefitting, Polynomial least squares and cubic Splinefitting. Numerical differentiation and integration, Newton-Cotes formulae, error estimates, Gauss method. Random variate, Monte Carlo evaluation of Integrals, Methods of importance sampling, Random walk and Metropolis method. Numerical solution of ordinary differential equations, Euler and Runge Kutta methods, Predictor and corrector method. Elementary ideas of solutions of partial differential equations.

Programming

Elementary information about Digital computer Principles, Compilers, Interpreters and Operating systems. Fortran programming, Flow Charts, Integer and Floating Point Arithmetic, Expressions, built in functions, executable and non-executable statements, assignment, control and input- output elements, Subroutines and functions, Operation with files.

Recommended Texts

Sastry: Introductory Methods of Numerical Analysis

Rajaraman: Numerical Analysis

Rajaraman: Fortran Programming

Vetterming, Teukolsky, Press and Flannery: Numerical Recipes

Subject Name: ELECTIVE PAPER (PHYSICS OF LIQUID CRYSTALS)

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 andorder parameters, macroscopic and microscopic order parameters. Measurement of order parameters, magnetic resonance, electron spin resonance, Raman Scattering and X- ray diffraction.

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-smectic Atransitions; Landau theory: Essential ingradients, application tonematic-isotropic, nematic-smectic Atransitions and transitions involving smectic phases.

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 nemato dynamics, Laminar flow, molecular motions.

Optical properties of Cholesterics

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

Ferroelectric 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.

Recommended Texts

1. Chandrasekhar: Liquid Crystals
2. Vertogen & deJeu: Thermotropic Liquid Crystals: Fundamentals
3. deGennes &Prost: The Physics of Liquid Crystals
4. Introduction toliquid crystals: Physics and Chemistry (1997, Taylor and Francis)
5. Elston &Sambles: The Optics of Thermotropic Liquid Crystal
6. Collyer: Liquid Crystal Polymers: From Structures to Applications
7. Goodby etal.: Ferroelectric Liquid Crystals :Principles, Properties & Applications

Subject Name: ELECTIVE PAPER (ATMOSPHERIC PHYSICS)

1. **Physical Meteorology**

   Atmospheric composition, laws of thermodynamics of the atmosphere. Adiabatic process, potential temperature. The clausiscl apyeron equation, laws of black body radiation, solar and terrestrial radiation, Albedo, Green-house effect, Heat balance of earth-atmosphere system.

2. **Dynamic Meteorology**

   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, voracity, potential vorticity, vorticity and potential vorticity equations.

3. **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 inter annual variability of monsoon. Quasi-be weekly and30-60dayoscillations. ENSO and dynamical mechanism for their existence.

4. **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.

5. Atmospheric Pollution

   Role of meteorology on atmospheric pollution, Atmospheric boundary layer, air stability, local wind structure, Ekman spiral, turbulence boundary layers caling.

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

6. Atmospheric Instrumentation Systems

   Ground based instruments for the measurement of Temperature, Pressure, Humidity, Wind and Rain fall Rate. Airborne instruments-Radisonde, Rawinsonde, Rockestsonde-satellite instrumentation (space borne instruments)

7. Radar Meteorology

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

Recommended Texts

1. The Atmosphere by Frederick K.Lutgens and Edward J.Tarbuk (for chapter IandVI)
2. Dynamic Meteorology by Holton, J.R.,3'" edition, Academic Press N.Yf. (1992).

3. The Physics of Monsoons, By R.N.Keshvamurthy and M.Shankar Rao,Allied Publishers, 1992(for chapter 3)

4. Numerical Weather Prediction, by G.J. Haltiner and R.T.Villians, John Wiley andsons, 1980(for chapter 4)

5. Principles of Air pollution meteorology by Tom Lyons and Prillscott, CBS publishers &Distributors (P)Ltd.

6. Radar Meterology by Henry Saugageot

Subject Name: ELECTIVE PAPER (ENVIRONMENTAL PHYSICS)

1. **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.

2. **Solar and Terrestrial Radiation**

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

3. **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

4. **Environmental Changes and Remote Sensing**

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

5. **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-azero-dimensional Greenhouse model.Global climate models.

Recommended Texts

1. Egbert Boeker &Rienk VanGroundelle: Environmental Physics (John Wiley).

2. J.T.Hougtion: The Physics of Atmosphere (Cambridge University Press, 1977).

3. J.Twidell and J.weir: Renewable Energy Resources (Elbs, 1988).

4. SolWieder: An Introduction to Solar Energy for Scientists and Engineers (John Wiley, 1982).

5. R.N.Keshavamurthy and M.Shanker Rao:The Physics of Monsoons (Allied Publishers, 1992).

6. G.J.Haltiner andR.T.wiliiams: Numerical Weather Prediction (John Wiley, 1980).

Subject Name: Special Paper III (CONDENSED MATTER PHYSICS)

Unit 1: Electrons in Solids and Surface States

Interacting electron gas: Hartree and Hartree-Fock approximations, correlation energy. Screening, plasma oscillations. Dielectric function of an electron gas in random phase approximation. Limiting cases and Friedel oscillation, strongly-interacting Fermi system. Elementary introduction to Landau's quasi-particle theory ota Fermi liquid. Strongly correlated electron gas. Elementary ideas regarding surface states, metallic surfaces and surface reconstruction.

Unit 2: Disordered Systems

Point-defects: Shallow impurity states in semiconductors. Localized lattice vibrational states in solids. Vacancies, interstitials and colour centers in ionic crystals.

Disorder in condensed matter, substitutional, positional and topographical disorder, Short and long range order. Atomic correlation function and structural descriptions of glasses and liquids.Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

RECOMMENDED TEXTS:

1. Madelung: Introduction to Solid State Theory
2. Callaway: Quantum Theory of Solid State
3. Huang: Theoretical Solid State Physics

Subject Name: Special Paper III (ADVANCED ELECTRONICS)

Unit 1: Digital Communications

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. Mathematical Representation of Noise: Sources of noise. Frequency domain representation of noise, Effect of filtering on the probability Density of Gaussian noise, spectral component of noise, Effect of a filter on the power spectral density of noise. Superposition of noises. Mixing involving noise. Linear filtering, Noise Bandwidth, Quadrature Components of noise. Power spectral density of 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 2:

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, OM output - signal - to quantization - noise ratio. Effect of thermal noise in Delta modulation, output signal-to-noise ratio in DM.

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.

Recommended Texts:

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

Subject Name: Special Paper IV (CONDENSED MATTER PHYSICS)

Unit 1: Imperfection in Crystals

Mechanism 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.

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

Unit 2: Films and Surfaces

Study of surface topography by multiple-beam interferometry, Conditions for accurate determination of step height and film thicknesses (Fizeau fringes). Electrical conductivity of thin films, difference of behavior of thin films from bulk, Boltzmann transport equation for a thin film (for diffused scattering), expression for electrical conductivity for thin film.

Elementary concepts of surface crystallography. Scanning, tunneling andatomic force microscopy.

RECOMMENDED TEXTS:

1. Azaroff: X-ray Crystallography
2. Weertman & Weertman: Elementary Dislocation Theory
3. Verma & Srivastave: Crystallography for Solid State Physics
4. Kittel: Solid State Physics
5. Azaroff & Buerger: The Powder Method
6. Buerger: Crystal Structure Analysis
7. Thomas: Transmission Electron Microscopy
8. Tolansky: Multiple Beam Interferometry

9. Heavens: Thin Films

10. Chopra: Physics of Thin Films

Subject Name: Special Paper IV (ADVANCED ELECTRONICS)

Unit 1: Microprocessors & Micro Computers

Microprocessors 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.

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

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 2:

Memory Interface : Memory devices, Address decoding, 8088 and 80188 (8-bit) memory interface, 8086, 80186, 80286 and 80386 (16-bit) memory interface, 80386DX 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)

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

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

RECOMMENDED TEXTS:

1. Barry B.Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium pro processor architecture, programming, andinterfacing" Fourth Edition, PHI, 1999.

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

3. Muhammad AliMaxidi and Janice Gillispie Mazidi, "The BOx86IBMPCand Compatible Computers (Volumes I&II), second edition, Prentice-Hall International, 1998.

Subject Name: PROJECT