Proposed Syllabus for M. Sc. Physics

Syllabus for M. Sc. Previous Physics

		Maximum Marks
Paper I	Mathematical Physics and Computational Methods	80
Paper II	Classical and Statistical Physics	80
Paper III	Quantum Mechanics	80
Paper IV	Condensed Matter Physics And Semiconductor Devices	80
Practical	Two practicals (50 marks each), Viva (40 marks), Record (40 marks)	180
Total		500

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M. Sc. I Paper I Mathematical Physics and Computational Methods

Unit I

Elementary ideas about tensors: Covariant and contravariant tensor, Addition and multiplication of tensors, Tensor contraction, Kronecker delta and Levi-Civita symbols, Definition of stress and strain tensor, moment of inertia tensor, dielectric tensor.

Elements of complex analysis: Analyticity, Cauchy-Riemann conditions, Singularities, Cauchy's theorem and integral formula, Calculus of residues, Evaluating integrals.

Unit II

Second order linear differential equation: Series solution of Bessel, Legendre, Laguerre and Hermite equations, Generating functions, Recurrence relations and orthonormal properties, Green function.

Fourier series and Integral transforms: Fourier series of even and odd function, Fourier sine and cosine integrals, Laplace transform, Inverse Laplace transform, its properties and applications, Laplace transform of Dirac delta function, Fourier transform and inverse Fourier transform, their properties and applications.

Unit III

Computational Methods:

Methods of determination of zeroes of linear and nonlinear algebraic and transcendental equations, convergence of solutions.

Solution of simultaneous linear equation, Gaussian elimination, 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 curve fitting, polynomial least squares and cubic spline fitting.

Unit IV

Numerical differentiation and integration, Trapezoidal rule, Newton-Cotes formula, Gaussian integration, Cubic spline method.

Random variate, Monte Carlo evaluation of integrals, Methods of importance sampling, Random walk and Metropolis method

Numerical solution of ordinary differential equations, Euler's and Runge-Kutta method, Predictor-Corrector methods, Elementary ideas of solutions of partial differential equations.

Text and Reference Books:

1. Mathematical Methods for Physics by G. Arfken
2. Advanced engineering mathematics by E. Kresig

3. Introductory methods of Numerical analysis by S. S. Sastry (Prentice Hall)
4. Matrices and tensors for physicist by A. W. Joshi
5. Numerical analysis by Rajaraman

M. Sc. (P) : Paper II CLASSICAL AND STATISTICAL PHYSICS

Classical Physics:

1. Review of Newtonian mechanics, Constraints, D' Alembert's principle, Generalized coordinates. Lagrange's equation, Gyroscopic forces, Dissipative systems, gauge invariance, Generalized momenta, Symmetries of space and time with conservation laws, Invariance under Galilean transformations.
2. Central forces, definition and characteristics, Two body problems, General analysis of orbits, Keplar's laws and equation, closure and stability of circular orbits, Rutherford scattering.
3. Hamiltonian equations, Principal of least action, derivation of equation of motion, Variation and end points, Hamilton principle and characteristic function.
4. Canonical transformations, generating functions, Properties, infinitesimal generators, Poisson Brackets, Poisson theorems, Angular momentum Poisson brackets.
5. Hamilton – Jacobi theory, Harmonic oscillator and Keplar's problem by Hamilton Jacobi method, Action angle variables.
6. Problem of small oscillations, Examples of two coupled oscillators, General theory of normal coordinates and normal modes of vibration.

Statistical Physics:

1. Foundation of Statistical Physics: Review of probability concepts; Random walk problem in one dimension-binomial distribution, Specification of state of system, Macrostates and microstates, Concept of statistical equilibrium, Fundamental postulates of equal a priory probability.
2. Ensembles: Micro-canonical, Canonical and grand canonical ensembles and their comparative study, Partition function, Calculation of statistical quantities in terms of partition function (connection to thermodynamics), Entropy of mixing of gases (using partition function), Gibbs paradox and its resolution; Derivation of equation of state of classical ideal gas using partition function.
3. Quantum statistics: Ideal quantum gases, Indistinguishability, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Photon statistics, Ideal Bose gas, Bose-Einstein condensation, Ideal Fermi gas, Correlation function.
4. Interacting systems: Virial expansion of equation of state, Second Virial coefficient, Ising model, Weiss molecular mean field theory of ferromagnetism.

5. Brownian motion, Langevenin theory of Brownian motion, Mean square displacement of a particle in a viscous liquid, Correlation function, Fluctuation dissipation theerem, Fokker-Plank equation.

Text and Reference Books:

1. Classical Mechanics by H. Goldstein, Narosa Publishing House, Delhi.
2. Classical Mechanics by N. C. Rana and P. S. Joag (Tata McGraw-Hill)
3. Classical Mechanics by JC Upadhyaya, Himalaya Publishing House, Mumbai.
4. Classical Mechanics of Particles and Rigid Bodies: KC Gupta, New Age International (P) Ltd, New Delhi.
5. Fundamentals of Statistical and Thermal by F. Reif (Tata McGraw-Hill)
6. Statistical Physics (Landau and Lifshitz course) Vol. 1 (Pergamon Press)
7. Statistical Mechanics by K. Huang (Wiley)
8. Statistical Physics by R. K. Patharia

M. Sc. (P) : Paper III QUANTUM MECHANICS

UNIT I

Dimension and basis of vector space, Hilbert space, Dirac bra-ket notation, equations of m tion, observables and operators, Eigen values and Eigen vectors of an operator, Matrix representati on of operators, soln. of one-dimensional harmonic oscillator by operator method, Unitary transforma ions, Dirac delta function, Postulates of QM, expectation values and their time evolution, Poisson bracket and commutator.

UNIT II

Angular momentum: Matrix representation, Eigen functions and Eigen values of L_z and L^2 operators, soln. of Schrodinger eqn. for spherically symmetric potentials, Hydrogen atom, spin angular momentum, spin ½ and Pauli matrices, total angular momentum, addition of two ar gular momenta, Clebsch -Gordan coefficients.

Identical particles: Symmetric and anti-symmetric wave functions, Pauli Exclusion prin iple, collision of identical particles.

UNIT III

Approximation methods for Stationary States: Perturbation theory (non degenerate and deger erate case), Variational method, WKB method.

Time-dependent perturbation theory: Fermi golden rule, Harmonic perturbation, Adiabati and Sudden Approximations.

Semi-classical theory of radiation: Transition probability for absorption and induced emi ssion (stimulated), Electric dipole approximation, Selection rules, Forbidden transitions.

Transition probability for spontaneous emission, Einstein's A and B coefficients.

UNIT IV

Scattering: Differential scattering cross section and total scattering cross section, scattering in the Lab and CM frames, scattering amplitude, Born approx., Partial wave analysis for elastic and inelastic scattering, phase shift, optical theorem, scattering by a perfectly rigid sphere and by an attractive square well potential.

Relativistic wave equations: Klein-Gordan eqn., its interpretation and free particle soln., Free particle Dirac eqn. and plane wave soln., alpha and beta matrices, covariant form of Dirac eqn. Gamma matrices, spin and magnetic moment of electron, interpretation of negative energy states.

TEXT AND REFERENCE BOOKS:

1. QM Theory and Applications: Ghatak and Lokanathan.
2. A Text book of QM: Mathews and Venkatesan.
3. QM Concepts & Applications: N Zettili.
4. QM: L. I. Schiff.
5. Introduction to QM: D. J. Griffiths.
6. QM: J. L. Powell and B. Crasemann.
7. QM: E. Merzbacher.

M. Sc. (P) : Paper IV CONDENSED MATTER PHYSICS AND SEMICONDUCTOR DEVICES

Unit I

Crystallography: Crystal structure, symmetry elements in crystals, proper rotation axis, plane of symmetry, inversion centre, screw axis, glide plane, Type of Bravais lattices, closed packed structures, diamond structure, Zinc blend structure, Weigner-Seitz cell, Miller indices, Liquid crystals.

X-rays Diffraction and Reciprocal Lattice: Choice of x-ray, electron and neutron for crystal structure determination, Bragg's diffraction, Reciprocal lattice, The Braggs condition and Ewald construction, Brillouin zones of SC, BC and FCC lattices, Atomic scattering factor, Geometrical structure factor, Laue method, Rotating crystal method, Powder method, Debye Scherer technique, Analysis of powder photograph, Crystal structure determination.

Unit II

Electron in a periodic lattice, Bloch theorem, Band theory, Effective mass, Nearly free electron approximation, tight binding approximation, Fermi surfaces, Cyclotron resonance, The De Hass-Van Alfen effect, Magnetoresistance, Quantum Hall effect.

Weiss theory of ferromagnetism, Heisenberg model, Mean field theory, Exchange interaction, Spin waves and magnons, Curie-Weiss law for susceptibility, Domain theory and hysteresis loop, Bloch wall, Antiferromagnetism, Ferrimagnetic materials.

Unit III

Power semiconductor devices: Power bipolar junction transistor (BJT), Power MOSFET - VMOS and DMOS transistors, Uni junction transistors (UJT), Silicon controlled rectifier (SCR), Diac, Triac.

High frequency devices: Frequency dependence of gain, transit time effect in bipolar and in field effect transistors, Schottky Barrier FET (MESFET), modulation doped transistor (MODFET or HEMT), Ballistic transistors- Metal base transistors, ballistic GaAs Transistors Two terminal devices- Gunn diode, IMPact avalanche and transit time (IMPATT) diode Tunnel diode.

Unit IV

Optoelectronic devices: Radiative and non-radiative transition, photon absorption and emission in semiconductors, Electron- Hole pair generation rate, Light emitting diode (LED)- construction, working principle, generation of light and external quantum efficiency, high frequency limit, effect of surface and indirect recombination current in LED. Photoconductive Cells, Photodiodes, Phototransistors, Light activated SCR (LASCR), optocouplers, Solar Cell- open circuit voltage, short circuit current, Fill factor.

Memory and other devices: Complementary metal oxide semiconductor (CMOS), MOSFET transistors as n-channel (NMOS), Static random access memory (SRAM) and dynamic random access memory (DRAM), Read only memory (ROM), electrically programmable ROM (EPROM) and electrically erasable programmable ROM (EEPROM), volatile and non volatile memory, Magnetic, optical and ferroelectric memories and devices, Charge coupled device (CCD). Piezoelectric, electrostrictive and magnetostrictive effect, related materials and their application in devices.

Text and Reference books:

1. Charles Kittel: Solid State Physics
2. Chaikin and Lubensky: Principles of Condensed Matter Physics
3. Aschroft and Mermin: Solid state physics
4. Azaroff: Introduction to Solids
5. Verma and Srivastava: Crystallography for Solid state Physics
6. A. Ghatak and K. Thygrajan Optical Electronics
7. M. S. Tyagi: Introduction to semiconductor devices
8. S. M. Sze: Physics and Technology of Semiconductor Devices

M. Sc. Previous Physics Practicals Suggested List

1. Study of a Regulated power supply
2. Measurement of inductance and capacitance and study of LCR series and paral el resonance circuits
3. I-V characteristics of Silicon controlled rectifier
4. I-V characteristics of Unijunction transistor
5. MOSFET characteristics.
6. Verification of network theorems.
7. Study of low pass, high pass and band pass filters
8. Measurement of inductance and capacitance using AC bridges
9. Measurement of Stephan's constant of radiation
10. Study of transistorised multivibrators
11. Measurement of wavelength of He-Ne laser using a steel scale
12. Measurement of intensity distribution in a single slit diffraction pattern produced by He-Ne laser
13. Thickness of mica sheet using a biprism
14. Thickness of quartz plate using constant deviation spectrometer
15. Resolving power of prism
16. Babinet compensator
17. Young's Modulus and Poisson's ratio of glass by Cornu's fringes
18. Michelson interferometer
19. Febri-Perot Interferometer
20. Verification of Fresnel's formula
21. Study of absorption spectrum of iodine
22. Velocity of ultrasonic waves in liquids

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Syllabus for M. Sc. Final Physics

		Maximum Marks
Paper I	**Atomic, Molecular, Particle and Nuclear Physics**	**80**
Paper II	**Special paper I**	**80**
Paper III	**Special paper II**	**80**
Paper IV	**Electrodynamics and Plasma Physics**	**40**
Paper V	**Elective paper**	**40**
Practical	**One practical (60 marks), Viva (20 marks), Record (20 marks)**	**100**
Project	**Dissertation**	**80**
Total		**500**

The candidate may offer one of the following special paper.

1. Condensed Matter Physics
2. Electronics

Any one of the following elective papers may be opted

1. Physics of Liquid Crystals
2. Physics of Lasers and Laser Applications
3. Physics of Nanomaterials
4. Atmospheric Sciences
5. Computer Programming in Physics

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M. Sc. II - Paper I:

Atomic, Molecular, Nuclear and Particle Physics

Unit-I

Atomic Spectra: Quantum States of an electron in an atom, Hydrogen Spectrum, Spin-orbit interaction and fine structure, Term symbols, equivalent and non equivalent electrons, spectra of alkali elements, Normal and anomalous Zeeman effect, Paschen-Back effect, Stark effect, LS and JJ Couplings, hyperfine structure, line broadening mechanisms

Unit-II

Molecular Spectra: Types of molecules, diatomic, linear, symmetric top, asymmetric top and spherical top molecules

Microwave Spectroscopy- Rotational spectra of diatomic molecules (rigid and non rigid rotor model), microwave spectrometer

Infrared Spectroscopy- Vibrational Spectra, Diatomic molecule as a simple harmonic and anharmonic oscillator, energy levels and infrared spectra, molecule as vibrating rotor, P, Q and R branches, IR spectra of polyatomic systems

Raman Spectra, Principle of mutual exclusion, Structure determination from Raman Spectroscopy.

Unit-III

Nuclear Forces: Nuclear two body problem, simple theory of deuteron, spin dependence and non central nature of nuclear forces, nucleon-nucleon scattering, scattering length and effective range theory, exchange force and meson theory of nuclear force.

Nuclear Reactions: Q value and threshold energy, compound nuclear and direct reaction mechanisms, nuclear reaction cross-sections, resonance phenomenon, Breit-Wigner one level formula

Nuclear models: Liquid drop model, Semi-emperical mass formula, Bohr-Wheeler theory of fission, Evidences of shell structure, Shell model, spin-orbit coupling, predictions of shell model, Collective model

Unit-IV

Nuclear Decay: Beta decay, Fermi theory of beta decay, Allowed and Forbidden transitions, Fermi and Gamow-Teller selection rules, Parity violation in beta decay, Neutrino detection

Gamma decay, Multipole transitions, angular momentum and parity selection rules, Internal conversion, Nuclear isomerism

Elementary Particle Physics: Four fundamental interactions, classification of elementary particles, Hadrons and Leptons, Symmetry and Conservation laws, CP violation and CPT invariance, SU(2) and SU(3) multiplets, Eight fold way, Quark model, Gell-Mann Okubo mass formula for hadrons, Basic ideas of standard model.

Text and Reference books:

1. Introduction to Atomic Spectra by H. E. White
2. Fundamentals of Molecular Spectroscopy by C. B. Banwell
3. Introduction to Molecula spectroscopy by G. M. Barrow
4. Molecular Spectroscopy by J. M. Brown
5. Spectra of Diatomic Molecules by Hertzberg
6. Atomic Nucleus by R. D. Evans
7. Introductory Nuclear Physics by Y. R. Waghmare
8. Concepts of Nuclear Physics by B. L. Cohen
9. Introduction to Elementary Particles by D. Griffiths
10. Atomic and Nuclear Physics by S. N. Ghoshal
11. Introduction to Nuclear Physics by M. A. Enge
12. Nuclear Physics by I. Kaplan
13. Introduction to High energy Physics by P. H. Perkins
14. Nuclear Physics by Roy and Nigam

M. Sc. II - Paper II A - Special Paper I – Condensed Matter Physics

Unit-I

Crystal Physics and X-Ray crystallography: Crystalline solids, Bravais lattices, Crystal system representation of directions and planes, External symmetry elements, Point groups, Glide planes and screw axes, Space groups, Crystal structure, Principal of X-ray diffraction, Structure factor, Powder method, Interpretation of X-ray powdered photographs, Accurate determination of lattice parameters, Application of powder method, Intensity of powder diffraction, X-ray diffraction for nanocrystals, Small angle X-ray scattering.

Unit-II

Lattice Dynamics and optical properties of Solids: Interatomic forces and lattice dynamics of simple metals, Ionic and covalent crystals, Optical phonons and dielectric constants, Inelastic neutron scattering, Anharmonicity, Thermal expansion and thermal conductivity, Linear optical absorption in insulators and semiconductors, Direct and indirect transitions, Optical properties of metals, Skin effect.

Unit-III

Electron – Phonon Interaction: Interaction of electrons with acoustic and optical phonons, Polaron, Superconductivity: Manifestation of energy gap, Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg-Landau theory and application to Josephson effect, High temperature superconductors.

Unit-IV

Exotic Solids: Amorphous solids: Glasses and polymers, Glass formation, Type of glasses and glass transition, amorphous semiconductors; Liquid crystals, Aperiodic solids and quasi crystals: Fibonacci sequence, Penrose lattices and their extension to 3 dimensions, Nano structural materials: Introduction, Methods of synthesis and experimental characterization techniques, Quantum size effect and its applications, Fullerene, Graphene, Single wall and multi wall carbon nanotubes, their formation, characterization and applications, Introduction to photonic crystal.

Text and Reference Books:

1. X-ray diffraction by B. D. Cullity
2. Crystallography for Solid State Physics by A. R. Verma and O. N. Srivastava
3. X-ray Crystallography by Azaroff
4. Interpretation of X-ray Diffraction Photographs by Henry, Lipson and Booster
5. Crystal Structure Analysis by Buerger
6. Elementary Solid State Physics by M. Ali Omar
7. Physics of Quasi Crystals by Steinhard and Oustland
8. Introduction to solid State Theory by Madelung
9. Quantum theory of Solids by Callaway
10. Theoretical Solid State Physics by Huang
11. Quantum theory of Solids by C. Kittel
12. Handbook of Nanostructured Materials (Volume 1-4) by H. S. Nalwa

M. Sc. II - Paper II B - Special Paper I – Electronics

UNIT I

Operational Amplifier: 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.

Integrator and differentiator, Oscillators principles, oscillator types, frequency stability, response, Phase shift, Wein bridge, LC tunable oscillators, Square wave and Triangular wave generators, VCO, Comparators, Schmitt trigger, V/F and F/V converter, A/D and D/A converters, Sample and hold circuit, Monostable, astable and bistable multivibrators, PLL, Voltage regulators, fixed regulators, adjustable voltage regulators, switching regulators.

UNIT II

Optoelectronics and Fiber Optics: Photo detectors with external photo effect, photo detectors with internal photo effect, photo conductors and photo resistors, junction photo detectors. LED, Circuits with LED, Diode tester, Polarity and voltage tester, measuring instruments with LED indication. Numeric and alphanumeric display units. Semiconductor switches and potential isolation. The phototransistor as a switch in the optocouplers, steady state performance, dynamic performance, use of optocouplers.

Fiber Optics, Structure and Classification, Single & Multimode, Step & Graded Index, light propagation through optical fiber, acceptance angle and numerical aperture, fiber fabrication techniques, Transmission characteristics of optical fibers, attenuation, pulse broadening mechanism, intermodal dispersion, material dispersion, Fiber Loss.

UNIT III

Microwave Devices & Communication: 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.

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 microwave communication systems.

UNIT IV

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 sideband modulation.

Frequency modulation, Frequency spectrum for sinusoidal FM, Non-sinusoidal modulation, Phase modulation, equivalence between PM & FM, Varactor diode modulators, Reactance modulator, FM transmitter, Armstrong indirect method, FM detectors, Foster-Seely discriminator, Ratio detector, PLL demodulator, Automatic frequency control, pre-emphasis and de-emphasis, difference between FM & PM

Satellite communication, orbital satellites, geostationary satellites, orbital patterns, look angle, orbital spacing, satellite systems, Link modules.

Recommended Books:

Op-Amp & Linear Integrated Circuits, Ramakanth A. Gayakwad, Printice Hall of India.

Electronic Devices and Circuit Theory, Robert Boylested and Louis Nashdsky, Printice-Hall Inc.

Optoelectronics: Theory and Practice, Alien Chappal, McGraw Hill Book Co., NY.

Microelectronics, Jacob Miliman, McGraw Hill International Book Co., ND.

Microwaves, K.L. Gupta, Wiley Eastern Ltd, ND.

Advance Electronics Communications Systems, Wayne Tomasi, PHI, Edn.

Electronic Communication System, George Kennedy & Bernard Davis, McGraw Hill Pub.

M. Sc. II - Paper III A - Special Paper II – Condensed Matter Physics

Unit-I

Imperfections in Crystals: Point imperfections, Vacancies, Interstitial, Schottky and Frenkel defect, Colour centres, Dislocation of elastic and plastic deformation of solids, Slip planes, Critical resolved shear stress, Elastic energy, Frank read source, Stacking faults, Grain boundaries, Tilt boundaries, and Twin boundaries, Whiskers, Observations of dislocation and other defects.

Unit-II

Electrons in Solids and Surface States: Interacting electron gas: Hartree and Hartree-Fock approximation, Landau's quasi particle theory, Fermi liquid, Elementary ideas of surface states in semiconductors, localized vibrational states, Elementary idea of Excitons.

Unit-III

Thin films and surfaces: Study of surface topography by multiple beam interferometry, Determination of film thickness (Fizeau and FECO method), Elementary concepts of surface crystallography, SEM, TEM and STM, Thin film preparation methods, Boltzmann transport equation for different scattering expression for electrical conductivity.

Unit-IV

Disorder System: Disorder in condensed matter, Substitutional, Positional and Topological Disorder, Short and long range order, Atomic correlation functional and structural description of glasses and liquids, Electronic structure of amorphous solids, Anderson model for random system and electron localization, Mobility edge, Qualitative application and hopping conduction.

Text and Reference Books:

1. Introduction to Dislocations by D. Hull
2. Introduction to Solid State Theory by Madelung
3. Quantum theory of solid State by Callaway
4. Theoretical Solid State Physics by Huang
5. Quantum theory of solids by Kittel
6. Physics of Thin Films by K. L. Chopra
7. Multiple beam interferrometry by Tolansky
8. Transmission Electron Microscopy by Thomas
9. Crystallography for Solid State Physics by A. R. Verma and O. N. Srivastava
10. X-ray Crystallography by Azaroff
11. Interpretation of X-ray Diffraction Photographs by Henry, Lipson and Booster
12. Crystal Structure Analysis by Buerger
13. Elementary Solid State Physics by M. Ali Omar
14. Solid State Physics by C. Kittel

M. Sc. II - Paper III B - Special Paper II - Electronics

UNIT I

Digital Electronics: Combinational logic: Karnaugh map, BCD code, Gray code, Serial & parallel binary adder/subtractor, Multiplexer and Demultiplexer, Encoder and Decoder, BCD to Decimal Decoder, Decimal to BCD Encoder. Sequential Logic: Latch, Triggering methods, Flip-Flops, RS, T, D, JK, Master/Slave JK Flip-Flops. Counters, synchronous & asynchronous counters, modified counters, decade counter and decoding gates, up-down counters and ring counter. Shift Registers, SISO, SIPO, PISO and PIPO.

Digital Systems: Converters: Binary Ladder and OPAMP types D/A converter, Simultaneous, Counter, Continuous and Successive Approximation types A/D converters. Applications of DAC and ADC.

UNIT II

Digital Communication I:

Components of digital communication system; Signals, Fourier transform- Fourier representation of periodic and non-periodic signals, Time and frequency domain analysis. Sampling theorem, sampling of Low -Pass and Band - pass signals, Pulse Modulation-PAM, PWM, PPM, Channel BW for a PAM signal, Natural sampling, Flat-top sampling, Signal recovery through Holding. Quantization of signals; Quantization, PCM, Differential PCM, Delta Modulation, Adaptive Delta modulation, CVSD, Line encoding; unipolar, polar, bipolar, Manchester encoding.

Digital Modulation Techniques: Amplitude Shift Keying (ASK) Phase Shift Keying (PSK) - Binary (BPSK), Differential (DPSK), Quadrature (QPSK) & M-ARY, Quadrature Amplitude Shift Keying (QASK), QAM, Frequency Shift Keying (FSK), Minimum Shift Keying (MSK).

UNIT III

Digital Communications II: Noise: sources of noise, Frequency domain representation of noise, Effect of filtering on the probability density of Gaussian noise, Noise bandwidth Calculation of quantization noise in PCM and DM.

Data Transmission and detection: central limit theorem, probability density function and Probability of Bit Error, Sources of Transmission impairments, Inter symbol interference (ISI), Regenerative Repeaters and Bit Error Rate (BER). Digital Transmission over the AWGN Channel, Optimum filter. Matched filter. Coherent and noncoherent detection. Coherent reception, correlation, Coherence detection of BASK, BPSK, BFSK, Non - coherent detection of BASK, BFSK, Differential PSK. Calculation of Probability of error for BASK, BFSK, BPSK, QPSK.

UNIT IV

Microprocessor: Introduction to microcomputers, memory, input/output interfacing devices, 8085 microprocessor, Architecture, Microprocessor initiated operations, Internal data operation, Externally initiated operations, Instruction set and addressing modes, 8085 programming, Writing simple programs of addition, subtraction, multiplication and division of two numbers, conversions of BCD to ASCII and ASCII to binary etc for 8085, applications of microprocessors in embedded systems.

Recommended Books:

Digital Principles and Applications, A. P. Malvino and D. P. Leach, Tata McGraw Hill.

Digital Integrated Electronics, Taub and Schilling, McGraw Hill Co.

Principles of Communication Systems, Taub and Schilling, McGraw Hill Co.

Communication Systems, Simon Haykin, John Wiley & Sons, Inc.

Modern Digital and Analog Communication Systems, BP Lathi, Oxford Univ. Press

Microprocessor Architecture, Programming and Application with 8085, Ramesh S. Gaonkar, Willey-Eastern Ltd.

Electronic Communications, Dennis Roddy & John Coolen, Pearson Education.

Electronic Communication System, George Kennedy & Bernard Davis, McGraw Hill Pub.

Computer Networks. Andrew S. Tanenbaum, Prentice Hall Inc.

M. Sc. (Final) Physics, Paper IV: Electrodynamics and Plasma Physics

1. Maxwell's equations, Wave equations for vector and scalar potential and solutions, Lineard-Wiechart potential, Electric and Magnetic fields due to a uniformly moving charge and an accelerated charge, Power radiated by a point charge, Linear and circular acceleration, angular distribution of power radiated, Synchrotron radiation and Cerenkov radiation, Reaction force of radiation.
2. Lorentz transformation in four dimensional space, Four vectors (x, del, p, J, A) and their transformation under LT, Electromagnetic field tensor F, Maxwell's equations in terms of F, Dual field tensor, Transformations of electric and magnetic field.
3. Plasma as a state of matter, Debye shielding, Motion of charged particles in uniform electric and magnetic field, time varying and space dependent electric and magnetic fields, Diffusion of electrons and ions in weakly ionised plasma without and with magnetic field, Plasma confinement, Magnetic mirror, First, second and third adiabatic invariants.
4. Plasma oscillations, Magnetohydrodynamics, pinch effect, Hydro magnetic (Alfven) waves and magenetosonic waves.

Text and Reference Books:

1. D. J. Griffiths: Introduction to Electrodynamics
2. W. K. H. Panofsky and M. Phillips: Classical Electricity and Magnetism
3. F. F. Chen: Plasma Physics
4. J. A. Bittencourt: Fundamentals of Plasma Physics
5. Jackson: Classical Electrodynamics

M. Sc. Physics (Final Year)

Electives Papers (Vth)

Maximum Marks: 40

Titles of Elective Papers

A. Physics of Liquid Crystals

B. Laser Physics and applications

C. Physics of nanomaterials

D. Atmospheric Science

E. Computer Programming in Physics

(Any one of the elective paper is to be opted in the final year)

M. Sc. II Elective: Physics of Liquid Crystals (Vth, A)

Classification of Liquid Crystals

Historical Outlook, Classification of Liquid Crystals, Polymorphism in LC, Optical Textures, Thermotropic Liquid Crystals, Calamitic Liquid Crystals: Nematic (N) Phase, Smectic phases (SmA and SmC), Chiral Nematic (N^*) Phase/Cholesteric Phase. A review of Discotic Liquid Crystals and Bent-Core Liquid Crystals, Polymer Liquid Crystals, Lyotropic Liquid Crystals.

Theories of Liquid Crystals and Phase Transitions

Nature of Phase Transitions and critical phenomenon in liquid crystals, hard particle model. Maier-Saupe Theory and Van der Waals theories for isotropic-nematic and nematic-Smectic A transitions; Landau theory: essential ingredients, application to isotropic-nematic, nematic-smectic A/C transitions and other smectics.

Nematic Liquid Crystals

Elastic Continuum Theory, Dielectric Constant and Refractive Indices, Flows and hydrodynamics, Alignment of Liquid Crystals (Planar and homeotropic), Field induced director reorientation, Threshold Voltage for Switching, Estimation of Elastic Constants (Splay Twist and bend coefficients), Birefengance and Order Parameter.

Cholesteric, Ferroelectric and Antiferroelectric Liquid Crystals

Chirality, Cholesteric Liquid Crystals: Free Energies, Field induced Effect and dynamics; Light Scattering in Cholesterics, Helix and Pitch Chiral Smectic Phase, Symmetry breaking, Spontaneous Polarization, Tilt angle, Ferro- and Antiferroelectric Phases, Free Energy of Ferroelectric Liquid Crystals, SmC*-SmA Phase Transtions.

Applications of Liquid Crystals

Display Applications: Principle, design and working of LC displays, Nematic Liquid Crystals Switches, 7-segment display. Non -Display Applications: Temperature Sensor, Spatial Light Modulators, Optical Shutters, Tunable Photonic Crystals, Biomedical Applications.

References:

Liquid Crystals, S. Chandrashekhar, Cambridge Univesity Press, Second Edition, 1992.

Liquid Crystals, Iam-Choon Khoo, Willey, Second Edition, 2007.

Introduction to Liquid Crystals, PJ Collings and M. Hird, Taylor Francis, Bristol, PA 1997.

PG D Gennes and J. Prost J. The physics of Liquid Crystals, Clarendon Press, Oxford, 1993.

Liquid Crystal Devices: Physics and Applications, VG Chigrinov Artech House, Boston, London, 1999.

M. Sc. II Elective: Laser Physics and applications (Vth, B)

Properties of laser beams, Basic elements of a laser, Population inversion, gain and Threshold, Three level and four level laser, rate equations, CW operation of laser, optical resonators, cavity modes, mode selection, pulsed operation of laser, Q-switching and mode locking, Pulse shortening- picoseconds and femtosecond operation.

Different laser systems, Ruby laser, He-Ne laser, Nd:YAG laser, CO_2 laser, Semiconductor diode laser, Dye lasers, Excimer lasers

Laser induced fluorescence spectroscopy, Laser applications in metrology, optical communication, materials processing and holography, LIDAR, Medical applications.

Reference books:

1. Lasers by A. E. Siegmann, University science books
2. Laser Physics by P. W. Milonni and J. H. Eberly
3. Laser Spectroscopy by W. Demtroder
4. Principles of Laser by O. Swelto
5. Lasers, Theory and Applications by K. Thyagarajan and A. K. Ghatak

M. Sc. II Elective: Physics of Nanomaterials (Vth, C)

Physics of the Solid State: Crystal structures, Band and free electron theory of solids, Idea of band structure, Density of state in bands, Diffusive transport, scattering mechanisms, Surfaces, Interfaces, and Layered Systems.

Quantum Nature of Nanoworld; Introduction of Nanomaterials, Characteristic or Critical lengths in mesoscopic systems e.g. mean free path, scattering length, coherence lengthetc;Idea of quantum well, Quantum wires and Quantum dots; One and Two-dimensional electron systems: general properties, Quantum confinements, Variation of density of states and band gap with dimensionality, Optical properties of semiconductor and metal nanomaterials, Surface Plasmon Resonance in Metal Nanoparticles. Carbon Nanostructures (Fullerenes, Carbon Nanotubes and Graphene) and their Renewable Energy Applications.

Nano fabrication: Synthesis of Nanomaterials (0, 1& 2 Dimensional) by Top down and Bottom-up Approaches; Ball Milling, Lithography, etching, epitaxial growth, physical and chemical vapor deposition (PVD & CVD) methods, Microwave, Hydrothermal and Solvo-thermal synthesis methods, Chemical synthesis of nanomaterials etc.

Characterization of Nanomaterials; Structure (X-Ray and electron Diffraction); Determination of Particle size, Crystallography, atomic and surface structures, Microscopy (Scanning and Transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy); Spectroscopy (X-ray Photoelectron Spectroscopy, Infrared and Raman Spectroscopy)

Text and Reference Books:

1. Introduction of Nanotechnology by Charles P Poole Jr and F J Owens Wiley India
2. Nanotechnology for Microelectronics and optoelectronics by JMM Duart, RJM Palma and FA Rueda Elsevier
3. Introduction to Solids by Kittel
4. Physics of semiconductor nanostructures by KP Jain, Narosa
5. Physics of low dimensional semiconductors by John H. Davies
6. Nano particles and nanostructured films: Preparation, Characterisation and Application, Ed. J. H. Fendler, John Wiley

M. Sc. II Elective: Atmospheric Sciences (Vth, D)

Physical Meteorology

Atmospheric composition, laws of thermodynamics of the atmosphere, adiabatic process, potential temperature, Clausius-Clapyeron equation, laws of black body radiation, solar and terrestrial radiation, Albedo, Green house effect, heat balance of earth-atmosphere system.

Dynamic Meteorology

Fundamental forces, non-inertial reference frames and apparent forces, structure of static atmosphere.

Momentum, continuity and energy equations, thermodynamics of dry atmosphere, elementary applications of the basic equations.

The circulation theorem, voracity, potential vorticity, vorticity and potential vorticity equations.

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 merizonal (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 bi-weekly and 30-60 day oscillations, ENSO and dynamical mechanism for their existence.

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 particle trance gases.

Atmospheric Instrumentation Systems

Ground based instruments for the measurement of temperature, pressure, humidity, wind and rainfall rate.

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

Radar Meteorology

Basic meteorology- radar principles and technology-radar 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 phenomenon-other radar systems and applications.

Text and Reference Books:

1. The Atmosphere by Frederick K. Lutgens and Edward J. Tarbuk.
2. Dynamic Meteorology by J. R. Holton, 3rd edition, Academic Press N. Yf. (1992); The Physics of Monsoons by R. N. Keshvamurthy and M. Shankar Rao, Allied Publishers (1992).
3. Numerical Weather Prediction by G. J. Haltiner and R. T. Villians, John Wiley and sons (1980).
4. Principles of Air Pollution Meteorology by Tom Lyons and Bill Scott, CBS Publishers and Distributors (P) Ltd. (2000)
5. Radar Meteorology by Henri Sauvageot, Artech House Publishers (1992).

Algorithm and Flowchart: Control Structures; Sequence, Branching & Loop.
Programming in Fortran 77: character, real and integer data, constants and variables, type declaration and conversion, parameter and assignment statements, arithmetic, relational and logical operators, library functions. Input and output statements - list directed, formatted, format specification – X, I, F, E, A, H, T, /, \. Loop statements - DO loop, nested loop, Control statements – GOTO, computed GOTO, logical IF, block IF, nested block IF, arithmetic IF and STOP statements. One, two & amp; multidimensional arrays and subscripted variables. DIMENSION statement. Built-in and user-defined Functions and subroutines.

Programming in C: C Character set, Constants, Variables and Keywords. C Instructions, Type Declaration Instruction, Arithmetic Instruction, Integer and Float Conversions, Type Conversion in Assignments, Hierarchy of Operations, Associativity of Operators, Control Instructions in C. Decision Control Structure, IF, IF-ELSE, Nested IF-ELSE, forms of IF, Logical operator. Loop Control Structure, WHILE loop, FOR loop, Nesting of Loops, BREAK Statement, CONTINUE Statement, DO-WHILE Loop. Case Control Structure, SWITCH, GOTO. Functions & amp; Pointers, C Preprocessor, Arrays, Two and Three Dimensional Array, Puppetting On Strings, Standard Library String Functions, Structures, Array of Structures. Console Input/Output. File Input/Output.

Text and Refrence Books:

1. Computer Programming in Fortran 77, Fourth Edition, V. Rajaraman
2. Schaum's Outline of Programming with Fortran 77, Willam E. Mayo & Martin Cwiakala
3. Let Us C, Fifth Edition, YP Kanetkar

M. Sc. Final Physics Practicals Suggested List

Condensed Matter Physics:

1. Determination of lattice parameter and indexing of powder photographs
2. Study of dispersion curves of monoatomic lattice using given transmission lines
3. Measurement of resistivity of semiconductor by four probe method and determination of band gap
4. Measurement of Hall coefficient of given semiconductor to estimate charge carrier concentration
5. Measurement of thermal and electrical conductivity of copper and determination of Lorentz number.
6. Measurement of thermal conductivity of poor conductor (Perspex)
7. Measurement of thermal diffusivity of brass
8. Verification of Curie-Weiss law for ferroelectric material
9. B-H curve of a ferromagnetic material
10. Measurement of thermal relaxation time of a serial light bulb and verification of Debye relaxation formula.
11. Measurement of polarizability of nonpolar liquid and dipole moment of polar liquid.
12. Determination of Lande's g factor of DPPH using Electron Spin Resonance spectrometer
13. Determination of magnetic susceptibility of paramagnetic substance by Quincke's method
14. Measurement of dislocation density of a crystal by etching
15. Determination of magnetoresistance of bismuth
16. Dielectric constant of solid (wax) by Lecher wire

Electronics:

1. To study OP-AMP characteristics
2. To study OP-AMP applications
3. To study transistorized differential amplifier.
4. To study OP-AMP as a Comparator and Schmitt Trigger.
5. To study the operation of V/F & F/V converter.
6. To study Wien Bridge, Phase-Shift and Colpitt Oscillators.

7. To study Astable, Mono-stable and Bi-stable multivibrators.
8. To study the operation of PLL and VCO.
9. To study BCD to 7 segment Decoder, BCD to Excess-3 code, Binary to Gray and Gray to Binary conversion.
10. To study 4 Bit R-2R ladder DAC and 4 Bit Counter type ADC.
11. To study 4 Bit Synchronous and Ripple Counter.
12. To study losses in an Optical Fibre.
13. To measure Numerical Aperture (NA) of an optical fibre.
14. Addition, Subtraction, Multiplication and Division using 8085 microprocessor.
15. Signal Sampling and Generation in PAM.
16. Study of amplitude modulation
17. Study of frequency modulation
18. Study of amplitude demodulation
19. Study of frequency demodulation
20. Study of Gunn diode
21. Experiments based on microwaves
22. Study of Electronic devices.

M. Sc. (Physics) Final year

Maximum Marks: 80

Projects

It will be based on preliminary research oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects, will float projects and any one of them will be allotted to the student. At the completion of the project at year end, the student will submit Project Report in the form of Dissertation which will be examined by the Examiners. The examination shall consist of

(i) Presentation and

(ii) Comprehensive Viva-voce.

Convener (Physics)
C.S.J.M. University
Kanpur