# PROF. RAJENDRA SINGH (RAJJU BHAIYA) UNIVERSITY, PRAYAGRAJ

## Structure of Syllabus for the
## Program: M.Sc. Subject: PHYSICS

| Structure of Syllabus Developed by | | | |
|---|---|---|---|
| **Name of BoS Convener/ BoS Member** | **Designation** | **Department** | **College/ University** |
| Prof. Padam Singh | Convener | Physics | Mahamaya G.D.C. Dhanupur, Handia. Prayagraj |
| Dr. Vishalakshi Singh | Member | Physics | D.D.U. G.D.C. Saidabad, Prayagraj |
| Dr Aashit Kumar Jaiswal | Member | Physics | H.N.B. G.P.G.C. Naini Prayagraj |
| Prof. Pratima | Expert Member | Physics | Allahabad University, Allahabad |
| Prof. Sudesh Singh | Expert Member | Physics | T.D.P.G. College, Jaunpur |

| **Course Code** | | **Course Title** | **Credits** | **T/P** | **Evaluation** | |
|---|---|---|---|---|---|---|
| | | | | | **CIE** | **ETE** |
| A | B | C | D | E | F | G |
| **SEMESTER I (YEAR I)** | | | | | | |
| **B010701T** | CORE | Mathematical Physics | 5 | T | 25 | 75 |
| **B010702T** | CORE | Classical Mechanics | 5 | T | 25 | 75 |
| **B010703T** | CORE | Quantum Mechanics-I | 5 | T | 25 | 75 |
| **B010704T** | FIRST ELECTIVE (Select any one) | Electronics | 5 | T | 25 | 75 |
| **B010705T** | | Computational Method & Programming | | | | |
| **B010706P** | SECOND ELECTIVE (Select any one) | General Lab-1 | 4 | P | 50 | 50 |
| **B010707P** | | Electronics Lab-1 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **SEMESTER II (YEAR I)** | | | | | | |
| **B010801T** | CORE | Electromagnetic Theory & Plasma Physics | 5 | T | 25 | 75 |
| **B010802T** | CORE | Statistical Physics | 5 | T | 25 | 75 |
| **B010803T** | CORE | Atomic & Molecular Physics | 5 | T | 25 | 75 |
| **B010804T** | THIRD ELECTIVE (Select any one) | Nano Science and Sensor Technology | 5 | T | 25 | 75 |
| **B010805T** | | Satellite Communication & Remote Sensing | | | | |
| **B010806P** | FOURTH ELECTIVE (Select any one) | General Lab-2 | 4 | P | 50 | 50 |
| **B010807P** | | Electronics Lab-2 | | | | |
| **SEMESTER III (YEAR II)** | | | | | | |
| **B010901T** | CORE | Nuclear & Particle Physics | 5 | T | 25 | 75 |
| **B010902T** | CORE | Solid State Physics | 5 | T | 25 | 75 |
| **B010903T** | CORE | Electronics- I | 5 | T | 25 | 75 |
| **B010904T** | FIFTH ELECTIVE (Select any one) | Quantum Mechanics-II | 5 | T | 25 | 75 |
| **B010905T** | | Modern Optics | | | | |
| **B010906P** | SIXTH ELECTIVE (Select any one) | General Lab-3 | 4 | P | 50 | 50 |
| **B010907P** | | Electronics Lab-3 | | | | |
| **SEMESTER IV (YEAR II)** | | | | | | |
| **B011001T** | CORE | Electrodynamics | 5 | T | 25 | 75 |
| **B011002T** | CORE | Electronics II | 5 | T | 25 | 75 |
| **B011003T** | SEVENTH ELECTIVE (Select any one) | Electronics & Communication Lab-4 | 4 | T | 25 | 75 |
| **B011004T** | | Atmospheric Science | | | | |
| **B011005R** | RESEARCH PROJECT/ DISSERTATION | Major Research Project/ Dissertation | 10 | R | 50 | 50 |

**NOTE:**

1. **Do not mark any Code/Information in Column-A, it will be indorsed by the University.**
2. **T/P** in Column-E stands for **Theory/Practical**.
3. **CIE** in Column-F stands for **'Continuous Internal Evaluation'** and depicts the maximum internal marks. Respective examination will be conducted by subject teacher.

4. **ETE** in Column-G stands for **'External Evaluation'** and depicts the maximum external marks. Respective Examination will be conducted by the University.
5. Column-B defines the nature of course/paper. The word **CORE** herein stands for **Compulsory Subject Paper**.
6. Column-D depicts the credits assigned for the corresponding course/paper.
7. **First Elective:** It will be a Subject Elective. Students may select one of the two subject papers under this category.
8. **Second Elective:** It will designate a Practical Paper examination. Practical exam must be of 100 marks in which 25 marks are based on their internal assessment and 75 marks should be given by external examiner appointed by university along-with internal examiner of the college or university.
9. **Third Elective:** It will be a Subject Elective. Students may select one of the two subject papers under this category.
10. **Fourth Elective:** It will accommodate a practical paper examination. Practical exam must be of 100 marks in which 25 marks are based on their internal assessment and 75 marks should be given by external examiner appointed by university along-with internal examiner of the college or university
11. **Fifth Elective:** It will be a Subject Elective. Students may select one of the two subject papers under this category.
12. **Sixth Elective:** It will be a Practical Paper examination. Practical exam must be of 100 marks in which 25 marks are based on their internal assessment and 75 marks should be given by external examiner appointed by university along-with internal examiner of the college or university
13. **Seventh Elective:** It will be a Generic Elective. The student may study or receive training of the any subject of his interest (depends on the availability in his institution of enrollment).
14. **Major Research Project:** It will be a Major Research Project or equivalently a research-oriented Dissertation on the allotted topic. The student will have to complete his/her research project under any supervisor. The supervisor and the topic for research project shall be allotted in second semester. The student straight away will be awarded 05 credits if he publishes a research paper on the topic of Research Project or Dissertation. The dissertation will be evaluated by internal examiner and external examiner appointed by university,

# M. Sc. (PHYSICS)
# Semester I

**Paper I:**

**B010701T: Mathematical Physics**

## UNIT-I

**Special Function**s: Second order linear differential equations; Solution by series expansion; Legendre, Bessel, Hermite and Laguerre differential equations, their solutions and properties, Spherical Harmonics.

## UNIT-II

**Fourier and Laplace Transform**: Dirac Delta function, Fourier Transform, Sine and Cosine transform, Laplace transform, Inverse Laplace transform, Linearity, Change of Scale, Translation, Modulation, simple applications.

## UNIT- III

**Complex Variables I**: General function of complex variable, Cauchy-Riemann differential equation and analyticity, Cauchy's integral formula, Taylor's and Laurent's series, singularity poles.
**Complex Variables II:** Residue theorem, Evaluation of definite integrals, around (i) unit circle and (ii) infinite semi-circle using Jordan's lemma with poles lying on real axis.

## UNIT- IV

**Green Function**: Green's function as a technique to solve linear ordinary differential equations, Homogeneous and Inhomogeneous boundary conditions, Solution of Poisson equation using Green's function technique, Symmetry property.

**Reference Books:**

1. Mathematical Methods for Physicists by G. Arfken, H. Weber and F.E. Harris (Elsevier)
2. Mathematics for Physicist by P. Dennery and A. Krzynicki (Dover Publication)
3. Special Functions and their Applications by N. N. Lebedev (Dover Publication)
4. Mathematical Methods for Physics and Engineering by K. F. Riley, M.P. Hobson and S. J. Bence (Cambridge University Press)
5. Mathematical Physics by B. S. Rajput (Pragati Prakashan)
6. Complex Variables and Applications by J.W. Brown and R. V. Churchill (McGraw-Hill)

**Paper II:**

**B010702T: Classical Mechanics**

## UNIT-I

**Vectors**: Curvilinear Coordinates, Gradient, Divergence and Curl, Laplace equation in spherical polar and cylindrical polar coordinates and their solution, Green's theorem, Gauss and Stokes Theorems.

**Tensors**: Covariant and Contra-variant vectors, Tensors-Addition, Multiplication, Contraction, Symmetry properties; Tensor density, Pseudo-tensors.

## UNIT-II

**Mechanics of a system of particles**: System of particles and Constraints, Generalized coordinates, D'Alembert's principle, Lagrange's Equation, Hamilton's principle, Least action principle, Langrange's equations, symmetry properties and Noether's theorem, Lagrangian formulation for elementary mechanical systems-free particle, and simple pendulum.

## UNIT-III

**Two Body Problem**: Reduction to one-body problem, reduced mass, Virial Theorem, planetary orbits.
**Scattering:** Collision between particles, disintegration of particles, elastic collisions, scattering, Rutherford's formula.

## UNIT-IV

**Hamiltonian Formulation:** Hamilton equations, canonical transformations, Poisson's bracket, Symplectic approach to canonical transformations; Hamilton Principle function, Hamilton-Jacobi equation, Harmonic Oscillator Problem, Hamilton characteristic Function, Separation of variables, Central Force problem.

**Reference Books:**

1. Vector Analysis and Introductory Tensor Analysis by M.R. Spiegel (Schaum Series)
2. Matrices and Tensors in Physics by A.W. Joshi (New Age)
3. Classical Mechanics by H. Goldstein (Narosa, New Delhi)
4. Classical Mechanics by K.C. Gupta (Wiley Eastern)
5. Classical Mechanics by LD, Landau (Elsevier)
6. Classical Mechanics by N.C. Rana and P.S. Joag (Tata-McGraw-Hill)

**Paper-III:**

**B010703T: Quantum Mechanics - I**

## UNIT-I

**Wave Mechanical formulation:** Schrodinger wave equation: stationary states, boundary & continuity conditions, degeneracy, orthogonality of eigen functions and parity, Hermitian operators and observables, Dirac delta function, commuting observables and related algebra, Simple one-dimensional applications: potential well, barrier potential, and tunnel effect.

## UNIT-II

**Identical Particles and spin**: Distinguishability of identical particles, exchange degeneracy and operator, construction of symmetric and antisymmetric wave functions, Pauli's exclusion principle and Slater's determinant, Electron spin hypothesis, spin matrices and eigen value equations, symmetric and antisymmetric wave functions for hydrogen molecule.

## UNIT-III

**Matrix formulatio**n: Concept of Hilbert Space, Dirac's bra and ket notations, Orthonormality and completeness relations (discrete and continuous), linear and real operators, eigenvalue equations and related theorems, projection operators and measurement of Pure and mixed states, application to Harmonic Oscillator, Equivalence of wave and matrix mechanics.

## UNIT-IV

**Theory of Angular momentum**: Orbital, spin and total angular momentum operators: eigen value equations and matrix representations, Ladder operators, commutation relations, Addition of angular momenta, Clebsch-Gordon coefficients.

**Reference Books:**


1. Quantum Mechanics, Vol. I & II by Albert Messiah (Dover Publication)
2. The Principles of Quantum Mechanics by P.A.M. Dirac (Oxford University Press)
3. Quantum Mechanics by L.I. Schiff (Tata-McGraw-Hill)
4. Modern Quantum Mechanics by J.J. Sakurai (Addison Wesley)
5. Introduction to Quantum Mechanics by D.J. Griffiths (Pearson Education)
6. Quantum Mechanics by C. Cohen-Tannoudji, B. Diu and F. Laloe (Wiley VCH)
7. Quantum Mechanics by B. K. Agarwal and Hari Prakash (Prentice-Hall, India)
8. Introduction to Quantum Mechanics by C. J. Joachain and B. H. Bransden.

**Paper-IV: (FIRST ELECTIVE PAPER)**

**B010704T: Electronics**

## UNIT-I

**Power Electronic**s: Rectifier with LC Filter, Electronic regulators, SCR: Basic structure, I-V characteristics and two- transistor model of SCR, SCR controlled half and full wave rectifier circuit and their analysis, UJT, equivalent circuit, I-V characteristics, Saw tooth wave generation, Elements of SMPS.

## UNIT - II

**Operational Amplifier:** IC-741-Block diagram, operation, Characteristics of Op-Amp; inverting and non-inverting inputs: Input offset current and Input offset voltage, differential amplifier, CMRR, Slew rate and power band width, op-amp as an amplifier, Application of Op-amp: summer, integrator and differentiator, Timer: IC-555 -Block diagram, A stable and Monostable operations, application of IC-555 - VCO.

## UNIT - III

**Boolean Algebra and Gates:** Boolean algebra, composite function and their algebraic simplification, De-Morgan's theorem, duality in Boolean algebra, Universality of NAND and NOR gates, SOP and POS forms, Karnaugh map, design of logic circuits, X-OR gate and its applications, half adder and full adder, parallel adder, look ahead carry:

## UNIT – IV

**Elements of Logic Families:** Transistor as a switch, FAN IN, FAN OUT, Noise Immunity, propagation delay, RTL, DTL, TTL logic, Sourcing and Sinking logic, TTL loading and Fan out, ECL logic.

**Reference Books:**

1. Switch Mode Power Conversion by K. Kit Sum (Marcel Dekker).
2. Power Electronics by P.C. Sen (Tata Mc Graw-Hill)
3. Pulse. Digital and Switching Wave Forms by J. Milman and 11. Taub (McGraw-Hill)
4. Op-amp and Linear Integrated Circuits by R.A. Gayakwad (Prentice-Hall India)
5. Integrated Circuits by J. Millman and C.C. Halkias (Tata-McGraw-Hill)
6. Digital Principle and Application by A.P. Malvino and D.P. Leach (McGraw-Hill)
7. Modern Digital Electronics by R.P. Jain (Tata McGraw-Hill)

**Paper-IV: (FIRST ELECTIVE PAPER)**

**B010705T: Computational Methods and Programming**

## UNIT-I

**Numerical Analysis I**: Interpolation: methods of interpolation, least square curve fitting, Methods of equal intervals, unequal intervals, Central Differences, Inverse interpolation: Iteration of successive approximation, exchange of dependent and independent variables and **reversi**on of series, Numerical differentiation: method based on interpolation, finite differences, operator and undetermined coefficients.

## UNIT - II

**Numerical Analysis II**: Numerical integration: Simpson's one-third and one-eighth rule, Euler-Maclaurin formula, Quadrature formulae, Numerical Solution to ordinary differential equation by Euler's method and Runge-Kutta (second and fourth order) method, Newton Raphson method, Iterative methods.

## UNIT-III

**C++ keyword:** Various data types, implicit conversions, for loop, while and do- while loop, break and continue statements, switch statements, if else, conditional operator, functions with default arguments, function overloading.
++ and -operators. Arrays, Structures, pointers, compound assignment.
**Basic concept of OOP**: definition of class and object, declaration of classes and objects and simple applications.

## UNIT - IV

Programming in C++ for the following: Newton-Raphson Method, Matrix manipulation, Euler's method, Runge-Kutta (second and fourth order) method.

**Reference Books:**


1. Introductory Methods of Numerical Analysis by S.S. Sastry (Prentice-Hall India)
2. Numerical Methods by E. Balguruswamy (Tata McGraw-Hill)
3. Numerical Recipes: The art of Scientific Computing by W.H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery (Cambridge University Press)
4. Object Oriented Programming with C++ by E. Balguruswamy (McGraw Hill Education).
5. The C++ Programming Language by Bjarne Stroustrup (Pearson Education India).
6. Computational Method in Physics and Engineering by Wong.

**Paper-V: (SECOND ELECTIVE PAPER)**

**B010706P: GENERAL LAB -1**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. He-Ne Laser.
2. e/m by Zeeman effect.
3. Programming on PC
4. Velocity of ultrasonic wave.
5. Measurement of dipole moment
6. Determination of Dielectric Constant.
7. Study of RC coupled amplifier
8. Study of regulator circuits.
9. Study of switch mode power supply (SMPS)
10. Flip -Flop

**Paper-V: (SECOND ELECTIVE PAPER)**

**B010707P: ELECTRONICS LAB -1**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. Study of multivibrator: Use of 555
2. Study of saw tooth wave generation by UJT
3. Study of characteristics of operational amplifier
4. Study of TTL gates
5. Study of combinational logic circuits
6. Study of super heterodyne receiver
7. Study of linear and square wave detector

# Semester II

**Paper I:**

**B010801T: Electromagnetic Theory and Plasma Physics**

## UNIT -I

**Maxwell Equations**: Microscopic and Macroscopic fields, Macroscopic Maxwell equations, Fields D and H, Dielectric tensor, Principal dielectric axes.

**Potential and Gau**ges: Scalar and vector potentials, Gauge transformation, Lorentz guage and Transverse gauge, Maxwell equations in terms of electromagnetic potentials.

## UNIT-II

**Propagation of Electromagnetic Waves:** Propagation of electromagnetic waves in free space, conducting and non-conducting medium, skin depth, Boundary conditions on EM Fields, Reflection and refraction at a plane interface between dielectrics.

**Polarisation of EM Waves:** Fresnel's Formula; Normal- and anomalous- Dispersion, metallic reflection, EM Wave in bound media: rectangular and circular wave guides, TE, TM and TEM Modes, Cut-off frequency and Wavelength.

## UNIT –III

**Plasma State:** Plasma state of matter, Motion of charge particles in uniform E & B fields, non-uniform fields, drifting motion, electrostatic and magneto static drift; Time varying E& B fields, Adiabatic invariants, Plasma confinements (Pinch effect, Mirror confinement, Van Allen Belts), Elementary idea of fusion technology, Sun Spots.

## UNIT - IV

**Hydrodynamics of Plasma:** Hydrodynamical description, Equation of magneto hydrodynamics, High frequency plasma oscillations, Short wavelength limit and Debye-screening distance.

**Reference Books:**

1. Introduction to Electrodynamics by D. J. Griffiths (Prentice - Hall, New Delhi)
2. The Classical theory of Fields by L. D. Landau and E.M. Lifshitz. (Elsevier)
3. Classical Electrodynamics by J. D. Jackson (Wiley Eastern)
4. Introduction to Plasma Physics by F.F. Chen (Plenum Press, New York)
5. Plasma Physics by S.N. Sen (Pragati Prakashan)
6. Plasma Physics by A. Birien Court.

**Paper II:**

**B010802T: Statistical Physics**

## UNIT-I

A review of Gibbs ensembles, Partition function for Perfect Gas and ensemble of Harmonic Oscillators, Partition Function for Gases containing Monatomic, Diatomic and Polyatomic Molecules, Conditions for Equilibrium, Entropy of an Ideal Boltzmann gas, Gibb's paradox, Sackur-Tetrode equation.

## UNIT-II

Subrahmanyan Chandrasekhar Biography,Grand partition function, Grand potential, FD and BE distribution in Grand Canonical ensemble, Bose - Einstein Condensation, Ideal Fermi - Dirac gas, Fermi temperature, applications of degeneracy to free electrons in metals, Magnetic susceptibility, White dwarfs and Chandrasekhar limit.

## UNIT-III

**Fluctuations:** Mean square deviation, Fluctuation in ensembles, Concentration Fluctuation in quantum statistics, one dimensional Random walk: random walk and Brownian motion

## UNIT-IV

**Random processes:** Markoff process, Langevin Equation, Correlation functions, Dissipation Theorem, Weiner-Khintchine theorem, Nyquist theorem, Conditional probability, Fokker-Plank Equation.

**Reference Books:**

1. Fundamentals of Statistical and Thermal Physics by F. Reif (McGraw-Hill)
2. Statistical Mechanics by K. Huang (John Wiley & Sons)
3. Statistical Mechanics by R.K. Pathria (Elsevier)
4. Statistical Mechanics and Properties of Matter by E.S.R. Gopal (Macmillan Ltd., Delhi)
5. Statistical Mechanics by B. K. Agarwal and M. Eisner (Wiley Eastern)

**Paper-III:**

**B010803T: Atomic and Molecular Physics**

## UNIT-I

Quantum states of an electron in an atom, Spectrum of Hydrogen and Helium atom, fine structure, Spectra of Alkali atoms; energy level diagrams, Sharp, Principal, Diffuse and fundamental series.

## UNIT-II

Hyperfine structure, Width of spectral lines, Spectroscopic terms; LS & JJ couplings, Zeeman, Paschen Back & Stark effect, X-ray spectroscopy, Electron spin resonance, Nuclear magnetic resonance, chemical shift, Spectra of Diatomic Molecules.

## UNIT-III

Rotational Spectra (rigid rotator and non-rigid rotator model), Vibrational Spectra (harmonic and anharmonic model), Molecular Symmetric Top, Vibrating rotator, Isotopic shift.

## UNIT-IV

Chandrasekhara Venkata Raman Biography, Raman Spectra (Quantum mechanical and classical approach), Electronic Spectra-vibrational structure of band system, fine structure of the band systems, Intensity distribution in band systems: Frank Condon principle.

**Reference Books:**

1. Molecular Spectra and Molecular Structure by G. Herzberg (Dover Publication).
2. Fundamentals of Spectroscopy by C.N. Banwell and E.M. McCash (Tata-McGraw-Hill)
3. Introduction to Molecular Spectroscopy by G. M. Barrow (McGraw-Hill)
4. Modern Spectroscopy by M.J. Hollas (Wiley Inter Science)

**Paper-IV: (THIRD ELECTIVE PAPER)**

**B010804T: Nano Science and Sensor Technology**

## UNIT-I

**Nanomaterials Science:** Nanomaterials- Definition, Properties of Nanomaterials, Nanomaterials Scale, Nanoscale in One Dimension: Thin Films, Layer and Surfaces, Nanoscale in Two Dimension: Carbon Nanotubes, Inorganic Nanotubes, Nano wires, Biopolymers, Nanoscale in Three Dimensions: Nanoparticles, Fullerenes (C-60), Quantum Dots, Application of Nanomaterials

## UNIT-II

**Graphene:** Discovery, Synthesis and Structural Characterization through TEM, Elementary Concept of its applications.

**Quantum Wells, Wires and Dots:** Preparation of Quantum Nanostructures, Size Effects, Conduction Electrons and Dimensionality. Properties dependent on Density of States

## UNIT-III

**Nanoparticles-Synthesis and Properties:** Method of Synthesis: RF Plasma Chemical Methods, RF spurting method, Sol-gel Method, Physical Vapor Deposition, Chemical Vapor Deposition and Pulsed Laser Method.

## UNIT-IV

**Physics of Sensor-Technology:** Physical sensor, Chemical sensor, MOS gas sensor, MOS capacitor; C-V characteristics, Thin/thick films Sensor; sensing mechanism of gas sensors, Fabrication of MOS, Thick /Thin film gas sensors.

**Reference Books:**


1. Introduction to Nanotechnology: Poole and Owners
2. Quantum Dots: Jacak, Hawry lak and Wojs
3. Handbook of Nanostructured Materials and Nanotechnology: Nalva (editor)
4. Nano Technology/ Principles and Practices: S.K. Kulkarni
5. Carbon Nanotubes: Silvana Fiorito
6. Nanotechlongy: Richard Booker and Earl Boysen.
7. Functional Thin Films and Nanostructures for Sensors by Anis, Zribi, Jeffrey.
8. Gas Sensors by Xiao, Tun. Qiu.

**Paper-IV: (THIRD ELECTIVE PAPER)**

**B010805T: Satellite Communication and Remote Sensing**

## UNIT-I

**Principle of Satellite Communication:** General and Technical characteristics, Active and Passive satellites, Modem and Codec.
**Communication Satellite Link Design:** General link design equation, Atmospheric and Ionospheric effect on link, design, Earth station parameters.

## UNIT-II

**Satellite Analog Communication:** Baseband analog signal, FDM techniques, S/N and C/N ratio in FM in satellite link.

**Digital Satellite Transmission;** Advantages, Elements of digital satellite communication, Digital base band signal, Digital modulation Techniques, Digital link Design, TDM, TDMA, some applications of satellite communications,

## UNIT-III

**Concept and Foundations of Remote Sensing**: Electromagnetic Radiation (EMR), interaction of EMR with atmosphere and earth surface, Application area of Remote Sensing.

**Characteristics of Remote Sensing Platform & Sensors:** Ground, Air & Space platforms, Return Beam Vidicon, Multi-spectral Scanner, Brief idea of Digital Image Processing.

## UNIT-IV

**Microwave Remote Sensing Tools:** Radar Remote Sensing, Microwave Sensing, LIDAR (Single and double ended system), (Radar & Lidar): Data Characteristics.

**Earth Resource Satellites:** Brief description of Landsat and Indian remote sensing satellites (IRS) Satellites.

**Reference Books:**

1. Satellite Communication: D.C. Agrawal and A. K. Maini.
2. Satellite Communication: T. Pratt and C. W. Bostiern.
3. Satellite Communication System: M. Richharia.
4. Introduction of Remote Sensing: J.B. Campbell.
5. Manual of Remote Sensing Vol I and II : (Ed. R.N. Colwell).

**Paper-V: (FOURTH ELECTIVE PAPER)**

**B010806P: GENERAL LAB-2**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. Use of scintillation counter .
2. G M Counter characteristics.
3. Magnetic Susceptibility.
4. Energy band gap by four probe technique
5. EPR of free radicals
6. Hall effect
7. Study of characteristic of SCR and controlled rectification by SCR.
8. B. H Curve ( Hysteresis loss) by C.R.O.
9. ESR

**Paper-V: (FOURTH ELECTIVE PAPER)**

**B010807P: ELECTRONICS LAB-2**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. Study of emitter follower
2. Study of phase shift oscillator
3. Microwave measurement: Mode analysis and standing wave ratio
4. Linear characteristics of Operational amplifier
5. Non-linear characteristics of Operational amplifier
6. Active filters using Operational amplifier
7. D/A and A/D converters
8. Negative Feed Back amplifier

## Semester III

**Paper I:**

**B010901T: Nuclear and Particle Physics**

### UNIT-I

**Nuclear Models:** Evidence of Nuclear shell Structure; Nuclear Potential and sequence of energy levels of nucleons, spin orbit potential and explanation of magic numbers, Collective model.

### UNIT-II

**Nuclear Reactions**: Cross section; partial wave analysis, optical theorem and shadow scattering, Compound nucleus hypothesis, Breit-Wigner one level formula, Direct Reactions; pickup and stripping reactions.

### UNIT-III

**Beta Decay**: Pauli's neutrino hypothesis. Fermi theory of (β)-decay, Fermi-Kurie Plot and comparative half-lives, selection rules and classification of transitions, Parity non conservation and Wu's experiment.
**Nuclear f**orces: Deuteron problem, low energy (n-p) and (p-p) scattering, scattering length, effective range theory, Spin-dependence of (n-p) interaction

### UNIT-IV

**Elementary Particles**: Homi Jehangir Bhabha Biography, Fundamental interactions, Classification of elementary particles, symmetry and conservation laws, Elementary idea of CP and CPT invariance, Classification of Hadrons, Quantum numbers in strong interaction, Gell-Mann Nishijima formula, Lie algebra, SU(2)-SU(3) multiplets, Quark model of Hadrons.

**Reference Books:**


1. Nuclear Physics by Irvin Kaplan (Addison-Wesley)
2. Concepts of Nuclear Physics hy B.L. Choen (Tata McGraw Hill)
3. Atomic and Nuclear Plysics Vol-II by S. V.Ghoshal (S. Chand and Co. Ltd.)
4. Nuclear Physics (Theory and Experiment) by R.R. Roy and B.P. Nigam (Wiley Eastern)
5. Nuclear Physics Vol. I by Y M Shirikoy and N P Yudin, (Mir Publisher, Moscow 1982).
6. Nuclear and Particle Physics by E.B. Paul (North Holland Publishing)
7. Facts and Mysteries in Elementary Particle Physics by M. Veltman (World Scientific)

**Paper II:**

**B010902T: Solid State Physics**

## UNIT-I

**Crystal Structur**e: Ionic, covalent, metallic and hydrogen bonding, space lattice and basis; Types of lattice, Miller indices, crystal structures of NaCl, CsCl, ZnS, graphite and diamond; Reciprocal lattice and Brillouin Zones; Basic idea of crystal defects and dislocations.

## UNIT-II

**Band Theory of Solids:** Sommerfield model, Density of states, Fermi and mean energies at zero and finite temperatures; Origin of energy bands: Bloch Theorem; Kronig Penny model, Electron dynamics in crystalline lattice: light binding approximation.

## UNIT- III

**Thermal Properties:** Lattice vibrations of mono and diatomic chains, Quantization of lattice vibration, Phonon; Infrared absorption: Einstein and Debye theories of specific heat; Thermal conductivity; Anharmonicity and Thermal expansion.

## UNIT- IV

**Optical Properties:** Optical reflectance, Kramers-Kronig relations; Basic theory of luminescence, phosphorescence, thermoluminescence, etectroluminescence and photo-conductivity; Excitons in ionic and molecular crystals, Electron-hole drops (EHD) and colour centres.

**Reference Books:**


1. Solid state Physics by A. J. Dekkar (McMillan Publishers)
2. Introduction to Solid State Physics by C. Kittel (Wiley Eastern)
3. Elementary Solid State Physics by M. Ali Omar (Pearson Education)
4. Solid State Physics. N. W. Ashcroft and N. D. Mermin, (Harcourt Asia Limited)
5. Principles of the Theory of Solids by J. M. Ziman (Cambridge University Press)
6. Solid State Physics by S. O. Pillai (New Age Publishers)

**Paper – III:**

**B010903T: Electronics-I**

## UNIT-I

**Analog and Combinational Logic Circuits**: Analog computation, time and amplitude scaling, Analog to digital and digital to analog converter, Comparator, parity generator and checking, code conversion, Binary to gray and gray to binary, Logic design with MSI coder and decoder, multiplexer and demultiplexer circuits.

## UNIT-II

**Sequential Circuits:** Basic definition, finite state model SR, JK, T, D, Edge triggered flip flop, race condition and master slave flip flop, characteristic table and characteristic equation, sequential logic design state table, state diagram, state equation.

## UNIT-III

**Registers and Counters:** Register, shift register, universal shift register, Ring counter, twisted or Johnson counter, synchronous and asynchronours counters, UP/DOWN and scale of 2n counter.

## UNIT-IV

**Microprocesso**r: Basic idea of magnetic memory, Ferrite core memory, semiconductor memory viz. RAM, ROM, PROM, EPROM, EEPROM. Introduction to intel 8085 microprocessor architecture, instruction and timings assembly language programming, stack and subroutine, code conversion.

**Reference Books:**

1. Digital Systems by J. Ronald Tocci
2. Digital Principles and applications by Malvino and Leach
3. Microprocessor by Goenkar

**Paper – IV: (FIFTH ELECTIVE PAPER)**

**B010904T: Quantum Mechanics-II**

## UNIT-I

**Application of three-dimensional Schrodinger equations:** Particle in box, spherically symmetric systems: hydrogen atom, harmonic oscillator, Their solutions for quantum numbers, energy levels & degeneracy, and eigen functions

## UNIT-II

**Approximate methods:** Time independent perturbation theory and anharmonic oscillator, Variational method and Helium atom, Time dependent perturbation theory and transition probability (Fermi-Golden Rule), WKB method and alpha decay.

## UNIT-III

**Relativistic quantum mechanics:** Klein-Gordon equation, Plane wave solution and Physical interpretation, Inadequacy of Klein-Gordon equation; Dirac equation, $\alpha$ and $\beta$ matrices and related algebra, Representation and arbitrariness of $\alpha$ and $\beta$, Probabilistic interpretation.

## UNIT- IV

**Covariance of Dirac equation:** Covariant form of Dirac equation, Dirac($\gamma$) matrices, Representation and algebra, Linearly independent set of composite $\gamma$ matrices; Infinitesimal and Finite proper Lorentz transformation, Proof of covariance, Plane wave solution and negative energy states: Two component Pauli spin theory, Non relativistic correspondence,

**Reference Books;**


1. Quantum Mechanics by L.I. Schiff (Tata-McGraw-Hill)
2. Introduction to Quantum Mechanics by D. J. Griffith (Pearson Education)
3. Quantum Mechanics by C. Cohen-Tannoudji, B. Diu and F, Laloe (Wiley VCH)
4. Quantum Chemistry by Ira N. Levine (Pearson Education)
5. Relativistic Quantum Mechanics by James D. Bjorken and Sidney D. Drell (McGraw-Hill)
6. An Introduction to Relativistic Quantum Field Theory by S.S. Schweber (Harper & Row)

**Paper – IV: (FIFTH ELECTIVE PAPER)**

**B010905T: Modern Optics**

## UNIT-I

**Nonlinear Optics:** Non-linear polarizability tensors, Coupled amplitude equation; Manely-Rowe relationship; Parametric amplification and oscillation, Phase matching, Second harmonic generation.

## UNIT-II

**Quantum Optics:** Spatial and temporal coherence, classical and quantum coherence function; Glauber's theory of optical coherence, Over completeness of coherent states and its properties; Quasi phase distribution function.

## UNIT-III

**Fibre Optics:** Types of fibres, Single mode and multi-mode fibres: dispersion and loss in fibre; Principles of optical communication, Optical elements.

## UNIT-IV

**Holography:** Basic principle of holography, Method of hologram Recording and Reconstruction; Basic theory of plane hologram; practical consideration of holography and its application.

**Reference Books:**


1. *Optical Coherence and Quantum Optic*s by L. Mandel and E. Wolf (Cambridge University Press, Cambridge)
2. *Quantum Optic*s by M. O. Scully and M. Suhail Zubairy (Cambridge University Press, Cambridge)
3. *Physics of Non-Linear Optics* by Guang S. He and Song H. Liu (World Scientific Press, Singapore)
4. *Laser and holographic Data processing* by N. G. Bosov (Mir Publisher, Moscow)
5. *Nonlinear Optics* by R. W. Boyd.
6. *Nonlinear Fiber Optic*s by Govind P. Agarwal (Elesevier)
7. *Quantum Optic*s by Girish S. Agarwal

**Paper-V: (SIXTH ELECTIVE PAPER)**

**B010906P: GENERAL LAB-3**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. Use of constant deviation spectrograph
2. Use of Fabry-Perot interferometer
3. Use of concave grating
4. Power distribution within the laser beam
5. Spatial coherence with Young's double slits
6. Spot size and divergence of a laser beam
7. IC 555 Timer in different modes
8. Phase Locked Loops using IC 565 PLL
9. Sample and Hold circuit,
10. Pulse amplitude modulation and demodulation
11. PAM, PPM,PWM modulation and demodulation
12. Determination of wavelength of laser by grating (transmission/reflection)

**Paper-V: (SIXTH ELECTIVE PAPER)**

**B010907P: ELECTRONICS LAB-3**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. Combinational circuits
2. Sequential circuits
3. Characteristics of TTL logic
4. Multiplexer and Demultiplexer circuits
5. Semiconductor memory using IC 7489 RAM
6. Encoder and Decoder
7. Microprocessor 8085 – I
8. Microprocessor 8085 – II
9. Multivibrator

# Semester-IV

**Paper-I:**

**B011001T: Electrodynamics**

## UNIT-I

**Four Dimensional Formulation**: Postulates of special theory of relativity, Minkowski Space, Lorentz transformation, Intervals, Light cone, Proper time, Four Vectors, Doppler Effect (Transverse and Longitudinal) and Aberration.

## UNIT- II

**Relativistic Mechanics:** Langrangian formulation, Principle of least action, Four-momentum vector of a free particle, Hamiltonian, Equation of motion.

**Electromagnetic Field Equations:** Four Potential Four dimensional formulation: Action of a charged particle, Generalized Momentum and Hamiltonian, Equation of motion,
Electromagnetic field tensor, Transformation properties of electric and magnetic fields.

## UNIT-III

Invariants of Electromagnetic field, Four dimensional formulation of first and second pair of Maxwell equations, Equation of continuity.

The Field of Moving Charges: Retarded potentials, Lienard-Wiechert potentials, Field due to system of charges at large distances,

## UNIT-IV

Dipole radiation, Quadrupole and magnetic dipole radiation; Field at near distances, Radiation from a rapidly moving charge, Synchrotron radiation (magnetic bremsstrahlung), Radiation damping,

**Reference Books:**


1. *The Classical theory of Field*s by L.D. Landau and E.M. Lifshitz (Elsevier)
2. *Classical Electrodynamic*s by J.D. Jackson (Wiley Eastern)
3. *Classical Electricity and Magnetism* by W. Panofsky and M. Phillips (Dover Publication)
4. *Quantum Electrodynamic*s by F. Mandl & G, Shaw (John Wiley and Sons)
5. *A First Book of Quantum Field Theory* by A. Lahiri & P. B. Pal (Narosa, New Delhi)

**Paper – II:**

**B011002T: Electronics-II**

## UNIT-I

**Communication Theory:** Types of Noise and its Spectrum, S/N ratio in analog communication systems, information content of message, rate of information-transmission in discrete communication channels, channel capacity, Shanon- Hartly Theorem and its applications.

## UNIT-II

**Analog Modulation:** Sampling of analog signals, sampling theorem, Types of modulation and generation: PAM, PPM, and PWM; Quantization of Analog signals: Uniform and Non uniform.

## UNIT-III

**Digital Modulation**: Pule code modulation, Binary coding and PCM bandwidth DPCM, DM and ADM, Base Band data transmission, inter-symbol interference, RRC filters, Passband data transmission. ASK, PSK and FSK system, transmission and detection of binary system.

## UNIT-IV

**Microwaves and Antenna:** Microwave generation, Reflex Klystron Oscillator, Transfer Electron Effect, Gun Diode, Tunnel diode, IMPATT, Current and voltage distribution in antenna, Short electric dipole, linear and ground antenna, field -distribution around vertical antenna, antenna arrays.

**Reference Books:**


1. Communication Systems by B.P. Lathi (Oxford University Press)
2. Principles of Communication System by Taub & Schilling (Mc Graw Hill)
3. Microwave by K.C. Gupta (Hiley Tristem Limited)
4. Antennas and Wave Propagation by J.D. Kraus (Tata Mc Graw Hill Publishing Company Limited -2010
5. Communication System by Haykin

**Paper – III : (SEVENTH ELECTIVE PAPER)**

**B011003T: ELECTRONICS & COMMUNICATION LAB-4**

Students will be required to perform at least four experiments from each semester, They will have to maintain record books of experiments done for each course separately.

**LIST OF EXPERIMENTS**

1. Pulse amplitude modulation and demodulation
2. PAM, PPM, PWM modulation and demodulation
3. Generation and detection of Amplitude Shift Keying (ASK)
4. Generation and detection of Phase shift Keying (PSK)
5. Generation and detection of Frequency shift Keying (FSK)
6. V-I and P-I Characteristics of LED
7. V-I and P-I Characteristics of Photodiode
8. D/A and A/D converters
9. Encoder and Decoder
10. Superconducting transition and critical current density measurement

**Paper – III: (SEVENTH ELECTIVE PAPER)**

**B011004T: Atmospheric Science**

## UNIT-I

**Lower Atmosphere:** Its Composition, constituent, dynamics: Diurnal and seasonal variations of temperature, pressure and humidity: Cloud methodology, cloud microphysics.

## UNIT-II

**Aerosols:**

Aerosol Optical Depth, Effects of Aerosols in Indo-Gangetic basin.

**Synoptic systems in different seasons:**

Winter, western disturbances, Fog, cold wave: Summer; thunderstorm, dust storm, heat wave, cyclones; Monsoon; onset, withdrawal.

## UNIT-III

**Ozone:**

Temporal & spatial variation of ozone, Ozone hole and its impact on climate.

**Ionosphere:**

Its structure & formation: Ionospheric irregularities: Sporadic E and Spread-F irregularities and their distribution: Ionospheric Scintillations, Aurora Borealis: morphology of auroral region, distribution of auroral emissions.

## UNIT-IV

**Magnetosphere:**

Its structure, Bow shock, Magnetopause, Magnetopause current, Stand-off distance of stagnation point, Microstructure of magnetopause; Shape of magnetospheric cavity, Magnetotail; Planetary magnetospheres, VLF waves, Whistlers & its applications.

**Reference Books:**

1. Atmospheric Physics: J. V. Iribrine & H. R. Cho, D. Reidel, Pub. Company, Holland.
2. The Physics of Atmosphere: John Houghton. Cambridge University Press, U.K.

**B011005R- Major Research Project (MRP):**

The dissertation topic will be based on special papers or elective papers and topics of current interest. A departmental committee will distribute the topics.

Student must carry out review of a selected topic and make a presentation to an evaluation committee.

These projects will involve literature survey and collection of material, detailed study of the material, verification of results and writing of the review. Review projects will include exposure and conduct of experiments as require. The dissertation will be evaluated by the internal examiner and external examiner appointed by the University.