AKS University, Satna (M.P.)
FACULTY OF BASIC SCIENCE
COURSE: M.Sc. (PHYSICS)
SESSION: 2018-19 (Onwards)
Scheme of Examination

First Semester from July to December -

<table>
<thead>
<tr>
<th>S/N</th>
<th>Paper Code</th>
<th>Paper Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>77PH101</td>
<td>Mathematical Physics</td>
<td>4</td>
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<tr>
<td>2</td>
<td>77PH102</td>
<td>Classical Mechanics</td>
<td>4</td>
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<tr>
<td>3</td>
<td>77PH103</td>
<td>Condense Matter Physics</td>
<td>4</td>
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<tr>
<td>4</td>
<td>77PH104</td>
<td>Electronic Devices</td>
<td>4</td>
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<tr>
<td>5</td>
<td>77PH151</td>
<td>General Physics Lab-I</td>
<td>3</td>
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<tr>
<td>6</td>
<td>77PH152</td>
<td>Electronics Lab-I</td>
<td>3</td>
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Total Credits 22

Second Semester from January to June -

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<tr>
<th>S/N</th>
<th>Paper Code</th>
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<tbody>
<tr>
<td>1</td>
<td>77PH201</td>
<td>Thermodynamics and Statistical Physics</td>
<td>4</td>
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<tr>
<td>2</td>
<td>77PH202</td>
<td>Solid State Physics</td>
<td>4</td>
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<tr>
<td>3</td>
<td>77PH203</td>
<td>Quantum Mechanics-I</td>
<td>4</td>
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<tr>
<td>4</td>
<td>77PH204</td>
<td>Atomic, Molecular and Laser Physics</td>
<td>4</td>
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<tr>
<td>5</td>
<td>77PH251</td>
<td>General Physics Lab-II</td>
<td>3</td>
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<td>77PH252</td>
<td>Electronics Lab-II</td>
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Third Semester from July to December-

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<tr>
<td>1</td>
<td>77PH301</td>
<td>Electrodynamics and Plasma Physics</td>
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<tr>
<td>2</td>
<td>77PH302</td>
<td>Quantum Mechanics-II</td>
<td>4</td>
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<tr>
<td>3</td>
<td>77PH303</td>
<td>Communication and Digital Electronics &amp; Microprocessor</td>
<td>4</td>
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<tr>
<td>4</td>
<td>77PH304</td>
<td>Nuclear and Particle Physics</td>
<td>4</td>
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<td>5</td>
<td>77PH351</td>
<td>General Physics Lab-III</td>
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<td>77PH352</td>
<td>Electronics Lab-III</td>
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Total Credits 22

Fourth Semester from January to June -

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<tr>
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<tr>
<td>1</td>
<td>77PH401</td>
<td>Physics of Nano Materials</td>
<td>4</td>
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<tr>
<td>2</td>
<td>77PH402</td>
<td>Solar Cell and other Renewable Energy Devices</td>
<td>4</td>
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<tr>
<td>3</td>
<td>77PH403</td>
<td>Computational and Experimental Techniques and Data Analysis</td>
<td>4</td>
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<tr>
<td>4</td>
<td>77PH451</td>
<td>General Energy and Computational Lab</td>
<td>3</td>
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<tr>
<td>5</td>
<td>77PH452</td>
<td>Project Work</td>
<td>9</td>
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Total Credits= I Sem + II Sem+ III Sem+ IV Sem = 22 + 22 + 22 + 24 = 90

Others:
- Assignments to the theory and practical.
- Seminars on course work and research topic.
- Lectures by visiting scientists.
- Industrial/Scientific visit to all students.
- One research paper related to their course has to be submitted by all students.
M.Sc. (PHYSICS)
SEMESTER- I (PAPER-I)
[MATHEMATICAL PHYSICS]  (4+0+0=4)

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

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

Unit III (Elements of Complex Variable)
Functions of a complex variable, the derivative and the Cauchy-Riemann differential equations, line integrals of complex functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor's series, Laurent's series, residues; Cauchy's residue theorem, singular points of an analytic function, evaluation of residues, Jordon-Lemma, evaluation of definite integrals.

Unit IV (Special Functions)
Definition of special functions, Generating functions for Bessel function of integral order \( J_n(x) \), Recurrence relations, Integral representation; Legendre polynomials \( P_n(x) \), Generating functions for \( P_n(x) \), Recurrence relations; Hermite Polynomials, Generating functions, Rodrigue's formula for Hermite polynomials; Laguarrre polynomials, Generating function and Recurrence relations.

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

Text & Reference books:
3. Mathematical Methods - Potter and Goldberg (Prentice Hall of India)
4. Elements of Group Theory for Physicists: A.W. Joshi (Wiley Eastern Ltd.)
5. Vector Analysis (Schaum Series) (McGraw Hill)
M.Sc. (PHYSICS)
SEMESTER- I (PAPER-II)

[CLASSICAL MECHANICS] (4+0+0=4)

UNIT – I (Survey of Elementary Principles and Lagrangian Formulation)
Newtonian mechanics of one and many particles systems; Conservation theorems for linear momentum, angular momentum and energy; Constraints; their classification; Principle of virtual work; D’Alembert’s principle in generalized coordinates; The Lagrangian, Lagrange’s equations; velocity dependent potential and dissipative function. Configuration space, Hamilton’s principle; Generalized momenta and Lagrangian formulation of the conservation theorems and Jacobi’s integral. Reduction to the equivalent one body problem; The equation of motion and first integrals; The differential equation for the orbit and integration power law potentials.

UNIT – II (Kepler Problems)
The Kepler problem: inverse square law of force; Artificial satellites; Scattering in a central force field, Rutherford scattering; Legendre transformations and the Hamilton’s equations of motion; Conservation theorems and the physical significance of the Hamiltonian. Derivation of Hamilton’s equations from a variational principle. The principle of least action.

UNIT – III (Canonical Transformations)
The equations of canonical transformations and generating functions; Poisson’s Brackets: their canonical invariance; Simple algebraic properties of Poisson Brackets. The equations of motion in Poisson’s Brackets notation; Poisson’s theorem; Angular momentum PB’s Hamilton’s principal and characteristic functions; The Hamilton-Jacobi equation; Action Angle variables.

UNIT – IV (small oscillations and Moving coordinate systems)

UNIT – V (Relativistic Mechanics)
Symmetries of space and time. Invariance under Galilion transformation, Covariant four-dimensional formulation. 4-Vectors and 4-Scalars. Relativistic generalisation of Newton’s laws, 4-momentum and 4-force. Invariance under Lorentz transformation relativistic energy. Lagrangian and Gange invariance Hamiltonian formulation in relativistic mechanics. Covariant Lagrangian, covariant Hamiltonian, Examples.

Text and References Books
Classical Mechanics : H. Goldstein (Addision Wesley, 1980)
Mechanics : A Sommerfiels (Academi Press 1952)
Introduction to Dynamics : I. Perceival and Richards (Cambridge Univ. Press, 1982)
M.Sc. (PHYSICS)
SEMESTER- I (PAPER-III)
[CONDENSE MATTER PHYSICS] (4+0+0=4)

Unit-I (Crystal Structure)

Unit - II (X-ray and Its Application)
Interaction of X-ray with matter, absorption of X-rays, Elastic scattering from a perfect lattice. The reciprocal lattice and its application to diffraction techniques, the Lave, power and rotating crystal methods. Crystal structure factor and intensity diffraction maxima. Extinction due to lattice centering. Point defeats, line defects and planer (stacking) faults. The role of dislocation in plastic deformation and crystal growth. The observation of imperfections in crystals. X-ray and electron microscopic techniques

Unit – III (Defects in Crystals)
Point defects : Shallow impurity states in semiconductors. Localized lattice vibrational states in solids, vacancies, interstitial and colour centers in ionic crystals. Structure and symmetries of liquids, liquid crystals and amorphous solids. Aperiodic solids and quasicrystals; Fibonacci sequence, penrose lattice and their extension to 3-dimensions.

UNIT – IV (Crystal Mechanism)
Disorder in condense matter, subsitutional, 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.

Unit -V (Free Electron Theory)

Text and Reference Books
1. Solid State Physics : Kittle
2. Solid State Physics : Aschroft & Mermin
3. Introduction to Solid State Physics : L.V. Azaroff
5. Solid State Physics : A.J. Dekker
UNIT-I (Diodes)
**Photonic Devices**: Radiative and non-radiative transitions in thin film, 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 lasers (conditions for population inversion, inactive region, light confinement factor, Optical gain and threshold current for lasing Fabry-Pettot cavity length for lasing and the separation).

**Other devices**: P-N Junction Diode, Zener Diode, Tunnel diode, Gunn diode, Impact diode.

UNIT-II (Transistors)
JFET, BJT, MOSFET and MESFET, Construction, Structure, working Derivations of the equations for I-V characteristics under different conditions. High frequency limits. Classification of Amplifiers.

UNIT – III (Digital Integrated Circuits)
Characteristics of logic families, saturated logic families. RTL, DCTL, DTL, TTL, IIL, HTL Non saturated bipolar logic families, TTC, ECL, Unipolar logic families, Digital integrated circuits-SSI, MSI, LSI and VLSI circuits.

UNIT – IV (Operational Amplifiers)
Differential amplifier, operational amplifier, OP-AMP Parameters, Inverting and Non-Inverting modes, Use of OPAMP as adder, substractor, inverter, differentiator, integrator, function generator, active filters.

UNIT – V (Memory Devices)
Memory Devices: Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, non-volatile memory, magnetic, optical and ferroelectrics memories, charge coupled devices (CCD).

Introduction to other electronic devices: Electro optic, magneto optic and Acousto-optic effects; Examples of some active devices in integrated optics based on these effects., Liquid crystal display devices. Piezoelectric effect, important materials exhibiting this property, piezoelectric filters and resonators, high frequency piezoelectric devices – surface acoustic devices. Capacitor, Electrets and piezo electric electro mechanical transducer devices.

**Text and reference books**
- Introduction to Semiconductor devices : M.S. Tyagi (John Wiley and Sons)
- Measurement, Instrumentation and Experimental Design in Physics and Engineering : M. Sayer and A. Mansingh
- Optical Electronics : Ajoy Ghatak and K. Thyagarajan (Cambridge Univ. Press.).
M.Sc. (PHYSICS)  
SEMESTER- I  
[General Physics Lab-I]  
(0+0+6=3)

1) Measurement of wave length of He-Ne laser light using ruler.  
2) Measurement of thickness of thin wire with laser.  
3) Determination of characteristic parameters of an optical fiber.  
4) Identification of unknown sample using powder diffraction method.  
5) Photoconductivity Experiment [(i) To plot the current-voltage characteristics of a CdS photo-resistor at constant irradiance (ii) To measure the photocurrent as a function of irradiance at a constant voltage].  
6) Characteristics of Photovoltaic Cell.  
7) Determine angle of specific rotation of sugar solution by using Polarimeter.  
8) To determine diameter of the even and odd rings by using Newtons rings apparatus.  
9) To determine the grating element of a diffraction grating with the help of spectrometer.  
10) Determination of the Plank’s Constant by Photo cell.

M.Sc. (PHYSICS)  
SEMESTER- I  
[Electronics Lab-I]  
(0+0+6=3)

1. To study characteristics of tunnel diode.  
2. To study characteristics of gun diode.  
3. To study characteristics of FET and use in an amplifier.  
4. Experiments on MOSFET characterization and application as an amplifier.  
5. Operational amplifier (OP Amp) as integrator & differentiator.  
6. Use OP Amplifier as a) Inverting amplifier, b) Non-inverting amplifier and c) Study the frequency response.  
7. To study of Differential Amplifiers.  
8. To study of Emitter follower.  
9. Characteristics and applications of Silicon Controller Rectifier.  
10. Study of Passive filters (L and π-section).  
12. BCD to Seven Segment display.
UNIT-I (Thermodynamics)
Concept of entropy, Change in entropy in adiabatic process, Change in entropy in reversible cycle. Principle of increase of entropy, Change in entropy in irreversible process. T-S diagram, Physical significance of Entropy, Entropy of a perfect gas, Kelvin’s thermodynamic scale of temperature, The size of a degree, Laws of Thermodynamics and their consequences. Thermodynamic and chemical potentials, phase equilibria, Identity of a perfect gas scale and absolute scale. Zero point energy, Negative temperatures (not possible), Heat death of the universe. Relation between thermodynamic variables (Maxwell’s relations).

UNIT-II (Fundamentals of Statistical Mechanics)
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. Microcanonical 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 – III (Condensation)

UNIT – IV (Phase Transition)

UNIT – V (Thermodynamics fluctuations)

Text and Reference Books
Thermal and Statistical Physics: K.M. Jain, South Asian Publication.
Fundamentals of Statistical and Thermal Physics : F. Reif
Statistical Mechanics : K. Huang
Statistical Mechanics : R.K. Pathria
Statistical Mechanics : R. Kubo
Statistical Mechanics : Landau and Lifshitz
UNIT-I (Semiconductor Materials)
Energy Bands, carrier concentration and Fermi levels for Intrinsic and extrinsic semiconductors. Donors and Acceptors, Direct and Indirect band semiconductors. Degenerate and compensated semiconductors, Elemental (Si) and compound semiconductors (GaAs). Replacement of group III element and Group V elements to get tertiary alloys such as Alx Ga(1-x) As or GaPyAs(1-y) and quaternary InxGa(1-x)PyAs(1-y) alloys and their important properties such as band gap and refractive index changes with x and Y. Doping of Si (Group III (n) and Group V (P) compounds) and GaAs (Group II (P), IV (n-p) and VI (n compounds). Diffusion of impurities – Thermal Diffusion, constant surface concentration, Constant Total Dopant Diffusion, ion implantation.

UNIT-II (Carrier Transport in Semiconductors)
Carrier Drift under low and high fields in (Si and GaAs) saturation of drift velocity. High field effects in two valley semiconductors. Carrier Diffusion carrier injection, Generation Recombination processes- Direct, indirect bandgap semiconductors. Minority carrier Life Time, Drift and Diffusion of minority carriers (Haynes= Shockley Experiment) Determination of conductivity (a) four probe and (b) van der Pauw techniques. Hall coefficient, minority carrier Life Time.

UNIT-III (Dielectric Properties)
Atomic and molecular Polarizibility, Claussius-Mosso relation, types of polarizibility, dipolar polarizibility and frequency dependence of dipolar polarizibility, ionic and electronic polarizibility, Hall effect, Quantum Hall Effects, Magneto resistance.

UNIT-IV (Magnetic Properties)

UNIT-V (Superconductivity)
Concept of superconducting state, persistent current, critical temperature, meissner’s effect, thermodynamics of the superconducting transitions, properties, Isotope effect, Manifestations of energy gap, London equation & penetration depth, Two fluid model, Flux quantization, single particle tunneling, dc and ac Josephson effect, quantum interference, electron-phonon interaction, Cooper pairing, Interaction of electrons with acoustic and optical phonons, polarons, BCS theory of superconductivity, High temperature superconductors and their applications.

Text and reference books:
3. Introduction to Solid State Physics : L.V. Azaroff
4 Crystellographic Solid State Physics. : Verma & Srivastava
5. Solid State Physics : A.J. Dekker
UNIT – I (Foundation of Quantum mechanics)
Why QM? Brief prevision. Basic postulates of quantum mechanics, Wave-particle duality, wave packets, wave function, expectation values, continuity equation, Ehrenfest theorem, Heisenberg uncertainty principle. equation of continuity, Normality, orthogonality and closure properties of eigen functions, Expectation values and Ehrenfest theorems. Free particle solution of Schrodinger equation, Box normalization, Dirac delta-function and its properties, solution of Schrodinger equation for one dimensional (a) potential well (b) potential step and (c) potential barrier.

UNIT – II (One and Three dimensional problems)
One-dimensional problems: Free particle, potential step, rectangular barrier, tunneling, infinite square well, finite square well, periodic lattice, and linear harmonic oscillator. Three-dimensional problems: Free particle (in Cartesian and Spherical coordinates), Three dimensional Square well, three-dimensional linear harmonic oscillator (in Cartesian and in Spherical coordinates), rigid rotator, Hydrogen atom, and potential barrier.

UNIT – III (Solution and application of Schrodinger equation)
Solution of Schrodinger equation for (a) linear harmonic oscillator (b) hydrogen-like atom (c) three-dimensional harmonic oscillator (d) square well potential and their respective applications to atomic spectra, molecular spectra and low energy nuclear states (deuteron).

UNIT – IV (Angular momentum and Coupling)
Angular momentum, Eigen values and eigen functions of L2 and L2 in terms of spherical harmonics, Relation of angular momentum with rotation operator, commutation relations, Matrix representation of angular momentum, Pauli spin matrices and their algebra, Coupling of two angular moments and Clebsch-Gorden coefficients for j1=j2=1/2 and j1=1/2 and j2=1.

UNIT – V (Quantum approximations)
Time-independent perturbation theory: Non-degenerate unperturbed states, Degenerate unperturbed states, Stark effect and Zeeman effect (Normal and anomalous), Variational method and applications to helium atom and simple cases;, WKB approximation and wave functions, connection formulae, application to bound states, transmission through a potential barrier. Fermi’s Golden rule, Semi-classical theory of interaction of atoms with radiation.

Text and Reference Books
Quantum Mechanics : L I. Schiff (Mc Graw-Hill)
Quantum Physics : S. Gasiorowiz (Wiley)
Quantum Mechanics : B. Craseman and J.D. Powel (Addison Wesley)
Quantum Mechanics : AP Messiah Modern Quantum Mechanics : J.J. Sakurai
Quantum Mechanics : Mathews and Venkatesan
M.Sc. (PHYSICS)

SEMESTER- II (PAPER-IV)

[ATOMIC, MOLECULAR AND LASER PHYSICS] (4+0+0=4)

UNIT –I (Atomic Spectra)
Quantum states of one electron atoms Atomic orbitals, Hydrogen spectrum, Paulis principle. Spectra of alkali elements, spin orbit interaction and line structure of alkali spectra, Methods of molecular Quantum Mechanics, Thomas Fermi Statistical Model, Hartree and Hartree Fock Method. Two electron system, interaction energy in LS and JJ coupling, Hyperfine structure (qualitative), line broadening mechanisms (general ideas).

UNIT – II (Molecular Spectra)
Types of molecules, Diatomic linear, symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, Energy level and spectra of non-rigid rotator, intensity of rotational lines.

UNIT – III (Oscillator)
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).

UNIT – IV(Spectroscopy)
Introduction to ultraviolet, visible and infra-red spectroscopy, Raman spectroscopy: Introduction, Pure rotational and vibrational spectra, Techniques and instrumentation, Stimulated Raman spectroscopy, Experimental techniques: Photo electron spectroscopy, Elementary idea about photoacoustic spectroscopy and Mossbauer spectroscopy and NMR Spectroscopy.

UNIT –V (Laser)

Text and Reference Books
Introduction to Atomic Spectra : H.E. White
Fundamentals of molecular spectroscopy : C.B. Banwell
Spectroscopy vol.I, II & III : Walker and Stanghen
Introduction to molecular spectroscopy : G.M. Barrow
Spectra of diatomic molecules : Herzberg.
Molecular spectroscopy : Jeanne L. Mc Hale
Molecular spectroscopy : J.M.Brown
Spectra of atoms and molecules : P.F.Bemath.
Modern spectroscopy : J.M. Halian
Lasers and Non-Linear Optics : B.B. Laud. – (Wiley Eastern Ltd.)
Laser Fundamentals : William T. Silfvast – (Cambridge Univ. Press.)
M.Sc. (PHYSICS)
SEMESTER- II
[General Physics Lab-II]  (0+0+6=3)

1) To study of Hysteris loss and determine the B-H Curve.
2) Determine Stefan constant.
3) Verification of Newton’s cooling law.
4) Measurement of Band positions and determination of vibrational constants of N2 molecule.
5) To study dielectric properties of a liquid.
6) To study dielectric properties of a Solid.
7) To study magnetic susceptibility.
8) To study the ferroelectric transition in TGS crystal and measurement of Curie temperature.
9) To determine magnetoresistance of a Bismuth crystal as a function of magnetic field.
10) Determination of e/m of electron by normal Zeeman effect using Febry Perot Etalon.

M.Sc. (PHYSICS)
SEMESTER- II
[Electronics Lab-II]  (0+0+6=3)

1. To study characteristics of zener diode and use in voltage Regulation.
2. To study of Transistor Biasing and Stability.
5. Experiments on Uni-junction Transistor and its application.
6. To study of IC 555 Timer.
7. Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.
8. Determination of Hall coefficient of a given semiconductor and estimation of charge carrier concentration.
UNIT – I (Electrostatics)

UNIT – II (Electrodynamics)

UNIT – III (Maxwell equations)
Review of Four-vectors and Lorentz transformation is 4-dimensional spaces Invariance of electric charge, relativistic transformation properties of E and H fields, electromagnetic field tensor in 4-dimensional Maxwell equation 4-vector current and potential and their invariance under Lorentz transformation.

UNIT – IV (Electromagnetic Fields)
Covariance of electrodynamics Lagrangian and Hamiltonion for a relativistic charged particle in External EM field; motion of charged particles in electromagnetic fields, uniform and non-uniform E and B fields, Particle Drifts in Non-uniform field, static magnetic fields, Adiabatic invariant.

UNIT – V (Plasma Physics)
Magnetohydrodynamic equations, Magnetic diffusion, viscosity and Pressure, Magnetohydrodynamic flow between Boundaries with crossed Electric and magnetic fields, Pinch Effect, Instability in a Pinched Plasma column, magnetohydrodynamic waves, magneto sonic and Alfven waves, Plasma oscillations, short wave length limit for plasma oscillations and Debye Screening Distance.

Text and Reference Books
Classical Electronics : Jackson
Electromagnetic Theory : B.B. Laud
Classical Electricity and Magnetism : Pan of sky and Philips
Plasma Physics : Chen
Plasma Physics : Buttencourt
M.Sc. (PHYSICS)  
SEMESTER- III (PAPER-II)  
[QUANTUM MECHANICS-II]  
(4+0+0=4)

UNIT – I (Approximation methods)
Approximation method for bound states: Rayleigh-Schrodinger perturbation theory of non-degenerate and degenerate levels and their application to perturbation of an oscillator, normal Helium atom, and First order Stark effect in Hydrogen. Variation method and its application to ground state of helium, W.K.B. approximation method, connection formula, Ideas on potential barrier with applications to the theory of alpha decay.

UNIT-II (Perturbation theory)
Time dependent perturbation theory: Method of variation of constants, constant and harmonic perturbation, transition probability, adiabatic and sudden approximation. Hamiltonian for a charged particle under the influence of external electromagnetic field, Absorption and induced emission, Transition probability in Electric dipole transition, Einstein's A and B coefficients.

UNIT – III (Scattering)

UNIT – IV (Quantum equation-I)
Schrodinger’s relativistic equation (Klein-Gordon equation), Probability and current density, Klein-Gordon equation in presence of electromagnetic field, Hydrogen atom, shortcomings of Klein-Gordon equation.

UNIT – V (Quantum equation-II)
Dirac’s relativistic equation for a free electron, Dirac’s matrices, Equation of motion for operators, position momentum and angular momentum; spin of an electron, Zitterbewegung Dirac’s relativistic equation in electromagnetic field, negative energy states and their interpretation, Hydrogen atom, Hyperfine splitting.

Text and Reference Books
Quantum Mechanics : L. I. Schiff  
Quantum Mechanics : S. Gasiorowicz  
Quantum Physics : B. Craseman and J.D. Powell  
Quantum Mechanics : A.P. Messiah  
Modern Quantum Mechanics : J.J. Sakurai  
Quantum Mechanics : Mathews and Venkatesan  
Quantum Mechanics : A.K. Ghatak and Loknathan.
UNIT – I (Communication Electronics)

UNIT – II (Basics of Digital Electronics)

UNIT – III (Digital Electronics)

UNIT – IV (Microprocessor)

UNIT-V (Interfacing devices)

Books Recommended:
Communication Electronics : John Kennedy
Microprocessor Architecture : Ramesh S. Gaonkar
Digital Principles and Applications : Malvino & Leech
Digital computer electronics and introduction to micro computers : Malvino
Introduction to microprocessors
Software, hardware, programming : L.A. Leventhal.
Programming &Application with 8085 Microprocessors : B. Ram
M.Sc. (PHYSICS)
SEMESTER- III (PAPER-IV)
[Nuclear and Particle Physics] (4+0+0=4)

UNIT – I (Nuclear Interactions and Nuclear Reactions)

UNIT – II (Nuclear Models)
Nuclear models: Liquid drop model, Semi empirical mass formula and isobaric stability, 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 moment and Schmidt lines, Collective model of Bohr and Mottelson, Rotational and vibrational spectra and elementary idea of unified model.

UNIT – III (Nuclear Decay)
Beta decay, Fermi theory of beta decay, Comparative half, lives, Parity violation, Two component theory of neutrino decay, Detection and properties of neutrino Gamma decay, Multipole transition in nuclei Angular momentum and parity selection rules Internal conversion, Nuclear isomerism. General ideas of nuclear radiation detectors, Linear acceleration, Betatron, Proton- synchrotron, Electron synchrotron.

UNIT – IV (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 octet and decuplet hadrons, Charm, bottom and top quarks.

UNIT – V (Cosmic Rays)
Cosmic rays, nature, composition, charge and energy spectrum of primary cosmic rays, production and propagation of secondary cosmic rays. Soft, penetrating and nucleonic components, Origin of cosmic rays, Rossi curve, Bhabha – Heitler theory of cascade showers.

Text and Reference Books
H.A. Enge, Introduction to Nuclear Physics, Addison- Wesley ,,1975.
Y.R. Waghmare, Introductory Nuclear Physics, Oxford-IBH Bombay,1981
I. Kaplan, Nuclear Physics, 2” Ed. Narosa, Madras, 1989
B.N. Shrivastava, Basic Nuclear Physics and Cosmic Rays
M.P. Khanna, Particle Physics, Prentice Hall.
M.Sc. (PHYSICS)
SEMESTER- III
[General Physics Lab-III] (0+0+6=3)

1) To determine the operating voltage, slope k of the plateau and dead time of a G.M. Counter.
2) Features analysis using G.M. Counter.
3) Study of Rutherford scattering with the help model.
4) To determine half-life of a radio isotope using GM counter.
5) To study characteristics of a GM counter and to study statistical nature of radioactive decay.
6) Decoding and display of the outputs from the IC 7490.
7) To study the Compton scattering using gamma rays of suitable energy.
8) To study production techniques of nuclear reactors.
9) To study of production methods of nuclear power energy.

M.Sc. (PHYSICS)
SEMESTER- III
[Electronics Lab-III] (0+0+6=3)

1. Astable, Monostable and Bistable Multivibrator.
2. To assemble Logic gates using discrete components and to verify truth table.
3. Study of logic circuits TTL, NAND, NOR and XOR gates.
4. To study of R-S Flip-Flop and verify its truth table.
5. To study of J-K Flip-Flop and race around condition followed by verifying its truth table.
6. Addition, Subtraction and Binary to BCD conversion.
7. Experiments on MUX and DEMUX,
8. To study of encoder and Decoder
9. To study of shift register and counter.
10. Arithmetic operations using microprocessors 8085/8086.
11. D/A converter interfacing and frequency/temperature measurement with microprocessor 8085 / 8086
12. A/D converter interfacing and AC/DC voltage/current measurement using microprocessor 8085/8086
UNIT-I (Concept of Quantum Confinement)
Density of states in bands, Variation of density of states with energy. Electron confinement in infinitely deep square well, confinement in two and three dimension, Idea of quantum well, quantum wire and quantum dots, classification of nanostructured materials.

UNIT-II (Quantum wells and Superlattices)
Energy levels and density of states in quantum wells. Band structure in quantum well, coupling between the wells, multiple quantum well structure, superlattice dispersion relation and density of states, Band structure in superlattice, Types of superlattices. Techniques of Fabrication of MQW and SL structures (MBE, MOCVD, LPE etc).

UNIT-III (Nanoparticles)
Synthesis of nanoparticles: Bottom up: cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques; and Top up: Ball milling. Physical properties of nanoparticles: Impurities and composition surface roughness, structure, thermodynamic properties. Determination of particle size by width of XRD peaks.

UNIT – IV (Carbon Nano Tubes)

UNIT-V (Characteristics of nanomaterials)
Special experimental techniques for characterization of nanostructured materials. Optical properties (Absorption spectra, luminescence, Raman scattering), thermal and Mechanical characterizations (DSC and DMA), spectral response. Determination of particle size by shift in photoluminescence peaks and XRD peaks. Electrical properties of nanoparticles, nanostructured magnetic materials, stability of nanocrystals. Application of nanostructured materials.

Text and Reference Books:
1. Introduction to Nanotechnology: Poole and Owners
2. Quantum Dots : Jacak, Hawrylak and Wojs
3. Handbook of Nanostructured Materials and Nanotechnology : Nalva (editor)
5. Carbon Nanotubes: Silvana Fiorito
6. Nanotechnology: Richard Booker and Earl Boysen
14. Wave mechanics applied to semiconductor heterostructures by Gerald Bastard.
UNIT-I (Solar Energy)
Fundamentals of photovoltaic Energy, Conversion Physics and Material Properties
Basic to Photovoltaic Energy Conversion: Optical properties of Solids. Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.

UNIT-II (Solar cell)
Types of Solar Cells, p-n junction solar cell, Transport Equation, Current Density, Ipen circuits voltage and short circuit current, Brief descriptions of single crystal silicon and amorphous silicon solar cells, elementary ideas of advanced solar cells e.g. Tandem Solar Cells. solid Liquid Junction Solar Cells, Nature of Semiconductor, Electrolyte Junction, Principles of Photoelectrochemical solar Cells.

UNIT-III (Eco-friendly energy)

UNIT-IV (Applications of hydrogen energy)
Safety and Utilisation of Hydrogen: Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, proton conducting batteries. Elementary concepts of other Hydrogen Based devices such as Air Conditioners and Hydride Batteries.

UNIT-V (Clean energy)

Text and Reference Books:
M.Sc. (PHYSICS)

SEMESTER- IV (PAPER-III)

[Computational and Experimental Techniques and Data Analysis] (4+0+0=4)

Unit I (Numerical Integration)
Newton-cotes formulae: Trapezoidal rule, Simpson’s 1/3 rule, error estimates in Trapezoidal rule and Simpson 1/3 rule using Richardson deferred limit approach; Gauss-Legendre quadrature method; Monte Carlo (mean sampling) method for single, double and triple integrals.

Unit-II (Differentiation equ and its solution)
Numerical Differentiation: Taylor Series method; Generalized numerical differentiation: truncation errors. Numerical Solution of First Order Differential Eqns: First order Taylor Series method; Euler’s method; Runge Kutta methods; Predictor corrector method; Elementary ideas of solutions of partial differential eqns.
Numerical Solutions of Second Order Differential Eqns: Initial and boundary value problems: shooting methods

UNIT – III Introduction to Computer Simulation
Molecular Dynamic Simulation Gas with random collisions, N body gas, Monte carlo simulations, The 2-D Ising model for interacting spins, specific heat, average energy, Magnetization, susceptibility.

UNIT – IV (Computer Application to problems in Condensed Matter Physics)
Simulation of phonon dispersion curves and density of states, The reciprocal lattice and Harrison construction(2D), One dimensional phonon propagation, Two dimensional Lattice vibrations, Two dimensional nearly free electrons

Unit-V (Experimental Techniques and Data analysis)
Transducers: Temperature, pressure/vacuum, magnetic field, vibration, optical and particle detectors. Measurement and control: Signal conditioning & recovery, impedance matching. Shielding and grounding. Data interpretation and analysis: Precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and non-linear curve fitting, Chi-square test, Linear regression; Polynomial regression; Exponential and Geometric regression.

Text and Reference Books:
Sastry : Introductory methods of Numerical Analysis.
Rajaraman: Numerical Analysis.
Jain, Iyngar and Jain: Numerical methods for Scientific and Engineering Computation”
Gould and Tobochnik : An Introduction to Computer Simulation methods part I and Part II.
Mc Calla : Introduction to Numerical methods and Fortran programming.
M.Sc. (PHYSICS)

SEMESTER- IV

[General Energy and Computational Lab]  (0+0+6=3)

1. To study of Carbon Nanotubes by Spray Pyrolysis method and its verification through x-ray diffraction.
2. To study the I-V characteristics of the supplied solar cell and find its spectral response.
3. Analysis of H-atom spectra in minerals.
4. To study of Neutron activation analysis.
5. Synthesis of Polymer electrolytes by using solution cast method.
7. Synthesis of Nanocomposite Polymer electrolytes with the help of sol-gel method.
8. Study of synthesis of nanofibers using gel-spinning and electrospinning techniques.
9. To determine the current density, open circuit voltage, power density for hydrogen batteries (proton conducting).
10. To study design and fabrication of solar panels.
11. To study of charging-discharging behavior of electrochemical devices.
12. To study production techniques of fuel cell.
13. To study production methods of wind energy devices.
14. Numerical solution of ordinary differential equation with the help of PC.
15. Numerical Solution of second order ordinary differential equations by using PC.
16. Numerical solution of simultaneous linear algebraic equations
17. To study of least square fitting with simple example.