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 -

S/N	Paper Code	Paper Title	Credits
1	77PH101	Mathematical Physics	4
2	77PH102	Classical Mechanics	4
3	77PH103	Condense Matter Physics	4
4	77PH104	Electronic Devices	4
5	77PH151	General Physics Lab-I	3
6	77PH152	Electronics Lab-I	3
Total Credits			**22**

Second Semester from January to June -

S/N	Paper Code	Paper Title	Credits
1	77PH201	Thermodynamics and Statistical Physics	4
2	77PH202	Solid State Physics	4
3	77PH203	Quantum Mechanics-I	4
4	77PH204	Atomic, Molecular and Laser Physics	4
5	77PH251	General Physics Lab-II	3
6	77PH252	Electronics Lab-II	3
Total Credits			**22**

Third Semester from July to December-

S/N	Paper Code	Paper Title	Credits
1	77PH301	Electrodynamics and Plasma Physics	4
2	77PH302	Quantum Mechanics-II	4
3	77PH303	Communication and Digital Electronics & Microprocessor	4
4	77PH304	Nuclear and Particle Physics	4
5	77PH351	General Physics Lab-III	3
6	77PH352	Electronics Lab-III	3
Total Credits			**22**

Fourth Semester from January to June -

S/N	Paper Code	Paper Title	Credits
1	77PH401	Physics of Nano Materials	4
2	77PH402	Solar Cell and other Renewable Energy Devices	4
3	77PH403	Computational and Experimental Techniques and Data Analysis	4
4	77PH451	General Energy and Computational Lab	3
5	77PH452	Project Work	9
			24

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 Laguarre 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 Jn(x) , Recurrence relations, Integral representation; Legendre polynomials Pn(x) , Generating functions for Pn(x) , Recurrence relations; Hermite Polynomials, Generating functions, Rodrigue's formula for Hermite polynomials; Laguerre 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:

1. Mathematical Methods for Physicists: George Arfken (Academic Press)
2. Applied Mathematics for Engineers and Physicists: L. A. Pipe (McGraw Hill)
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 Lagragian 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'Alember'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)
Theory of small oscillations, Equations of motion, Eigen frequencies and general motion. Normal modes and coordinates. Applications to coupled pendulum and linear triatomic molecule. Rotating co-ordinate systems, Acceleration in rotating frames. Coriolis force and its terrestrial and astronomical applications. Elementary treatment of Eulerian co-ordinates and transformation matrices. Angular momentum inertia tensor. Eular equations of motion for a rigid body. Torque free motion for a rigid body. Symmetrical top and gyroscopic forces.

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-momenturn 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 : N. C. Rana and P.S. Jog (Tata Mc Graw Hill, 1991)
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 Sructure)

Crystalline and amorphous solids. The crystal lattice. Basis vectors. Unit cell. Symmetry operations. Point groups and space groups. Plane lattices and their symmetries. Three dimensional crystal systems. Miller indices. Directions and planes in crystals. Inter-planar spacings. Simple crystal structures: FCC, BCC, Nacl, CsCl, Diamond and ZnS structure, HCP 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; Fibonaccy 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)

Free electron Fermi gas, Energy levels of orbital in one and three dimensions. Electrons in a periodic lattice. Bloch theorem, band theory of solids, Classification of solids effective mass, Kronig Penney model, Metals–Semimetals–Semiconductors–Insulators,Tight binding, cellular and pseudo potential methods. Drude Model, Lorentz theory, Sommerfeld theory of Metals, Fermi surface. De Hass von Alfen effect.

Text and Reference Books

1. Solid State Physics	: Kittle
2. Solid State Physics	: Aschroft & Mermin
3. Introduction to Solid State Physics	: L.V. Azaroff
4 Crystellographic Solid State Physics.	: Verma & Srivastava
5. Solid State Physics	: A.J. Dekker
6. Principles of Condense Matter Physics	: P.M. Chaiken& T.C. Lubensky

M.Sc. (PHYSICS)
SEMESTER- I (PAPER-IV)
[ELECTRONIC DEVICES] (4+0+0=4)

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

Semi Conductor Devices – Physics and Technology : SM Sze (Wiley, 1985)

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. Thygarajan (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 photo-current as a function of irradiance at a constant voltage].
6) Characteristics of Photovoltic 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).
11. Study of Active filters using Op-amp.
12. BCD to Seven Segment display.

M.Sc. (PHYSICS)
SEMESTER- II (PAPER-I)
[THERMODYNAMICS AND STATISTICAL PHYSICS] (4+0+0=4)

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)

Statistics of ensembles, statistics of indistinguishable particles, Density matrix, Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics, properties of ideal Bose gases, Bose-Einstein condensation. Properties of ideal Fermi gas, electron gas in metals. Boltzmann's transport equation.

UNIT – IV (Phase Transition)

Cluster expansion for a classical gas, Virial equation of state, Dynamical model of phase transition, Ising model in zeroth approximation, Ising model in first approximation. Exact solution in one-dimension. Landau theory of phase transition, scaling hypothesis for thermodynamic functions.

UNIT – V (Thermodynamics fluctuations)

Thermodynamics fluctuation, spatial correlation. Brownian motion, Langevin theory, fluctuation dissipation theorem. The Fokker-Planck equation. Onsager reciprocity relations.

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

M.Sc. (PHYSICS)
SEMESTER- II (PAPER-II)

[Solid State Physics] **(4+0+0=4)**

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 Polariziblity, Claussius-Mossotti relation, types of polarzibility, dipolar polarizibility and frequency dependence of dipolar polarizibility, ionic and electronic polarizibilty, Hall effect, Quantum Hall Effects, Magneto resistance..

UNIT-IV (Magnetic Properties)

Magnetic properties of solids. Diamagnetism, Langevin equation. Quantum theory of paramagnetism. Curie law. Hund's rules. Paramagnetism in rare earth and iron group ions. Elementary idea of crystal field effects. Ferromagnetism. Curie- weiss law for susceptibility. Heisenberg exchange interaction. Mean field theory. Antiferromagnetism. Neel point. Other kinds of magnetic order. Nuclear magnetic resonance.

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
6. Principles of Condense Matter Physics : P.M. Chaiken& T.C. Lubensky

M.Sc. (PHYSICS)
SEMESTER- II (PAPER-III)

[QUANTUM MECHANICS-I] (4+0+0=4)

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, orthogonlity 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)

Stimulated emission, Population inversion, Laser amplification, Oscillation condition, Characteristic of laser light, Line broadening mechanism, Spectral narrowing in a laser, Gain clamping. Spatial and spectral hole burning and their consequences, Power in Laser Oscillator, Optimum coupling. Atomic and molecular gas lasers (He-Ne, CO2), Solid State (Ruby, Nd:YAG & Nd:Glass), Dye lasers (one example) and their application in isotope separation, single atom detection

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.)
Lasers principles and Applications (Lied) – Wilson & Hawkes (Prentice Hall).
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.

3. Study of a Regulated Power Supply using transistor.

4. Measurement of Hybrid parameters of transistor.

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.

9. Estimation of band energy gap of a semiconductor.

M.Sc. (PHYSICS)
SEMESTER- III (PAPER-I)
[ELECTRODYNAMICS AND PLASMA PHYSICS] (4+0+0=4)

UNIT – I (Electrostatics)
Review of basics of electrostatics and magnetostatics. (Electric field, Gausse law, Laplaces and Poisson's equations, method of images. Biot-sawart law, Ampere's law). Maxwell's equations, scalar and vector potentials, Guage transformation Lorentz Guage, Coulomb guage, Solution of Maxwell's equation in conducting media.

UNIT – II (Electodynamics)
Radiations by moving charges, Retarded potentials, Lienard-wiechert potentials, Fields of charged particle in uniform m+otion, Fields of arbitrarily moving charged particle, Fields of an accelerated charged particle at low velocity and high velocity. Angular distributions of power radiated, Bremsstrahlung, Reaction force of radiation, Abrahm-Lorentz method of self-force, Difficulty with the Abrahm-Lorentz model, line-breadth and level-shift of an oscillator.

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-dimensionl 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)

Theory of scattering, Physical concepts, Scattering amplitude, scattering cross section. Born approximation and partial waves. Scattering by a perfectly rigid sphere, complex potential and absorption, scattering by spherically symmetric potential. Identical particles with spin, symmetric and antisymmetric wave functions, Pauli's exclusion principle, Pauli's spin matrices.

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, short comings 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.

M.Sc. (PHYSICS)
SEMESTER- III (PAPER-III)
[COMMUNICATION & DIGITAL ELECTRONICS AND MICROPROCESSOR]
(4+0+0=4)

UNIT – I (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 division multiplexing (FDM). Advantages and disadvantages of microwave transmission and its applications in Radar.

UNIT – II (Basics of Digital Electronics)
Boolean laws and Theorem. Binary, decimal, octel and hexa decimal number and inter conversion. Simple combinational circuits. Karnaugh map pairs, Quads and octets. Karnaugh simplications. Don’t care conditions. The ASCII code. Excess III code. Gray code. Binary addition, Subtraction, unsigned binary numbers. Sign magnitude numbers. 2’s compliment representation. 2’s compliment arithmetic. Arithmetic building blocks. The adder and subtractor. Logic Gates.

UNIT – III (Digital Electronics)
Multiplexers, Demultiplexer, 1-of-16 decoder, BCD to decimal decoder, 7 segment decoders, Encoders. Exclusive OR gates. Parity generators-checkers. 7400 devices. A-01 gates. Positive and negative logic. 74C00 devices. CMOS logic gates. Flip-flops. Shift registers, counters, A/D and D/A converters, A/D and D/A accuracy and resolution. Semiconductor memory, (RAM, ROM & EPROM).

UNIT – IV (Microprocessor)
Basic architecture of intel 8085 microprocessor. Microprocessor and its architecture-data. Address and control buses. ALU registers, program counters. Flow chart and assembly language. Writing some programs in assembly language for 8085 microprocessor. instruction set for 8085, and addressing modes, Data Transfer, Arithmetic, Logical and branch group of instructions. Stack, I/O and machine control group. (Examples related to each group of instructions). Timing and operation status, Memory read write, I/O read, I/O write, register move, and move immediate, Timing diagrams. Interrupts : Various interrupts handling facilities of inlet 8085 vector and non vectored interrupt Maskable and non maskable interrupts.

UNIT-V (Interfacing devices)
Programmable Interface devices: Internal Architecture and pin out diagrams of 8155 and 8255
programmable interface. Programmable interrupt controller Intel 8259, Direct memory access and 8257 DMA controller 8279 display/ key board controller. Interfacing with D/A and A/D converters, Elementary method of digital to analog conversion. Working of DAC 0808 and programme for interfacing with 8255 in 8085 based system. Basic technique for analog to digital conversion. Internal block diagram of ADC 809 and working. Interfacing of IC 809 with 8085 based systems.

Books Recommended:

Communication System : Taub and Schilling McGraw Hill.
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)

Nuclear sizes and shapes. Experimental methods of determining nuclear radius. Two-nucleon problem: Deuteron problem. Nucleon- nucleon interaction, exchange forces and tensor forces, meson theory of nuclear forces, nucleon, nucleon scattering, Effective range theory, spin dependence of nuclear forces, charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction. Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, compound nucleus, scattering matrix, Reciprocity theorem, Breit- Wigner one–level formula, Resonance scattering.

UNIT – 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, Qualtative 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

Kenneth S. Kiane. Introductory Nuclear Physics, Wiley New York 1988..
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
R.D.Evans, Atomic Nucleus, McGraw Hill, New York, 1955.
B.L. Cohen, Concepts of Nuclear Physics, TMGH, Bombay, 1971.
R.R. Roy and B.P. Nigam Nuclear Physics, Wiley- Eastem Ltd, 1983.
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 kof 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
13. Motor Speed control, Temperature control using 8085/8086.

M.Sc. (PHYSICS)
SEMESTER- IV (PAPER-I)

[Physics of Nano Materials] (4+0+0=4)

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)

Special carbon solids; fullerenes and tubules, formation and characterization of fullerenes and tubules. Single wall and multi -wall carbon tubules. Electronic properties of tubes. Carbon nanotubule based electronic devices.

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)
4. Nano Technology/ Principles and Practices: S.K. Kulkarni
5. Carbon Nanotubes: Silvana Fiorito
6. Nanotechlongy: Richard Booker and Earl Boysen

Nanotechnology Molecularly designed material by Gan-Moog, Chow , Kenneth. E Gonsalves, AmericanChemical Society.

Quantum dot heterostructure by D. Bimerg, M. Grundmann and N.N. Ledentsov John Wiley and sons 1998.

Nanotechnology: Molecular Speculations on global abundance by B.C. Gran dall MIT Press 1996.

Physics of low dimensional semiconductors by John W. Davies, Cambridge Univ. Press 1999.

Physics of semiconductor nanostructures by K.R. Jain Narosa 1999

Nano-fabrication and bio-systems: Integrating materials science engineering Science and biology by Harvey C. Hoch, Harold G. Craighead and Lynn Jelinski, Cambridge Univ. Press- 1996.

Nano particles and nano structured films: Preparation, characterization and application, Ed. J. H. Fendler, Jhon Wiley and sons 1998.

Wave mechanics applied to semiconductor heterostructures by Gerald Bastard.

M.Sc. (PHYSICS)
SEMESTER- IV (PAPER-II)

[Solar Cell and other Renewable Energy Devices] (4+0+0=4)

UNIT-I (Solar Energy)

Fundamentals of photovoltaic Energy, Conversion Physics and Material Properties Basic to Photovoltaic Energy Conversion : Optical properties o 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 circuit 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, Pricniples o Photoelectrochemcial solar Cells.

UNIT-III (Eco-friendly energy)

Hydrogen Energy : Relevance in depletion of fossil fuels and enviromnental considerations. Hydrogen Production : Solar Hydrogen through Photoelectrolysis and Photocatalytic process. Physics and material characteristics for production of Solar Hydrogen. Storage of Hydrogen : Brief discussion of various storage processes, special features of solid state hydrogen storage materials, structuraland electronic characteristics of storage materials. New Storage Modes.

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)

Renewabel Clean Energies : Elements of Solar Thermal Energy, Wind Energy and Ocean Thermal Energy Conversion. solar cooker; water heater, air dryer. Classifications and Description of Wind machines. Performances of wind machine (soladity factor Y(lamda); Energy in the wind. Economics of renewabel energy in india.

Text and Reference Books:

1. Fahrenbruch & Bube : Fundamentals of Solar Cells Photovoltatic Solar Energy.
2. Chandra : Photoelectrochemical Solar Cells.
3. Solar energy Thermal Processs : Dluffie and Backman. Wiley & Sons. New York.
4. Solar Energy Engg. : Jui Sheng Haieh,Prentic Hall, New Jersey.
5. Solar Energy : S.P, Tata McGraw Hill, New Delhi.
6. Winter & Nitch (Eds.) : Hydrogen as an Energy Carrier Technologies System Economy.

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

Unit-II (Differentiation equ and its solution)

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

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

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 paricle 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; Exponetial and Geometric regression.

Text and Reference Books:

Sastry : Introductory methods of Numerical Analysis.
Rajaraman: Numerical Analysis.
Mathew : Numerical methods for Mathematics, Science and Engineering.
Jain, Iyngar and Jain: Numerical methods for Scientific and Engineering Computation"
Gould and Tobochnik : An Introduction to Computer Simulation methods part I and Part II.
Mc Calla : Introduction to Numerical methods and Fortran programming.
Verma, Ahluwalia and Sharma : Computation Physics : An Introduction.

M.Sc. (PHYSICS)
SEMESTER- IV
[General Energy and Computational Lab] (0+0+6=3)

1. To study of Cabon Nanotubes by Spray Pysolysis 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.
6. Study of preparation techniques for oxides nanomaterials.
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.
18. Numerical solutions of equations (single veriable).