

**VEER NARMAD SOUTH GUJARAT UNIVERSITY,  
DEPARTMENT OF PHYSICS  
SURAT- 395 007 (GUJARAT)  
Revised Syllabus (Effective from June-2010)**

**M.Sc. (PHYSICS)  
Structure for Semester II**

**SECOND SEMESTER:**

Course No.	Title	Theory / Lab. Hours per week			External Exam. Marks	Internal Marks	Total Marks
		Theory	Tutorial	Total Hours			
PH-421	Quantum Mechanics	04	01	05	70	30	100
PH-422	Solid State Physics	04	01	05	70	30	100
PH-423	Classical Electrodynamics & Plasma Physics	04	01	05	70	30	100
PH-424	Numerical Analysis & Computer Programming	04	01	05	70	30	100
PH-425	Practicals	09	01	10	140	60	200

**Practicals :** 14 to 16 Practicals in each semester will be given in the Laboratory Work.

**DISTRIBUTION OF INTERNAL MARKS:**

For each Theory Papers :	Waitage of Marks
1. One Unit Test per Semester	15
2. One Tutorial Test per Paper Per Semester	10
3. One Assignment per Paper Per Semester	05
Total	30

For each Practical Course :	Waitage of Marks
1. One Practical Test per Semester	30
2. Assessment of Journal Per Semester	10
3. Viva Voce Examination	20
Total	60

## **M.Sc. - I (PHYSICS) : SEMESTER- II**

### **PH - 421 : QUANTUM MECHANICS - 1**

#### **Unit -1 :**

##### **The Schrödinger equation :**

Inadequacy of old quantum theory, De Broglie hypothesis, Heisenberg uncertainty principle, The Schrödinger equation, Normalization and probability interpretation, Non normalizable wave functions and Box normalization, Conservation of probability, Expectation value; Ehrenfest's Theorem, Admissibility Conditions on the wave function.

#### **Unit -2 :**

##### **Stationary states and energy spectra :**

Stationary states; Time Independent Schrödinger equation, A particle in a square well potential, Bound states in a square well ( $E < 0$ ), The square well; non localized states ( $E > 0$ ), The Schrödinger equation and the probability interpretation for an N particle system, The fundamental postulates of wave mechanics: Representation of states, Representation of dynamical variables; expectation values, observables.

#### **Unit -3 :**

##### **General Formalism of wave mechanics:**

The adjoint of an operator and self adjointness, The eigenvalue problem; Degeneracy, Eigenvalues and eigenfunctions of self adjoint operators, The Dirac delta function, Observables; Completeness and normalization of eigenfunctions, Closure, Physical interpretation of eigenvalues, eigenfunctions and expansion coefficients, Momentum eigenfunctions; Wave functions in momentum space, The uncertainty principle, States with minimum value for uncertainty product, Commuting observables; removal of degeneracy.

#### **Unit -4 :**

##### **Exactly soluble eigenvalue problems:**

Evolution of system with time; Constants of the motion, Non-interacting and interacting systems, Systems of identical particles, exactly soluble eigenvalue problems: The simple harmonic oscillator, The Schrödinger equation and energy eigenvalues, The abstract operator method, The angular momentum operators, The eigenvalue equation for  $L^2$ ; separation of variables, Admissibility conditions on solutions; Eigenvalues, The eigenfunctions; Spherical harmonics, Physical interpretation, parity.

#### **Unit -5 :**

##### **Representations, Transformations and symmetries :**

Quantum states; state vectors and wavefunctions, The Hilbert space of state vectors; Dirac Notation, Dynamical variables and linear operators, Abstract operators; The quantum condition, The adjoint; self adjointness, Eigenvalues and eigenvectors, Expansion of identity; Projection operators, Representation of state vectors, Dynamical variables as matrix operators. Product of operators. Self-adjointness and Hermiticity, Continuous basis - The Schrodinger representation, Degeneracy; Labelling by commuting observables, Change of basis; Unitary transformations.

#### **Unit -6 :**

##### **Approximation methods for stationary states:**

Time independent Perturbation theory for discrete levels: Equations in various orders of perturbation theory, The non-degenerate case, The degenerate case- Removal of Degeneracy, The effect of an electric field on the energy levels of an atom ( Stark effect), Two- electron atoms, The variation method : Upper bound on ground state energy, Application to excited states, Trial function linear in Variational parameters.

### **Reference Books**

1. A text book of Quantum Mechanics, by P. M. Mathews and K. Venkatesan (TMH)
2. Quantum Mechanics, by L. I. Schiff (McGraw, Hill)
3. Quantum Mechanics, by A. K. Ghatak and S. Lokanathan (Macmillan -India)
4. Quantum Mechanics, by Powell and Crasemann
5. Quantum Mechanics, by Frnaz Schwabl
6. Quantum Mechanics Vol.I, by A. Messiah,(North Holand)
7. Quantum Mechanics, by E. Merzbacher (Willey)

### **Theory Tutorials (PH- 421)**

1. Insignificance of de Broglie hypothesis in macrophysics,
2. General procedure to write down the Schrödinger equation for any system
3. Square potential barrier, quantum mechanical tunnelling
4. Relations giving the values of the commutators
5. Schmidt orthogonalization procedure
6. Prove that momentum operator is self adjoint
7. Interpretation of hydrogen atom wave-functions
8. Problems in three dimensions : Anisotropic and Isotropic Oscillators
9. The algebra of rotation generators
10. Transformation of dynamical variables
11. Problems of non-degenerate and degenerate time-independent perturbation theory
12. Estimate the ground state energy of a two-electron atom using variational method.

## **M.Sc. - I (Physics) : Semester -II**

### **PH-422 : Solid State Physics**

#### **Unit-1 :**

##### **Crystal Physics :**

Crystal classes and Systems, Lattice, Lattice Points and space lattice, unit cells and lattice parameters, 2D and 3D lattices, Symmetry and Symmetry operations, Directions, Planes and Miller Indices, Reciprocal lattices, Brillion Zones, Ideal and real crystal.

#### **Unit- 2 :**

##### **Imperfections in Crystals :**

Different type of imperfections, Schottky and Frenkel defects, edge and screw dislocations, Grain boundaries and stacking fault. X-Ray diffraction, Powder Crystal method, Rotating Crystal method, Laue methods, other probes for Crystal Structure determination.

#### **Unit-3 :**

##### **Lattice Dynamics :**

One dimensional mono-atomic and diatomic lattices, three dimensional lattice, lattice Vibrations, Concept of Phonons, Scattering of neutrons by Phonons, Phonon Spectroscopy, Raman Spectroscopy.

#### **Unit-4 :**

##### **Free Electron and Energy Band Theories :**

Specific heat of Solids, Free electron theory Fermi-statistics, Heat Capacity, Electron Motion in periodic potential, Energy bands in metals, inductors, and semi conductors, Tight binding approximation Electrical and thermal conductivity-weiss law Hall effect, Nearly free electron model, Origin of Energy Gap, Magnetydue of energy gap, Bloch function, Krony-Penning model.

#### **Unit-5 :**

##### **Semiconductors :**

Intrinsic Semiconductors, Extrinsic Semiconductors, Semiconductor Devices, Semiconductors in Computers, Microelectronics Mechanical Systems (MEMS), Quantom Dots (QDS) , Spintronics.

## **Unit-6 :**

### **Super Conductivity :**

Historical Introduction, Superconducting Materials, Josephson effect, The London Equation, Ginzburg-Landau theory, The BCS theory, HTSC cuprate Material Characterisations properties of HTSC Oxides, Potential Applications of Super Conductivity.

### **Reference Books**

1. Solid State Physics- S.O. Pillai (3rd edition), New Age International Ltd.
2. Introduction to Solid State Physics, C.Kittel, Vth edition
3. Solid State Physics, N.W.Aschroff & N.D.Mermin
4. Solid State Physics, Kachhara.
5. Super Conductivity Today, T.V. Ramkrishnan & C.M.R. Rao, Wiley Eastern Ltd.
6. Materials Science, S.L.Kakani , Amit Kakani, New Age International (2nd Edition) (2005)

### **Theory Tutorials (PH-422)**

1. Review of Crystal Structure.
2. Space Groups & Point Groups.
3. X-Ray diffraction Structure factor.
4. Phase diagrams of Binary alloys.
5. Thermistors and their properties & Application
6. Problems on Semiconductor
7. Crystal Defects.
8. Problems on magnetic materials.

## M.Sc. (Physics) : Semester - II

### PH-423 ; Classical Electrodynamics & Plasma Physics

#### Unit – 1 :

##### Electrostatics:

Coulomb's Law, electric field, Gauss's law, scalar potential, Poisson's and Laplace's equations.

##### Boundary-Value Problems in Electrostatics:

Method of images, solutions of Laplace's equation in rectangular, spherical and Cylindrical co-ordinates, simple applications of Laplace's and Poisson's equations, uniqueness theorem about solution.

#### Unit – 2 :

##### Multipoles:

Multipole expansions of the potential of a charge distribution, simple dielectric and boundary conditions, electrostatic energy in dielectric medium, electrostatics for macroscopic media.

#### Unit – 3 :

##### Magnetostatics:

Biot-Savart law, Ampere's law, vector potential, magnetic multipoles, vector potential and magnetic induction for a circular current loop, magnetic moment, force and torque on and energy of a localized current distributions, boundary conditions in an internal magnetic induction, macroscopic equations, boundary conditions on **B** and **H**, methods of solving boundary value problems in magnetostatics, uniformly magnetized spheres, magnetic shielding.

#### **Unit – 4 :**

##### **Maxwell Equations:**

Maxwell's displacement current, Maxwell's equations, scalar and vector potentials, gauge transformations, Poynting's theorem, macroscopic equations.

##### **Wave Propagation:**

Plane waves in a non-conducting medium, polarization, superposition of waves in one dimension, group velocity, plane waves in conducting medium, skin depth.

#### **Unit – 5 :**

##### **Wave Guides:**

Rectangular wave guides, modes in rectangular wave guides, retarded potential.

##### **Radiating Systems:**

Lienard Wiechart potential, Larmor formula, radiation from antenna and antenna arrays.

#### **Unit – 6 :**

##### **Plasma Physics And Magnetohydrodynamics**

Introduction of plasma physics and magnetohydrodynamics, magneto-hydrodynamic equations, magnetic diffusion, viscosity and pressure, magnetohydrodynamic flow between boundaries with crossed electric and magnetic fields, pinch effect, instabilities in a pinched plasma column, magnetohydrodynamic waves, plasma oscillations, Debye screening. Applications of plasma physics and controlled thermonuclear reactions.

#### **Recommended Books**

1. J.D. Jackson, Classical Electrodynamics, Wiley Eastern, 1975.
2. D J Griffiths, Introduction to electrodynamics 3<sup>rd</sup> Ed, Prentice Hall India, 1999
3. W.K.H. Panofsky and M. Philips, Classical Electricity and Magnetism, India Book Co., 1970.
4. E.C. Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall, 1985.
5. J.B. Marion, Classical Electromagnetic Radiation, Academic Press, 1965.
6. F F Chen, Introduction to Plasma Physics and Controlled Fusion

### **Theory Tutorials (PH-423)**

1. Calculation of charge density for a given potential function. Mean value theorem for electrostatic potential.
2. Problems on method of images.
3. Calculation of multipole moments of discrete and continuous charge configuration. Interaction energy of a nucleus in an external field.
4. Problems in magnetostatics.
5. Rotating metal disc in a uniform magnetic field. Problem on Hall Effect, magnetic held inside a coaxial tube.
6. Problem involving gauge other than Coulomb and Lorentz gauge.
7. Problem monopole and charge quantization.
8. Problem on Brewster angle, spreading of a wave propagating in a dispersive medium, problem on spherical wave.
9. Energy associated with the skin depth of a conductor. Radiation due to a cube with charge at alternate corners.

## M. Sc. (Physics) : Semester-II

### PH-424: Numerical Analysis and Computer Programming

#### Unit - 1 :

##### Interpolation:

Review of Interpolation formulae. Errors in interpolation formulae,

##### Numerical Integration:

Newton-Cote's formula, Trapezoidal, Simpson  $1/3^{\text{rd}}$  and  $3/8^{\text{th}}$  rule and Weddle rules.

##### Numerical Solutions of Ordinary Differential Equations:

Euler, Picard and Taylor series methods, Runge – Kutta  $2^{\text{nd}}$  order and  $4^{\text{th}}$  order method, and Predictor Corrector methods,

#### Unit - 2 :

##### Solution of Simultaneous Linear Equations:

Matrix inversion method, Cramer's rule with Pivotal and triangle methods for determinants.

##### Eigenvalues and Eigenvectors of a Matrix:

Jacobi method, Householder method.

##### Least Square Techniques:

Least square techniques for fitting linear, quadratic, exponential and power law curves.

#### Unit -3 & 4 :

##### Computer Basics:

Basic component of a digital computer hardware and software; operating systems, higher level compiler languages, algorithm; flow charting,

##### FORTRAN Language:

Character set, structure of a program, constants and variables, arithmetic expressions, arithmetic statement; assignment statements, input and output statements, , control statements: IF-THEN-ELSE, arithmetic IF, logical expressions and assignments, GO TO, Computed GO TO statements; basic looping structure, Subscripted variables, DIMENSION statements; format specifications; OPEN and CLOSE statements; function statements, function subprograms and subroutines.

## **Unit -5 & 6 :**

### **C-Language :**

Introduction to C language, identifiers and keywords, data types, constants and variables, arithmetic expressions; input and output statements, conditional statements; *while*-loop, *for*-loop, *do while* – loop; arrays; logical operators and expressions, structures, *switch*, *break* and *continue* statements; functions; structures; pointer data type; random and sequential files, file handling in C.

### **Programs:**

Program writing in FORTRAN and C for interpolation, integration, roots of equations, matrix diagonalization, solution of differential equations. Good programming practices,

### **Recommended Books**

1. J. B. Scarborough, Numerical Mathematical Analysis, Oxford Books Co., 1962.
2. S. S. Sastry, Introductory Methods of Numerical Analysis. PHI, 1998.
3. K. S. Rao. Numerical Methods for Scientists and Engineers, PHI, 2001
4. V. Rajaraman, Computer Oriented Numerical Methods, PHI, 1994.
5. J. H. Mathews, Numerical Methods for Math., Science and Engineering, PHI, 1994
6. V. Rajaraman, Computer Programming in FORTRAN 77, PHI, 1994.
7. P. S. Grover, Programming and computing with FORTRAN 77 and 90.
8. V. Rajaraman, Computer Programming in C, PHI, 1997.
9. C. Xavier, C Language and Numerical Methods, 1999.
10. B.W. Kernigham and D.M. Ritchie, The C Programming language, PHI, 1988.

### **Theory Tutorial (PH-424)**

#### **(Discussion and Problem Solving Sessions)**

1. Error in numerical computation, error in construction of a model, approximations.
2. Truncation error and their estimation.
3. Propagated rounding error and methods to minimize it.
4. Order of convergence of iterative procedures.
5. Analysis of errors in various interpolation formulas.
6. Errors in computed eigenvalues and eigenvectors.
7. Flow charts.
8. Elementary programs using FORTRAN.
9. Elementary programs using C.

## **M. Sc. (Physics) : Semester-II**

**PH-425 :**

### **Practicals**

1. Lattice Dynamics
2. Computer Experiment -II
3. Energy Gap of a Semiconductor
4. Electrical Conductivity & Resistivity of a Semiconductor by Four Probe Method.
5. Measurement of Susceptibility of Liquid by Quinck's Methods.
6. X-Ray Diffraction
7. Energy Gap of a Thermister
8. Electron Spin Resonance Analysis
9. Feby Perot's Interferometer
10. Normal Modes
11. Photo Cell
12. 'h' by Solar Cell
13. To design, build & test Counter using J-K flip-flop
14. To design, build & test Astable Multi vibrator
15. To design, build & test Regulated Power Supply
16. To design, build & test Active Filters