

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**  
**DEPARTMENT OF PHYSICS**  
**SURAT- 395007 (GUJARAT)**  
**Revised syllabus (Effective from June-2011)**  
**M.Sc.(PHYSICS)**  
**Structure for Semester III**

**THIRD SEMESTER:**

| Course No. | Title   | Theory\ lab<br>Hours per Week |          |                | Marks    |          |       |
|------------|---|-------------------------------|----------|----------------|----------|----------|-------|
|            |   | Theory                        | Tutorial | Total<br>Hours | External | Internal | Total |
| PH-531     | Quantum Mechanics-II                            | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH-532     | Physics of Lasers & Lasers applications         | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH(E) -533 | Physics of Semiconductor Devices                | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH(E)- 534 | Microprocessor & its applications               | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH(M)-533  | Crystal Growth & Characterizations              | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH(M)-534  | Advanced Materials Science                      | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH(T)-533  | Computer Applications in Physics                | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH(T)-534  | Computational and Simulation methods in Physics | 04                            | 01       | 05             | 70       | 30       | 100   |
| PH -535    | Practicals                                      | 09                            | 01       | 10             | 140      | 60       | 200   |

**DISTRIBUTION OF INTERNAL MARKS:**

| <b>For each Theory Papers :</b>             | <b>Weightage of Marks</b> |
|---|---------------------------|
| 1. One Unit Test per Semester               | 20                        |
| 2. One Tutorial Test per Paper Per Semester | 05                        |
| 3. One Assignment per Paper Per Semester    | 05                        |
| Total                                       | 30                        |

| <b>For each Practical Course :</b>    | <b>Weightage of Marks</b> |
|---------------------------------------|---------------------------|
| 1. One Practical Test per Semester    | 40                        |
| 2. Assessment of Journal Per Semester | 20                        |
| Total                                 | 60                        |

## M.Sc. (PHYSICS): SEMESTER- III

### PH – 531: QUANTUM MECHANICS - II

- UNIT-1: Evolution with Time:**  
The Schrödinger equation; General solution, Propagators, Alteration of Hamiltonian: Transitions; Sudden approximation, Perturbative solution for transition amplitude, First and second order transitions: constant perturbation, Alternative pictures of time evolution: The Schrödinger picture, The Heisenberg picture, The interaction picture
- UNIT-2: Scattering Theory:**  
Kinematics of the scattering process: Differential and total cross-sections, Wave mechanical picture of scattering: The scattering amplitude, Green's function; Formal expression for scattering amplitude, The Born approximation, Validity the Born approximation, The Born series, The Eikonal approximation, Partial Waves Analysis: Asymptotic behaviour of partial waves - phase shifts
- UNIT-3: Scattering Theory- Phase shifts:**  
Scattering amplitude in terms of phase shifts, Optical theorem, Phase shifts- relation to the potential, potentials of finite range, Low energy scattering, scattering by a square well potential, Scattering by a hard sphere, mutual scattering of two particles: Reduction of two body problem: The centre of mass frame, Transformation from centre of mass to Laboratory frame of reference, Collision between identical particles
- UNIT-4: Angular Momentum:**  
Introduction to angular momentum, Quantum theory of angular momentum, The eigenvalue spectrum, Matrix representation of angular momentum, Spin angular momentum, Pauli matrices and their properties, total wave function, Non-relativistic Hamiltonian including spin
- UNIT-5: Addition of Angular Momentum:**  
Addition of angular momenta, Clebsch – Gordan co-efficients, Spin wave functions for a system of two spin- $\frac{1}{2}$  particles, Identical particles with spin, Addition of spin and orbital angular momenta, Spherical tensors; Tensor operators, The Wigner-Eckart theorem
- UNIT-6: Relativistic wave equations:**  
Generalization of the Schrödinger equation, The Klein-Gordon equation: Plane wave solutions; Charge and current densities, The Dirac's Equation: Dirac's relativistic Hamiltonian, Position probability density; Expectation values, Dirac matrices, Plane wave solutions of the Dirac equation; Energy spectrum, The spin of the Dirac particles, Significance of the negative energy states; Dirac particle in Electromagnetic fields, Relativistic electron in a central potential; Total angular momentum

#### Recommended 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 Fraz Schwabl
6. Quantum Mechanics Vol.I, by A. Messiah,(North Holland)
7. Quantum Mechanics, by E. Merzbacher (Willey)

## Theory Tutorials

### PH – 531: QUANTUM MECHANICS - II

(Discussion and problem solving/exercise sessions)

1. Propagator for a free particle
2. Comparison of Schrödinger, Heisenberg and interaction pictures
3. Problems on scattering theory
4. Problems on Born approximation
5. Scattering by different potentials
6. Problems on Phase shift
7. Obtain the matrices for  $j=3/2$  using eigenvalue equations of  $J^2$ ,  $J_z$  and  $J_{\pm}$ .
8. Show that  $(\boldsymbol{\sigma}\cdot\mathbf{A})(\boldsymbol{\sigma}\cdot\mathbf{B}) = (\mathbf{A}\cdot\mathbf{B}) + i \boldsymbol{\sigma}(\mathbf{A} \times \mathbf{B})$  if the components of  $\mathbf{A}$  and  $\mathbf{B}$  commute with those of  $\boldsymbol{\sigma}$ .
9. What is the spin wave function for  $S=1/2$  if the spin component in the direction of the unit vector has the value  $1/2\hbar$ ?
10. Show that  $(\boldsymbol{\sigma}\cdot\mathbf{A})^2 = A^2$
11. Hydrogen atom using Klein-Gordon equation
12. Hydrogen atom using Dirac equation

## M.Sc. (PHYSICS): SEMESTER- III

### PH- 532: Physics of Lasers and Lasers Applications

#### Unit :1

Laser : Introduction, Einstein coefficients, Population inversion, Methods of population inversion, Threshold conditions, Laser rate equations: Two, three & four level systems, Variation of Laser power around threshold, Optimum output coupling.

#### Unit :2

Optical Resonators: Modes of a rectangular cavity & open planar resonator, Quality factor, Ultimate linewidth of the laser, Transverse & longitudinal mode selection, Q- switching, Techniques & for Q- switching, Mode locking in lasers, Techniques for mode locking, Modes of confocal resonator system, General spherical resonator, Higher order modes.

#### Unit :3

Properties of laser beams & types of lasers: Coherence properties of laser light, Temporal Coherence, Spatial Coherence, Directionality, Ruby laser, Neodymium lasers ( Nd: YAG & Nd: Glass) He- Ne laser, CO<sub>2</sub> laser, Argon ion laser, Dye laser, Semiconductor lasers.

#### Unit :4

Applications of lasers: Holography, Laser induced fusion: Introductoin, Fusion Process, Laser energy requirements, Laser induced fusion reactor, Light wave communications : Light information carrying capacity of light waves, Optical fiber amplifier, Amplifier modeling.

#### Unit:5

Non-linear optics: Introduction, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, Parametric generation light, self focusing of light, Multiphoton process: Multiquantum Photoelectric effect, Two photon processes, Theory of two photon processes, Experiments in two photon processes, Three photon processes, SHG & parametric generation of light in three photon process, Parametric light oscillator, Frequency up conversion, Phase conjugate optics.

#### Unit: 6

Laser Spectroscopy: Rayleigh & Raman scattering, Stimulated Raman effect, Hyper- Raman effect Classical & Quantum mechanical treatment, Coherent anti stokes Raman Scattering, Spin Flip Raman laser, Free- electron laser, photo-acoustic Raman spectroscopy, Brillouin Scattering, Saturation Absorption spectroscopy, Doppler free two photon spectroscopy.

Optical Solitons: Introduction, Self phase modulation, Spectra of self phase modulated pulses, Derivation of soliton power, compression of a chirped pulses.

#### Recommended Books:

- 1 Optical Electronics: A. K. Ghatak & K. Thyagarajan ( Cambridge university press, 1990)
- 2 Lasers & Non – linear optics : B.B.Laud (Wiley Eastern Limited )
- 3 Introduction to Fiber Optics : Ajay Ghatak & K. Thyagarajan (Cambridge university press, 1999)
- 4 Principal's of Lasers : Orazio svelto & David C. Hanna (Plenum Press- New York and London)
- 5 Optical communications : components & systems : J. H. Franz & V. K. Jain ( Narosa Publishing House )
- 6 optics: Eugene Hecht ( PEARSON Education; Inc, 2002) Fourth Edition

## **Theory Tutorial**

### **PH- 532: Physics of Laser and Lasers Applications**

**(Discussion and problem solving/exercise sessions)**

1. Applications of laser in pure & applied sciences.
2. Chemical lasers
3. Non- liners effects in Fibers
4. Kerr effect
5. Fourier transforms & Optical application
6. Coherence & stellar interferometry.
7. Components of a lightwave communication system:Optical fiber
8. Modulators & Dectors of a lightwave communication system.

**M.Sc. (Physics) : Semester - III**  
**PH(E)-533 : Physics of Semiconductor Devices**

**Unit-1 (Introduction)**

Carrier transport phenomena, Phonon spectra, optical thermal and high field properties of semiconductor, basic equation for semiconductor device operation.

**Unit-2 (p-n Junction Diode)**

Depletion region and depletion capacitance, current-voltage characteristics, junction breakdown.

**Unit-3 (Bipolar transistor)**

Junction transistors, microwave transistors, power transistors, switching transistor.

**Unit-4 (Thyristor)**

Basic characteristic, Shockley diode and three terminal Thyristor, uni-junction transistor and trigger Thyristor.

**Unit-5 (Optical Devices)**

Optical absorption, solar cell, photo-detectors, photoluminescence and electroluminescence, light emitting diode, laser diode.

**Unit-6 (Semiconductor Power Devices)**

Power bipolar transistor, power MOSFETs, heat sinks and junction temperature, power thyristor, diac and triac, IGBT, SIT, HEMT.

**Recommended Books:**

1. D.A. Neamen, Semiconductor Physics and devices, Tata McGraw-Hill Publishing Company Limited. 2002.
2. S.M. Sze, Physics, of semiconductor devices, Wiley-Interscience, 1981.
3. B.G. Streetman, Solid State Electronic Devices, Prentice-Hall of India Private Linlited 3<sup>rd</sup> Ed.1994.
4. R.M. Warner and B.Z. Grang, Transistors, John Wiley, 1983.

## **Theory Tutorials**

### **PH(E)-533 : Solid State Devices**

#### **(Discussion and problem solving/exercise sessions)**

- 1 Importance and Effects of carrier transportation in semiconductors.
- 2 Study of the decay of photo-excited carriers in semiconductors using Maxwell Equations.
- 3 Applications of diode.
- 4 Transient behavior of the Diode.
- 5 Applications of switching transistor.
- 6 Comparison between microwave transistor and switching transistors.
- 7 Applications of Shockley diode.
- 8 Applications of thyristor for low and medium power control.
- 9 Circuit design for photo detection techniques.
- 10 Applications of solar cell and its limitations.
- 11 Applications of laser diode.
- 12 Circuit design for power control using power devices.

## **M.Sc. (Physics) : Semester –III**

### **PH(E)-534 :Microprocessor and its applications**

#### **Unit-1 (Review)**

Review of number systems, combinational and sequential digital electronics, memory elements, primary and secondary storage, microprocessor and microcomputers

#### **Unit-2 (Microprocessor Architecture)**

Intel 8085, ALU, timing and control unit, registers data and address bus, pin configuration, instructions, op-code and operands, fetch operation, execute operation, machine cycle and state, instruction and dataflow, timing diagram for op-code fetch cycle, timing diagram for memory read/write operation, timing diagram for I/O read/write operation.

#### **Unit-3 (Assembly language programming)**

Intel 8085 Instruction set, instruction and data formats, addressing modes, status flags, data transfer group, arithmetic group, logical group, branch group, stack, I/O and machine control group.

#### **Unit-4 (Peripheral devices and their Interfacing)**

Address space partitioning, memory and I/O interfacing, hardware and software interrupts of Intel-8085, programmable peripheral interface, 8255-I/O port, 8251-Programmable communication interface, 8253-Programmable counter/interval timer, interfacing of DAC and ADC chips.

#### **Unit-5 (Microprocessor applications)**

Delay subroutine, connecting common anode and common cathode type 7-segment displays, over current relays, directional relay, frequency measurement, phase angle and power factor measurement, measurement of voltage and current, measurement of reactance and resistance, KVA and KW measurement, temperature measurement, strain measurement, water level indicator.

#### **Unit-6 (Introduction of Microcontrollers)**

Introduction, 8051 Architecture, Addressing modes, 8051-instruction set Microcontroller assembly language programming, embedded C-programming.

#### **Recommended Books:**

1. R.S.Gaonkar, Microprocessor Architecture, Programming and applications, Wiley Eastern Limited,
2. L.A.Leventhal 8080A-8085 Assembly Language Programming, McGraw-Hill Inc.
3. B.Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications.
4. Kenneth J. Ayeala, The 8051 microcontroller, Architecture, programming and application, West publishing compny.

## **Theory Tutorials**

### **PH(E)-534 :Microprocessor and its applications**

**(Discussion and problem solving/exercise sessions)**

- 1 Number representation
- 2 Application of combinational logic.
- 3 Application of sequential logic.
- 4 Fetch and execution timing of instructions
- 5 Simple assembly language programming
- 6 Assembly language programming-Arithmetic problems
- 7 Assembly language programming-Data arrangement
- 8 I/O related assembly language programming.
- 9 Interfacing related assembly language programming
- 10 Microprocessor application-I
- 11 Microprocessor application-II
- 12 LED and LCD interfacing to microcontroller.

## M.Sc. (Physics) : Semester –III

### PH(M)– 533: Crystal Growth & Characterizations

#### Unit - I:

Crystals: Single Crystals, Importance of single crystals crystal, Theories of crystals Growth, Methods of crystal Growth, Applications of single crystals.

#### Unit- II:

Melt Growth : Normal freezing, zone Melting, Czochralski crystal pulling Technique ,Bridge Mann – stock Barger Technique, Verneuil flame fusion Technique

#### Unit- III:

Solution Growth: Flux Growth, Hydrothermal Growth, Aqueous Solution Growth, Gel Growth and other methods.

#### Unit- IV:

Vapour Growth :Vapour phase Epitaxy, chemical vapour deposition, Molecular Beam Epitaxy, Vacuum Evaporation Technique, other methods

#### Unit- V:

Qualitative and chemical Analysis : Introduction, stages of Analysis, selection of Analysis Method, Searching of Literature, Chemical Analysis, Thermal Analysis ( TGA, DTA, DSC, etc.),x-ray Analysis (XRD, EDAX, etc.)

#### Unit- VI:

Spectroscopic Methods : Introduction, Infrared spectroscopy ( IR, FTIR, etc.) Ultraviolet spectroscopy,Optical microscopy and morphology studies, SEM, TEM and other physical tools..

#### Recommended Books:

- (1) P. Ramaswamy & Santhan Raghavan Crystal Growth  
KRU Publications, Chennai
- (2) Henisch H. K.Crystal Growth in Gel  
The Pennsylvania state University Press , London (1973)
- (3) Vogel A. I.  
Elementary Practical Organic Chemistry part-2  
Qualitative Organic Analysis,Longmans Green and Co.  
Ltd. (1966)
- (4) Crystal Growth Method – A. R. Patel

## **Theory Tutorials**

### **PH(M)– 533: Crystal Growth & Characterizations**

**(Discussion and problem solving/exercise sessions)**

1. Study of Natural Crystals
2. Growth Study of Diamonds
3. Growth Study of Bio-Materials
4. Morphology study of crystals
5. Crystal Growth Models and their limitations
6. Tools for property determination

## **M.Sc. (Physics) : Semester –III**

### **PH(M) – 534: Advanced Materials Science**

#### **UNIT- 1**

Introduction, Materials and Civilization, Materials and Engineering requirements, Structure – Properties – Performance, Classification of Engineering Materials, Advanced Materials – Smart Materials, Quantum Dots, Spintronics, Nano structured Materials, Modern Materials need

#### **UNIT- 2**

States of matter – Theory of liquids – transition between states of matter, structure of solids, crystallization, Formation of Amorphous solids, colloidal state of Matter, Gels, Emulsions, Liquids crystals, The Plasma state of matter, Applications of Plasma

#### **UNIT -3**

Macromolecules, characteristics of Ionic solids, characteristics of covalent compounds, characteristics of Metallic crystals, comparison of Ionic, covalent and metallic bonds Three dimensional bonding, Interatomic Distances, Generalization based on atomic bonding .

#### **UNIT -4**

Phase Diagram, Definition and basic concepts, The phase Rule, one component diagrams, two component diagrams, phases in organic polymers, properties of phases in non crystalline and crystalline phases, Applications of phase diagrams

#### **UNIT -5**

Practical aspects of phase diagrams – Non Equilibrium in phase diagrams, Iron –carbon system, Iron – carbon equilibrium or phase diagram, modified Iron – carbon phase diagram, ceramic systems, composite systems.

#### **UNIT -6**

Nano structured Materials, Fullerenes, carbon nanotubes, Nanowires, Nanocones, Haecelites, Production methods for carbon nanotubes, Key issues in nanomanufacturing, nanomaterial advantages, Applications of Nanomaterials

Recommended Books:

#### **Recommended Books:**

1. S.K.Kakani Amit kakani ,  
Materials science – New Age International publishers (2005)
2. V. Raghavan,  
Materials Science and Engineering- A First Course,(Fifth Edition),  
Prentice -Hall of India Publisers, New Delhi(2005).
3. James F. Shackelford , Madan palli K. Muralidhara,  
Introduction to - Materials Science for Engineers, (Sixth Edition),  
Pearson Education Publishers, Delhi,India .
4. L. H. Van vlack,  
Elements of Materials Science and Engineering (sixth Edition) Addison – Wesley publishing  
company . (1999)
5. A. G.Gay,  
Essential of Material science – Mc Gvaw Hill, (1976)
6. Manas Ghande,  
Science of Engineering Materials Vol- 3 ,  
Mc Millan Publisher, India, (1980)

## **Theory Tutorials**

### **PH(M) – 534: Advanced Materials Science**

**(Discussion and problem solving/exercise sessions)**

- Scopes and Trends in Materials Science
- Advances in Nanomaterials
- Advances in Composites
- Advances in Ceramics
- Alloys and Their Phase Diagrams
- Selection of Materials for industrial applications

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

### PH(T)-533: Computer Applications in Physics

#### UNIT-1

Basic features and simple commands of operating systems: WINDOWS, DOS, UNIX, LINUX and their uses.

#### UNIT-2 & 3

Software Package: Mathematica

- Introduction: interfaces, numerical and algebraic calculations.
- Symbolic mathematics: differentiation, integration, sums and products, solving equations, differential equations, power series, limits, integral transforms, recurrence equations.
- Numerical mathematics: numerical sums, products and integrals numerical equation solving, numerical differential equations, optimization.
- Functions and programs,
- Lists
- Graphics and sound,
- Input/output
- File operations.

#### UNIT-4

- Basic introduction of other scientific software packages such as MATLAB, MathCAD.
- Spreadsheets/Worksheets packages like EXCEL, SIGMAPLOT etc and their use for numerical solutions and graph plotting/data visualization.

#### UNIT-5

Essentials of parallel computation, need for high speed computing and parallel computers, temporal and data parallelism, pipelined parallel computers, array processors, generalized structure of a parallel computer, shared memory multiprocessors, message passing multiprocessors, multilink multidimensional multi-computers. Programming parallel computers.

#### UNIT-6

- **FORTRAN 90:** additional features different from FORTRAN 77 such as named constants, conditional operators, loops, CASE statement, arrays, variable dimensions, pointers, given functions, masking, sub-arrays, MODULES, INTERFACE, WHERE.
- **FORTRAN 95:** features for parallel computers, FORALL etc.

#### **Recommended Books**

1. K Srengan, Understanding UNIX, PHI, 2006.
2. Paul Love *et al*, Beginning Unix, Wiley India, 2005
3. Ed Bott and C. Siechert, Microsoft Windows XP (inside Out), PHI, 2001
4. N. Matthew, R. Stones, Beginning Linux Programming, Wiley India, 4<sup>th</sup> ed., 2008
5. S. Wolfram, Mathematica book, 5<sup>th</sup> ed. 2003.
6. Y. K. Singh, B. B. Chaudhuri, Matlab Programming, PHI, 2007.
7. C. Stinson and M. Dodge, Microsoft Office Excel 2003 (Inside Out), PHI, 2004
8. SIGMAPLOT 11.0 users guide, systat software, inc, 2008.
9. V.Rajaraman, Elements of Parallel Computing, PHI, 2006
10. V.Rajaraman and C. Siva Ram Murthy, Parallel Computers: Architecture and Programming, 2004.
11. V.Rajaraman, Computer Programming in Fortran 90 and 95, PHI, 1999.
12. P.S. Grover, programming and computing with FORTAN 77-90, Allied publishers, 1990.

## **Theory Tutorials**

### **PH(T)-533: Computer Applications in Physics**

#### **(Discussion and problem solving/exercise sessions)**

1. Simple directory, file copy exercises in UNIX, LINUX and DOS.
2. Discussion on comparison of commands in different OS for the same give task.
3. Solving differential equations using Mathematica.
4. Exercises on differentiation and integration using symbolic manipulation in Mathematica.
5. Multiplication of two matrices in Mathematica and Matlab.
6. Finding real roots of a transcendental equation using Mathematica and MathCAD.
7. Interpolation using spreadsheet.
8. Exercises on various types of graphs in SIGMAPLOT and Excel.
9. Discussion on parallelization in matrix multiplication.
10. Survey on different supercomputers and parallel machines with their speeds in FLOPS.
11. Program for matrix multiplication in FORTRAN 77 and FORTRAN 90.
12. Program for matrix multiplication using parallelization in FORTRAN 95.

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

### PH(T)-534: Computational and Simulation methods in Physics

#### UNIT-1

LU decomposition methods for solution of linear algebraic equations.  
Quadratic and Cubic Spline fitting.  
Least squares fitting techniques.

#### UNIT-2

Eigen value problem, power method, location of bound, largest and smallest eigen values.  
Richardson's extrapolation.  
Romberg integration, Gauss Quadrature, improper integrals.

#### UNIT-3

Discrete and Fast Fourier Transforms,  
Finite-element method for partial differential equations

#### UNIT-4

- Simulation of one-dimensional motion: falling object, oscillatory motion, model of an accelerating car.
- Simulation in two-dimensions: projectile motion.
- Simulation of RC, LR, and LRC circuits.

#### UNIT-5

- Rutherford scattering.
- Basics of simulative Molecular Dynamics.

#### UNIT-6

- Boundary value problems, Simulation of Quantum systems.
- Monte Carlo simulations: Modeling of Radioactive decay.

#### **Recommended Books**

1. S.C. Chapra, R.P. Canale, Numerical methods for Engineers, 5<sup>th</sup> ed., McGraw Hill, 2006.
2. K. Sankara Rao, Numerical Methods for Scientists and Engineers, PHI, 2001.
3. M.L. Dejong, Introduction to computational physics, Addison Wesley, 1977.
4. T. Pang, An introduction to computational physics, Cambridge Uni. Press, 1971.
5. H. Gould and Tobochnik, An Introduction to computer simulation methods, vols. 1-2, Addison Wesley, 1988.
6. S.E. Koonin, Computational Physics, Addison Wesley, 1986.
7. R. C. Verma, Computer Simulation in Physics, Anamaya Publishers, 2004.
8. G.I. Duchi, spreadsheet Applications for Scientists & Engineers, Addison-Wesley, 1988.

## **Theory Tutorials**

### **PH(T)-534: Computational and Simulation methods in Physics**

#### **(Discussion and problem solving/exercise sessions)**

1. Problem on LU decomposition method.
2. An example for cubic Splines method
3. Find all the Eigen values of a 3x3 matrix using power method.
4. Propagation of inherent error in Romberg integration method.
5. Write program for FFT.
6. Solve projectile motion problem and compare simulation results with your calculations.
7. Derive Rutherford scattering formula.
8. Generate a random distribution of N particle positions in a cubical box of side L and calculate the total potential energy of this system for two-body Lennard Jones potential.
9. List applications of molecular dynamics.
10. Simulate a quantum particle in an infinitely deep potential well.
11. Simulate the motion of a wave-packet.
12. Describe random-walk problem.

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

### PH-535: Practicals

#### Note:

Practicals consist of experiments in two groups **A** and **B**.

Group **A** experiments are common for all the specialization.

Group **B** experiments are different for different specializations.

#### Group A: List of Experiment

(3 hours/ week + 1 hour/week tutorial)

#### Numerical Analysis Experiments:

1. Interpolation and inverse interpolation using Lagrange's formula.
2. Numerical integration using Simpson's  $1/3^{\text{rd}}$  rule.
3. Solving ordinary differential equations.

#### FORTRAN Programming Experiments:

4. Writing and testing FORTRAN programs for Interpolation and inverse interpolation using Lagrange's formula.
5. Writing and testing FORTRAN programs for Numerical integration using Simpson's  $1/3^{\text{rd}}$  rule.
6. Writing and testing FORTRAN programs for solving ordinary differential equations.

#### **Laboratory Tutorial**

Discussion of techniques of actual numerical computation, program writing concepts, error analysis to supplement actual exercise given for numerical analysis and computer programming.

## **Group B: List of Experiments**

**(6 hours/ week)**

### **Specialization: Electronics**

1. To design, build and test a Wide-band amplifier.
2. To design, build and test Wein Bridge Oscillator using IC 741.
3. To design, build and test a Bistable multivibrator.
4. To design, build and test a Mono-stable multivibrator.
5. To design, build and test Schmitt Trigger circuit.
6. Voltage to Frequency converter using ICs.
7. Operational Amplifier applications (i) Voltage regulator and (ii) Function generator.
8. To design, build and test (i) a 4 bit binary Up/Down-counter  
(ii) A module N-counter using JK flip-flops and other gates.
9. To design, build and test Analog to Digital converter.
10. To design, build and test a ROM using diode matrix for BCD to seven segment code conversion for 7-segment LED display and study 74147/74148 IC.
11. To design, the basic RAM memory cell and its conversion to (i) 2 x 1 RAM and (ii) 1 x 2 RAM.
12. Microprocessor assembly language programming-I.  
(Arithmetical operation related programming)
13. Microprocessor assembly language programming-II.  
(Sorting and code conversion related programming)
14. Microprocessor assembly language programming-III.  
(I/O & Interfacing related programming)

### **Recommended Books:**

- 1 David A Bell, Solid State Pulse circuits, Reston publishing company, Inc.
- 2 R.A. Gaikwad, Op. Amps and linear Integrated circuits PHI.
- 3 L.A.Leventhal, 8080A-8085 Assembly Language Programming, McGraw-Hill Inc.
- 4 A.P.Malvino, D.P.Leach, Digital principal and applications, Tata McGraw-Hill Company Ltd.

## **Group B: List of Experiments**

**(6 hours/ week)**

### **Specialization: Materials Science**

1. Growth of different Crystals.
2. Chemical etching
3. Curie temperature
4. Dielectric Constant of Ferro electric materials
5. Magnetic susceptibility of solid / liquid materials
6. preparation of thin film
7. Study of properties of thin film
8. Study of divergence of a laser beam.
9. Study of Microwave
10. Study of retentively by Hysteries loop tracer .
11. Study of liquid Penetrate Testing (NDT)
12. Study of X- ray Diffraction
13. Study of molecular weight of Polymer
14. Study of Hardness for different materials
15. Study of Defects in Crystals

**Group B: List of Experiments**

**(6 hours/ week)**

**Specialization: Theoretical Physics**

1. Interpolation and inverse interpolation with unequal intervals of arguments using Newton's divided difference formula.
2. Solving a system of simultaneous equations using Newton-Rapson method.
3. Obtaining eigenvalues and eigenvectors of a square matrix using Jacobi method.
4. Solving a system of linear equations using matrix inversion.
- 5-8. Writing and testing FORTRAN programs for experiments no.1-4.
- 9-12. Writing and testing C programs for experiments no.1-4.
13. Numerical simulation of simple harmonic oscillator, anharmonic oscillator.
14. Numerical simulation of projectile.
15. Numerical algorithm and solution of Shrodinger equation.
16. Use of spreadsheet for solving numerical and physics problems.