<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam(Hours)</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-501 B</td>
<td>Mathematical Physics</td>
<td>4</td>
<td>0</td>
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<tr>
<td>PHY-503 B</td>
<td>Classical Mechanics</td>
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<tr>
<td>PHY-505 B</td>
<td>Computational Physics</td>
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<tr>
<td>PHY-507 B</td>
<td>Fundamental of Electronics</td>
<td>4</td>
<td>0</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>PHY-509 B</td>
<td>Physics Lab-I (General)</td>
<td>0</td>
<td>8</td>
<td>50</td>
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<tr>
<td>PHY-511 B</td>
<td>Computational Physics &amp; Programming Lab</td>
<td>0</td>
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<td>Total</td>
<td></td>
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<td>12</td>
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<td>550</td>
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<tr>
<td>Paper No.</td>
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<td>Examination Scheme</td>
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<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-502 B</td>
<td>Elements of solid State Physics</td>
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<td>0</td>
<td>50</td>
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<tr>
<td>PHY-504 B</td>
<td>Atomic &amp; Molecular Physics</td>
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<td>PHY-506 B</td>
<td>Quantum Mechanics-I</td>
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<td>PHY-508 B</td>
<td>Elements of Nuclear Physics</td>
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<tr>
<td>PHY-510 B</td>
<td>Physics Lab-II (General)</td>
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<td>50</td>
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<tr>
<td>PHY-512 B</td>
<td>Computational Physics &amp; Simulation Lab</td>
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<tr>
<td></td>
<td>Total</td>
<td>16</td>
<td>12</td>
<td>275</td>
<td>550</td>
</tr>
<tr>
<td>Paper No.</td>
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<td>Examination Scheme</td>
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<td>Credit</td>
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<td>--------</td>
</tr>
<tr>
<td>PHY-601 B</td>
<td>Electrodynamics &amp; Plasma Physics</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PHY-603 B</td>
<td>Quantum Mechanics-II</td>
<td>4 0</td>
<td>50 100 150</td>
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</table>

Any one of the following options

**OPTION-1 (Condensed Matter Physics)**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-605B</td>
<td>Crystallography and imperfections in crystals</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PHY-607B</td>
<td>Characterization of materials</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
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</table>

**OPTION-2 (Electronics)**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
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<tbody>
<tr>
<td>PHY-609B</td>
<td>Analog Communication</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PHY-611B</td>
<td>Digital Communication</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
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**OPTION-3 (Nuclear Physics)**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-613B</td>
<td>Nuclear Reactions</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PHY-615B</td>
<td>Nuclear Detectors</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
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</table>

**OPTION-4 (Spectroscopy)**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-617B</td>
<td>Laser Physics &amp; Quantum Optics</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PHY-619B</td>
<td>Integrated optics</td>
<td>4 0</td>
<td>50 100 150</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Any one of the following practical paper corresponding to the theory paper will be assigned.

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>PHY-621B</td>
<td>CMP-Lab-I</td>
<td>0 12</td>
<td>75 150 225</td>
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<tr>
<td>PHY-623B</td>
<td>Electronics Lab –I</td>
<td>0 12</td>
<td>75 150 225</td>
<td>4</td>
<td>6</td>
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<tr>
<td>PHY-625B</td>
<td>Nuclear Phy Lab-I</td>
<td>0 12</td>
<td>75 150 225</td>
<td>4</td>
<td>6</td>
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<tr>
<td>PHY-625B</td>
<td>Laser Lab-I</td>
<td>0 12</td>
<td>75 150 225</td>
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<td>6</td>
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</table>

Total: 16 12 275 550 825 22

**Note:** The student will opt any one option which will be continued in IV Semester as well.
<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-602 B</td>
<td>Statistical Mechanics</td>
<td>4</td>
<td>0</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>PHY-604 B</td>
<td>Advance Quantum Mechanics &amp; Elements of Particle Physics</td>
<td>4</td>
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</table>

Any one of the following options

**OPTION-1 (CMP)**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-606B</td>
<td>Renewable Energy Sources</td>
<td>4</td>
<td>0</td>
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<td>PHY-608B</td>
<td>Nano Science &amp; Technology</td>
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**OPTION-2 (Electronics)**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-610B</td>
<td>Electronic Device &amp; Smart Materials</td>
<td>4</td>
<td>0</td>
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<tr>
<td>PHY-612B</td>
<td>Microprocessor &amp; Interfacing</td>
<td>4</td>
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**OPTION-3 (Nuclear Physics)**

<table>
<thead>
<tr>
<th>Paper No.</th>
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<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Duration of Exam (Hours)</th>
<th>Credit</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-614B</td>
<td>Nuclear Models</td>
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<td>0</td>
<td>50</td>
<td>100</td>
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<tr>
<td>PHY-616B</td>
<td>Nuclear Technique</td>
<td>4</td>
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**OPTION-4 (Spectroscopy)**

<table>
<thead>
<tr>
<th>Paper No.</th>
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<th>Duration of Exam (Hours)</th>
<th>Credit</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-618B</td>
<td>Fibre Optics and communication</td>
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<tr>
<td>PHY-620B</td>
<td>Optical Electronics</td>
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</table>

Any one of the following practical paper corresponding to the theory paper will be assigned.

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<td></td>
<td>L</td>
<td>P</td>
<td>Sessional Marks</td>
<td>External Marks</td>
</tr>
<tr>
<td>PHY-622B</td>
<td>CMP-Lab-II</td>
<td>0</td>
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<td>50</td>
<td>100</td>
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<tr>
<td>PHY-624B</td>
<td>Electrons Lab –II</td>
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<td>Dissertation</td>
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Total: 16  12  275  550  825  22
M.Sc. Physics  
Semester-I  

MATHMATICAL PHYSICS  

Paper No.-PHY-501B  
Credits: 04  
04 Hrs /week  
Max. Marks: 100+50  
Total: 60 Hrs.  
Duration of Exam: 03 Hrs.  
Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT- I  

MATRICES AND TENSORS  
Matrices: Orthogonal, Unitary and Hermitian Matrices with examples, Inverse of a matrix, Independent element of orthogonal and unitary matrices of order 2, Eigen values & Eigen vectors, Matrix diagonalization, complete orthonormal sets of functions.

Tensors: Introduction, definition, Covariant and Contravariant tensors, symmetric and skew-symmetric tensor, Contraction theorem, product of tensors, Quotient rule, Levi-Civita symbol, Non-cartesian tensors, Metric tensors, Covariant differentiation.

UNIT-II  

SOLUTION OF LINEAR ODE’S OF SECOND ORDER & SPECIAL FUNCTIONS  

Bessel function of first and second kind, Generating function and recurrence relations, integral representation.

Legendre Polynomial: \( P_n(x) \) as solution of Legendre differential equation, Generating function, recurrence relations and special properties, Orthogonality of \( P_n(x) \), Rodrigue’s formula.

Hermite and Laguerre Polynomial; solution of Hermite & Laguerre differential equation, Generating function and recurrence relation only

UNIT-III  

COMPLEX VARIABLE  
Function of complex variable, limit, continuity and differentiability of function of complex variables, Analytic function, Cauchy-Riemann conditions, Cauchy’s integral theorem, Cauchy’s Integral formula, Taylor’s and Laurent’s series, singular points, residues, evaluation of residues, Cauchy’s residue theorem, Jordan’s lemma, evaluation of real definite integrals.
UNIT-IV

INTEGRAL TRANSFORM

Fourier series, Dirichlet's conditions, Fourier series of arbitrary period, Half-wave expansions, development of the Fourier integral, Fourier integral theorem, Fourier transforms, Properties of Fourier transform, Convolution theorem, Fourier transform of Dirac Delta function

Laplace transform, first and second shifting theorem, Laplace transforms of derivatives and integral of a function, convolution theorem, Inverse Laplace transform by partial fraction and by using convolution theorem, application of Laplace transform in solving differential equations.

TEXT AND REFERENCE BOOKS:

7. Mathematics for Physicist: Mary L. Boas
M.Sc. Physics  
Semester-I  

CLASSICAL MECHANICS  

Paper No.-PHY-503B  
Credits: 04  
04 Hrs /week  
Max. Marks: 100+50  
Total: 60 Hrs.  
Duration of Exam: 03 Hrs.  

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.  

UNIT-I  

LAGRANGIAN FORMULATION & HAMILTON’S PRINCIPLES  
Mechanics of a system of particles, constraints of motion, generalized coordinates, D’Alembert’s Principle and Lagrange’s velocity dependent forces (gyroscopic) and the dissipation function, Application of Lagrangian formulation. Hamilton principle, Lagrange’s equation from Hamilton principle, extension to non-holonomic systems.  

UNIT-II  

RIGID BODY MOTION  
Reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one – dimensional problem and the classification of orbits, the differential equation for orbits, the Kepler’s problem (inverse square law), scattering (Rutherford) in central force field. The Euler’s angles, rate of change of a vector, the Coriolis force and its applications.  

UNIT-III  

SMALL OSCILLATIONS & HAMILTON EQUATION  
Euler equation of motion, Torque free motion of rigid body, motion of a symmetrical top, Eigen value equation, Free vibrations, Normal coordinates, vibration of Tri-atomic Molecule. Legendre Transformation, Hamilton’s equations of motion, Hamilton’s equations from variation principle, Principle of least action.  

UNIT-IV  

CANONICAL TRANSFORMATION AND HAMILTON-JACOBI THEORY  
Canonical transformation and its examples, Poisson’s brackets, Equation of motion, Angular momentum, Poisson’s Brackets relations, infinitesimal canonical transformation, Conservation Theorems., Hamilton-Jacobi equation for Hamilton’s principal function, Harmonic Oscillator problem.  

TEXT AND REFERENCE BOOKS:  
1. H. Goldstein, C. Poole & J. Safko, Classical Mechanics (Pearson Education Asia, New Delhi)  
M.Sc. Physics  
Semester-I  

COMPUTATIONAL PHYSICS  

Paper No.-PHY-505B  
Credits: 04  
04 Hrs /week  
Max. Marks: 100+50  
Total: 60 Hrs.  
Duration of Exam: 03 Hrs.  

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.  

UNIT-I  

Basic Computer organization: Input and output units, Storage unit, Arithmetic Logic unit, Control unit, Central processing unit.  
Fortran Programming: Data types, Arithmetic & logical expression, Input-output statements, If statement, Do loop, Arrays and subscripted variables, functions and subroutines, Handling input and output files.  

UNIT-II  

Errors: Round off errors, truncation error, machine error, random error.  
Solution of algebraic equation: Bisection method, iteration method, Newton Raphson method, Muller method.  
Interpolation and extrapolation: Finite difference, forward difference, backward difference, central differences, Lagrange method.  
Curve Fitting: Least-square curve fitting, straight line and polynomial fits.  

UNIT-III  

Differentiation: Taylor series method, numerical differention using Newton’s forward difference formula, strilling formula.  
Integration: Trapezoidal rule, Simpson 1/3 rule, Gaussian Quadrature, Legendre-Gauss Quadrature, Numerical double integration  

UNIT-IV  

Second order differential equation: Initial and boundary value problem, Numerical solution of radial Schorindger for hydrogen atom using forth order Runga Kutta method (when eigen value is given).  

REFERENCES:  
1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co.)  
2. Computational: Physics an introduction by RC Verma, PK Ahulawalia and K C Sharma (New Age International Publisher)  
3. Introduction to Numerical Analysis by F b Hilderbrand( Tata McGraw Hill, New Delhi)
M.Sc. Physics
Semester-I

ELECTRONICS - I

Paper No.-PHY-507B

Credits: 04
04 Hrs./week
Total: 60 Hrs.

Max. Marks: 100+50
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consist of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT-I

SEMICONDUCTOR DEVICES & DATA INTERPRETATION
Drift and diffusion current, Generation and recombination of charges, p-n junction, Capacitance of p-n junctions, Varactors, switching diodes, Clippers & Clampers, photoconductors, photodiode, light emitting diodes and liquid crystal display.
Junction Field Effect Transistor (JFET): Basic structure & Operation, pinch off voltage, single ended geometry of JFET, Volt–Ampere characteristic, Transfer Characteristics. JFET as Switch and Amplifier.
MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, comparison of p & n Channel FET, SCR, 4 layer pn-pn devices, Tunnel diode

UNIT-II

OPERATION AMPLIFIER
Differential Amplifier: Circuit configuration, dual input balanced output different amplifier, Inverting and Non-inverting inputs, CMRR.
Operational Amplifiers: Block diagram, open and close loop configuration, inverting & non-inverting amplifier, Op-amp with negative feedback – Voltage series feedback, Effect of feedback on closed loop voltage gain, Input resistance, output resistance, band width, output offset voltage, Measurements of Opamp parameters.
Op-amp Application: d.c. and a.c. amplifier, summing, scaling and Averaging amplifier, Integrator, Differentiator, Electronic analog computation comparator

UNIT-III

DIGITAL CIRCUITS
Boolean algebra, de Morgans theorem, truth table to Karnaugh map and simplification.
Data processing circuits: Multiplexers, Demultiplexers, Adders, Encoders, Decoders, Parity generators. Sequential Circuits: RS, JK, D, clocked, preset and clear operation, race a round condition in JK flipflops, master-slave JK flip-flops as building block of sequential circuits. Shift registers, Asynchronous and synchronous counter, counter Design and applications.
UNIT-IV

MEMORIES AND CONVERTERS
Semiconductor Memories: ROM, PROM, and EPROM, Ram, Static and Dynamic Random Access Memories (SRAM and DRAM), Content addressable memory, other advanced memories. D/A and A/D Converters: Parallel comparator A/D converter, A/D converter using voltage to frequency and using voltage to time conversion, accuracy and resolution. D/A converter resistive network, accuracy and resolution.

Text and References Books:
J. Millman, CC. Halkias Integrated Electronics (Tata McGraw Hill)
R.P.Jain Modern Digital Electronics (Tata McGraw Hill)
Malvino & Leach Digital Electronics
S.M. Sze Semiconductor Devices: Physics and Technology
A.P. Malvino and Donald Principals and Applications in Electronics (Tata McGraw-Hill, N.Delhi,1993)
P. Laach Digital Electronics (Pearson Pub.)
Thomas L. Floyd Modern Electronic Instrumentation and measurement techniques (PHI)
A.D. Helfrick & W.D. Cooper
J.D. Ryder Fundamental of electronics
M.Sc. Physics  
Semester-I  
PHYSICS LAB - 1

Paper No.-PHY-509B  
08Hrs /week  
Total: 120 Hrs.  

Credits: 04  
Max. Marks: 100+50  
Duration of Exam: 03 Hrs.

Note: Students are expected to perform at least eight experiments out of following list.

1. To study the characteristics of Junction Field Effect Transistor.
2. To study the characteristic of Metal Oxide Semiconductor Field Effect Transistor.
3. To study the characteristics of optoelectronics Devices (LED, Photodetector).
4. To measure the band gap of Germanium using Four Probe Method.
5. To determine Hall Voltage, concentration of charge carrier and the type of semiconductor in the Hall effect experiment.
6. To study the Magnetostriction effect in a metallic rod.
7. (i) To measure input offset voltage, input bias current, input offset current and CMRR of opamp.  
   (ii) To study the frequency response of an operational amplifier.
8. To study the use of operational amplifier for different mathematical operation.
9. To study the use of operational amplifier for voltage to current & current to voltage conversion conversion.
10. To study the characteristic of SCR and its application as a switching device.
11. To determine plank’s constant using photovoltaic cell.
12. To determine the variation of refractive index of the material of prism with wavelength and to verify Cauchy’s dispersion formula.
13. To study SR & JK flipflop circuits using logic gates.
14. To study the use of digital comparator.
15. To study use of multiplexer, demultiplexer, decoder & phase shifter.
M.Sc. Physics
Semester-1st
Computational Physics & Programming Laboratory

Paper No.-PHY-511B
04 Hrs /week
Total: 120 Hrs.

Credits: 02
Max. Marks: 50+25
Duration of Exam: 03 Hrs.

Note: Students are expected to perform at least five experiments out of following list.

1. To perform Matrix summation, subtraction and multiplication.
2. To find the root of algebraic equation using bisection method.
3. To find the root of algebraic equation Newton Raphson method.
4. To find the root of algebraic equation using Muller method.
5. To fit a straight line through given data using Least square method.
6. To fit the given data using polynomial fitting.
8. To perform Numerical differentiation using Newton’s method.
M.Sc. Physics
Semester-II

ELEMENTS OF SOLID STATE PHYSICS

Paper No.-PHY-502 B  Credit: 04
04 Hrs /week  Max. Marks: 100+50
Total: 60 Hrs.  Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT – I

CRYSTAL STRUCTURE

Crystalline solids, Direct lattice, translational vectors, two and three – dimensional Bravais lattices, Miller Indices, Closed packed structures.


UNIT – II

LATTICE VIBRATION, PHONONS AND FREE ELECTRON THEORY OF METALS


Classical theory of Free electron, Fermi gas, energy levels and density of orbitals, Fermi-Dirac distribution function, Quantum theory of free electrons in a 3 –D box, electronic specific heat of a metal.

UNIT – III

BAND THEORY OF SOLIDS AND SUPERCONDUCTIVITY

Electrons in a periodic lattice: Bloch theorem, band theory and classification of solids, effective mass. Tight binding approximations. Fermi surface, Conduction in Semiconductors (both Intrinsic and Extrinsic), quantum Hall effect.

Basic Properties of Superconductors, Meissner Effect, Transport Behavior, Types of Superconductors, London’s equations, penetration depth, coherence length, energy gap parameter, Josephson Effects, BCS theory of Superconductivity, Introduction to high temperature superconductors.
UNIT – IV

MAGNETISM


TEXT AND REFERENCE BOOKS:

- C. Kittel: Introduction to Solid State Physics (Wiley, New York)
- Verma and Srivastava: Crystallography for Solid-State Physics
- Azaroff: Introduction to Solids
- Omar: Elementary Solid-State Physics
- Aschroft & Mermin: Solid State Physics (Reinhert & Winston, Berlin)
- Chaikil & Lubensk: Principles of Condensed Matter Physics
- M. Tinkham: Introduction to Superconductivity
- S. O. Pillai: Solid State Physics (new Age International Publishers)
- M. A. Wohab: Soild State Physics (Narosa).
M.Sc. Physics  
Semester-II  

ATOMIC AND MOLECULAR PHYSICS  

Paper No.-PHY-504 B  
Credits: 04  
04 Hrs /week  
Max. Marks: 100+50  
Total: 60 Hrs.  
Duration of Exam: 03 Hrs.  

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.  

UNIT – I  

ATOMIC PHYSICS  
Two electron system: Interaction energy in L-S and J-J coupling, atomic states arriving due to different electronic configuration (L-S coupling only), Briet’s scheme, Spectrum of He-atom and Heisenberg resonance.  
Hyperfine structure of spectral line: Isotope effect, nuclear spin and hyperfine multiplet, Determination of nuclear spin using hyperfine structure  

UNIT –II  

MOLECULAR PHYSICS  
Microwave spectroscopy: Diatomic molecule as rigid rotator; its energy level and spectra, Intensity of rotational lines, Diatomic molecule as non rigid rotator. Isotope effect in rotational spectra  
Infrared spectroscopy: Diatomic molecules as harmonic and anharmonic oscillator, Diatomic molecule as vibrating rotator, Energy levels and spectrum, thermal distribution of quantum states, Isotope effect in vibration spectra.  
Raman spectroscopy: Introduction, Pure rotational Raman spectra, Pure Vibrational Raman spectra, Raman rotational vibrational spectra,  

UNIT –III  

ELECTRONIC BAND SPECTRA  

UNIT –IV  

LASER PHYSICS & FLUORESCENCE SPECTROSCOPY
Laser: Spontaneous and stimulated emission, Einstein A & B coefficient, optical pumping, population inversion, rate equation, modes of resonator and coherence length.

Fluorescence and Phosphorescence, Kasha’s rule, quantum yield, nonradioactive transition, Jablonski diagram, Time resolved fluorescence and determination of excited state life time.

REFERENCES BOOKS:

1. Introduction to Atomic spectra: H.E. White
2. Fundamental of Molecular spectroscopy: C.N. Banwell
3. Atomic spectra & Structure: G. Herzberg
4. Physics of Atoms and Molecule: Bransden and Joachain
5. Molecular spectroscopy: J. M. Brown
6. Introduction to Molecular spectroscopy : G. M. Barrow
7. Spectra of Atoms and Molecule: P.F. Bemath
10. Theory & Interpretation of Fluorescence and Phosphorescence: Ralph S Beck
M.Sc. Physics
Semester-II

QUANTUM MECHANICS-I

Paper No.-PHY-506 B
Credits: 04
04 Hrs./week
Max. Marks: 100+50
Total: 60 Hrs.
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT – I

SCHROEDINGER EQUATIONS AND APPLICATIONS:
The Schroedinger equations: Time dependent and time independent forms, Probability current density, expectation values, Ehrenfest's theorem, Gaussian wave packet and its spreading. Exact statement and proof of the uncertainty principle, eigenvalues and Eigen functions, wave function in coordinate and momentum representations, Degeneracy and orthogonality. Application of Schrodinger equation for a particle in one dimensional box, Tunneling problem and Linear Harmonic Oscillator.

UNIT – II

OPERATORS
Operator in quantum mechanics, Hermitian operator and Unitary operator change of basis, Eigenvalues and eigenvectors of operators, Dirac's Bra and Ket algebra, Linear harmonic oscillator, coherent states, Time development of states and operators, Heisenberg, Schroedinger and interactive pictures, annihilation & creation operators, Matrix representation of an operator, Unitary transformations.

UNIT – III

ANGULAR MOMENTUM
The angular momentum operators and their representation in spherical polar coordinates, solution of Schrodinger equation for spherically symmetric (central) potentials, spherical harmonics, Hydrogen atom. Commutators and various commutation relations. Eigen values and eigenvectors of $L^2$ and $L_z$. Spin angular momentum, Eigenvalues and eigenvectors of $J^2$ and $J_z$. Representation of general angular momentum operator, Addition of angular momentum, C.G. coefficients, Stern-Gerlach experiment.

UNIT – IV

TIME INDEPENDENT PERTURBATION THEORY
Time independent perturbation theory: Nondegenerate case, first and second order perturbation, Degenerate case, First order Stark effect in hydrogen.
The Variational Method: expectation value of the energy, application to the ground state of Harmonic oscillator, Hydrogen and Helium atoms, Vander-Waal interactions.

**TEXT AND REFERENCE BOOKS:**

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Publisher</th>
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<tbody>
<tr>
<td>L.I. Schiff</td>
<td>Quantum Mechanics</td>
<td>Tata McGraw-Hill, Delhi</td>
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<tr>
<td>J.J. Sakurai</td>
<td>Modern Quantum Mechanics</td>
<td>Addison Wesley</td>
</tr>
<tr>
<td>P.M. Mathews &amp; K. Venkatesan</td>
<td>Quantum Mechanics</td>
<td>Tata McGraw-Hill, Delhi</td>
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<tr>
<td>Ghatak &amp; Loknathan</td>
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<tr>
<td>M.P. Khanna</td>
<td>Quantum Mechanics</td>
<td>Har Anand, N. Delhi</td>
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<tr>
<td>V.K. Thankappan</td>
<td>Quantum Mechanics</td>
<td>New Age, N. Delhi</td>
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<tr>
<td>N. Zettili</td>
<td>Quantum Mechanics: Concepts and applications</td>
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<tr>
<td>Bransden and Jochain</td>
<td>Quantum Mechanics</td>
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<td>Satya prakash</td>
<td>Quantum Mechanics</td>
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<tr>
<td>B. S. Rajput</td>
<td>Advanced Quantum Mechanics</td>
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</tbody>
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M.Sc. Physics
Semester-II

ELEMENTS OF NUCLEAR PHYSICS

Paper No.-PHY-508 B
Credits: 04
04 Hrs /week
Max. Marks: 100+50
Total: 60 Hrs.
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT -I

UNIT -II
Qualitative description of various modes of energy loss of charged particles in matter. Stopping power and Bethe-Bloch formula. Dependence of stopping power on energy of projectile, nature of projectile and stopping medium. Concept of energy and range straggling, Bragg curve.

Interaction of gamma radiation with matter: Qualitative idea of Photoelectric effect, Compton scattering and pair production. Linear and mass attenuation coefficients of gamma rays in matter. Positron annihilation in matter.

Radiation Detectors: Gas detectors; Direct-Current mode Ionization chamber, Proportional counter. G.M Counter.

UNIT -III
Alpha decay, Tunnel theory of alpha decay, Beta decay, Fermi theory of beta decay, shape of beta spectrum, Fermi- Kurie plot and its importance. Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rule. Internal conversion and Nuclear isomerism.

UNIT -IV
Overview of deuteron problem. Introduction to liquid drop model with its validity and limitations. Evidence of shell structure, Magic numbers, single particle shell model.

Nuclear energy: The fission process-Neutrons released in the fission process, cross section, the fission reactors, nuclear Fusion and thermonuclear reactions, Energy production in stars.

REFERENCES:
1. Nuclear Physics: Principle and Application by John Lilley (Wiley Pub.).
3. Nuclear Physics Experimental and Theoretical by H S Hans (New Age Int.).
4. Nuclear Radiation Detector by S S Kapoor and V S Ramamurthy (New Age Int.).
5. Introduction to Nuclear Physics by H.A. Enge (Addison-Wesley).
Note: Students are expected to perform at least ten experiment in each semester.

1. To study the characteristics of G.M. Counter.
2. To find the end point energy of given source using G.M. Counter.
3. To find the absorption coefficient of given material using G.M. counter.
4. To measure the Curie Temperature of a given ferroelectric material.
5. To measure the Curie Temperature of a given magnetic material.
6. To measure the thickness of hair and width of slit using He-Ne/Diode Lasers.
7. To measure the wavelength of He-Ne Laser using Transmission Grating.
8. To determine the wavelength of laser using Michelson Interferometer.
9. To study the hysteresis loss of the given sample by tracing B-H curve.
10. To study the working of DAC and measure resolution and setting time of DAC.
11. To study working of ADC and measure resolution and conversion time of ADC.
12. To measure (i) the frequency of an a.c. signal and (ii) the phase difference between the two voltages using CRO.
13. To design an (i) inverting amplifier and (ii) non-inverting amplifier, of a given gain using operational amplifier.
14. To study the characteristic of voltage doubler and voltage tripler.
M.Sc. Physics  
Semester-1st  
Computational Physics & Simulation  Laboratory

Paper No.-PHY-512B  
Credits: 02
04Hrs /week  
Max. Marks: 50+25
Total: 120 Hrs.  
Duration of Exam: 03 Hrs.

Note: Students are expected to perform at least five experiments out of following list.

1. To perform Numerical differentiation using Taylor series method.
2. To perform numerical differentiation using strilling formula.
3. To perform Numerical integration using the Simpson’s method.
4. To perform Numerical integration using the Trapezoidal method.
5. To perform numerical integration using Legendre-Gauss Quadrature.
6. To evaluate double integration numerically.
7. To find Solution of first order differential equations using the Runge-Kutta method.
8. To find the radial part of wave function of deuteron in its ground state using Runge-Kutta Method.
M.Sc. Physics
Semester-III

ELECTRO-DYNAMICS AND PLASMA PHYSICS

Paper No.-PHY-601 B
Credits: 04
04 Hrs /week
Max. Marks: 100+50
Total: 60 Hrs.
Duration of Exam: 03 Hrs.
Note: The Question Paper for end semester examination will consist of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT-I

TIME VARYING FIELDS & MAXWELL’S EQUATION
Energy stored in an electric and magnetic fields; Power flow in an electromagnetic field and Poynting’s theorem; Maxwell’s equations; The wave equation; Sinusoidal Waves; Electromagnetic waves, wave equations and their propagation in vacuum, linear dielectric medium and conductors, skin depth; Maxwell’s equations using phasor notation.

UNIT-II

ELECTROMAGNETIC WAVES
Reflection and refraction of plane waves: Boundary Conditions; Reflection by a perfect dielectric – normal and oblique incidence, Fresnel’s equations, Brewster’s angel; Reflection by a perfect conductor – normal incidence; Power loss in a plane conductor.

Polarization: Linear, elliptical and circular, Direction cosines.

Dispersion and Scattering: Coherent and Incoherent Scattered Light, Polarisation of scattered light. Dispersion in solids, liquids and gases.

UNIT -III

FIELDS AND RADIATIONS FROM MOVING CHARGE
Vector and Scalar Potential, Gauge transformation, Coulomb Gauge and Lorentz Gauge; Retarded Potential and Lienard-Wiechert Potential; Electric and Magnetic fields due to a uniformly moving point charge and an accelerated charge.

Power radiated by a point charge, Bremsstrahlung, Synchrotron radiation and Cerenkov radiation; Radiation reaction, Reaction Force of Radiation.

UNIT -IV

PLASMA PHYSICS AND WAVEGUIDES
Elementary Concepts: Plasma as fourth state of matter, Various kinds of Plasma, Debye Shielding, Plasma Parameters, Plasma Oscillations and plasma frequency expression, Fluid
equations, electron plasma wave, ion acoustic wave, Magnetoplasma and Plasma Confinement, applications of Plasma.

**EM Waves Guides:** Rectangular, Cylindrical, Parallel plane, Optical fiber & Dielectric slab wave guides; Lippman Fringes; TE, TM & TEM waves, TE waves in rectangular wave guide and concept of cut off frequency, Coaxial transmission line.

**TEXT AND REFERENCES BOOKS:**

1. Introduction to Electrodynamics: David J. Griffiths, (Prentice Hall India, New Delhi).
2. Keith W. Whites, EE 382.
5. Plasma Physics by Bittencourt
6. Introduction to Plasma Physics by F. F. Chen
7. Electromagnetic Waves by Jordan & Balme
M.Sc. Physics
Semester-III

QUANTUM MECHANICS - II

Paper No.-PHY-603 B Credits: 04
04 Hrs /week Max. Marks: 100+50
Total: 60 Hrs. Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions
from each unit. The candidates will attempt five questions selecting at least one question
from each unit. All questions will carry equal marks.

UNIT-I

WKB-APPROXIMATION AND TIME DEPENDENT PERTURBATION THEORY
WKB Approximation: WKB method for one-dimensional problems, Application to barrier
penetration, WKB method for three dimensional problems.
Time-dependent perturbation theory: General expression for the probability of transition from
one state to another, harmonic perturbation, Fermi’s golden rule, selection rule, adiabatic and
sudden approximations.

UNIT-II

COLLISION IN 3-D AND SCATTERING THEORY
Basic concept of scattering, Scattering cross-section, Scattering amplitude, scattering by
spherically symmetric potentials, partial wave analysis and phase shifts, scattering by a perfectly
rigid sphere and by square well potential. Born approximation and its applications to Yukawa
potential and other simple potentials. Electron scattering by an atom. Neumann equation and its
solution, Neumann series and Bessel function.

UNIT-III

IDENTICAL PARTICLES
Identical particles: Symmetric and antisymmetric wave functions, distinguishability of identical
particles, Pauli’s exclusion principle, connection with statistical mechanics, collisions of
identical particles. Spin angular momentum: connection between spin and statistics, spin
matrices and eigenfunctions. Spin functions for many electron system. Atomic levels of Helium
atoms as an example of two electron system.

UNIT-IV

RADIATION AND RELATIVISTIC QUANTUM MECHANICS
Semiclassical theory of radiation: Transition probability for absorption and induced emission,
electric dipole and forbidden transitions, selection rules.
Relativistic quantum mechanics: Klein – Gordon equation, Dirac equation and its plane wave
solutions.
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</tbody>
</table>
M.Sc. Physics  
Semester-III  
CRYSTALLOGRAPHY AND IMPERFACTIONS IN CRYSTALS

Paper No.-PHY-605 B  
04 Hrs /week  
Total: 60 Hrs.  
Credits: 04  
Max. Marks: 100+50  
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT - I  
CRYSTAL STRUCTURE:  

UNIT - II  
DIFFRACTION ANALYSIS:  
Interpretation of oscillation photograph, X-ray method of orienting crystals about a crystallographic direction, Bernal chart, Indexing of reflections, Burger’s precession method. Determination of relative structure amplitude from measured intensity (Lorentz and Polarization factors).

UNIT - III  
IMPERFECTION OF CRYSTALS:  
Point Defects (Schottkay and Frankel) and their thermodynamics, Color Centres F, M, R, V and H, Ploarons and Excitons, Edge dislocation and screw dislocation, Mechanism of plastic deformation, Stress and strain fields of screw and edge dislocation, Elastic energy of dislocations, Forces between dislocations, Stress needed to operate Frenkel-Read source, Dislocations in fcc, hcp and bcc lattices.

UNIT - IV  
DEFECT ANALYSIS:  
Partial dislocations and stacking faults in closed-packed structures. Experimental method of detecting dislocations and stacking faults in closed packed structures, Electron Microscopy: Kinematic theory of diffraction contrast and line imaging. Optical techniques for the observation of defects: Photoluminence (PL), Fourier Transform Infra Red (FTIR) and Raman spectroscopy.

REFERENCE BOOKS:  
M.Sc. Physics  
Semester-III  
CHARACTERIZATION OF MATERIALS

Paper No.-PHY-607 B  
Credits: 04

04 Hrs /week  
Max. Marks: 100+50

Total: 60 Hrs.  
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT-I  
STRUCTURAL ANALYSIS:  
X-ray characterization of imperfections in crystals, Basic concepts of small angle X-ray scattering and its application in evaluation of shape and size of surface particles. Neutron scattering and diffraction with reference to light elements and magnetic structures.

UNIT-II  
ELECTRON SPECTROSCOPY TECHNIQUES:  

UNIT-III  
OPTICAL SPECTROSCOPIC TECHNIQUES:  
Double Beam IR Spectrometers, Basic Concepts of Raman Spectrography in Solids, Sensitive Detectors such as CCD Camera, Concept of Space Group and Point Group, Identification and Analysis of Optic and Acoustic Modes in Solids. Electronic Absorption Study for Band Gap Determination.

UNIT-IV  
ANALYSIS OF TRACE ELEMENTS:  
Basic of nuclear magnetic resonance (NMR) and electronic spin resonance (ESR) spectroscopy, Mossbauer spectroscopy, Microwave spectroscopy, Photoacoustic spectroscopy and their applications. Laser as a source of radiation and its characteristics Laser fluorescence and absorption spectroscopy, Multiphoton ionization and separation of isotopes.

REFERENCE BOOKS:
2. Electron Microprobe Analysis: S.J.B. Reed.
3. Topics in Applied Physics, Vol. 4: R. Gomer (ed.).
   4. Analysis of high Temperature Materials: Van Der Biest (ed.)
M.Sc. Physics  
Semester-III 
ANALOG COMMUNICATION

Paper No.-PHY-609 B  
Credits: 04

04 Hrs/week  
Max. Marks: 100+50

Total: 60 Hrs.  
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consist of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT -I

MICROWAVE ELECTRONICS
Microwave characteristic features & applications, Wave guide and cavity resonators, Two cavities Klystron, Reflex Klystron, Gunn diode characteristics, microwave antenna, Detection of microwave, Dielectric constant measurement, Isolator and circulator, PIN diode modulator, Directional coupler, Avalanche Transist Time Devices: IMPATT Diode-Physical structure, Principle of operation, breakdown voltage, Avalanche and Drift region, Transferred Electron devices.

UNIT -II

RADAR COMMUNICATION
Basic Radar systems, Radar range equation and performance factor, Radar Cross-section, Pulsed Radar system, Duplexer, Radar display, Doppler Radar, CWIF Radar, FMCW Radar, Moving Target Indicator (MTI), Blind Speeds.

UNIT -III

ANALOG SIGNAL TRANSMISSION
Introduction, Amplitude, Frequency & phase modulation; AM, FM modulating and demodulating circuits; AM, FM Receivers functioning (Block Diagram) and characteristic features; Pulse modulation; Sampling Processes, PAM, PWM and PPM modulation and demodulation, Quantization noise, PCM, Differential PCM and Delta modulation systems, Comparison of PCM and PDM, Time division multiplexing.

Data interpretation and analysis: Precision and accuracy, Error analysis, Propagation of errors, Least square fitting, Linear and non-linear curve fitting, Chi-Square test.

UNIT -IV

SATELLITE COMMUNICATION
TEXT & REFERENCE BOOKS:
2. Electronic Communication : Roddy and Coolen.
5. Satellite Communication : Pratt and Bosterin.
M.Sc. Physics  
III Semester  

DIGITAL COMMUNICATION  

Paper No.-PHY-611 B  
Credits: 04  
04 Hrs /week  
Max. Marks: 100+50  
Total: 60 Hrs.  
Duration of Exam: 03 Hrs.  

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT -I  

SIGNALS, SYSTEMS AND NOISE  
Elements of communication systems, Fourier representation of periodic and non-periodic signals, Power spectral density, Impulse and step response of systems, Time and frequency domain analysis of systems, Ideal and Real filters, Noise in communication systems, Representation of narrow band noise, Signal to noise ratio, Noise equivalent band width and Noise figure.

UNIT -II  

INFORMATION THEORY AND CODING  
Introduction, Amount of information, Average information, Shannon’s encoding algorithm, Communication channels, Rate of information and capacity of discrete memory less channels, Shannon-Hartley theorem. Linear block cyclic codes and Convolutions codes.

UNIT -III  

DIGITAL SIGNAL (DATA) TRANSMISSION  
Introduction, Base band and pass band data transmission; Base band binary PAM system, Optimum receiver for binary digital modulation Schemes, Binary ASK, FSK, PSK and differential PSK signalling Schemes, Brief idea M-array signalling Schemes, Serial data Communication in Computers, USART 8251, MODEM.

UNIT -IV  

FIBRE OPTIC COMMUNICATION  
Basic optical communication system, wave propagation in optical fibre media, step and graded index fiber, Material dispersion and mode propagation, losses in fibre, optical fibre source and detector, optical joints and coupler, Digital optical fibre communication system, First/Second generation system, Data communication network.

TEXT & REFERENCE BOOKS:  
NUCLEAR REACTIONS

UNIT-I
Qualitative features and phenomenological potentials, Charge symmetry and charge independence of nuclear forces. Exchange forces, Generalized Pauli exclusion principle, Meson theory of nuclear forces, Relationship between the range of the force and mass of the mediating particle.
Type of nuclear reactions, Q-value of nuclear reactions and its determination. Invariance in nuclear reactions. Basic concepts of cross section: Total cross section, Partial cross section, differential cross section. Cross section in terms of partial wave analysis.

UNIT-II
Physical properties of deuteron: Mass, binding energy, spin or total angular momentum, parity, magnetic moment and electric quadrupole moment. Ground state of deuteron (square well potential), Range depth relationship for square well potential. Neutron-proton scattering at low energy, Concept of scattering length and significance of its sign. Spin dependence of neutron-proton scattering, Effective range theory of neutron-proton scattering.

UNIT-III
Nuclear reactions and cross sections, Breit-Wigner dispersion formula for s-wave neutrons of low energy, The compound nucleus, Continuum theory of cross section for the formation of compound nucleus, Statistical theory of nuclear reactions.
Form of the optical potential: Square well, Woods-Saxon and spin dependent optical potential. Elastic scattering and reaction cross section with optical model.

UNIT-IV
Kapur-Feierls dispersion formula for potential scattering, Limitations of the optical model. Stripping and pick-up reactions. General theory of striping and pick-up reactions, Born approximation or Butler theory of direct reactions.
REFERENCES:

1. Nuclear Physics: Principle and Application by John Lilley (Wiley Pub.).
3. Nuclear Physics: Theory and Experiment by R R Roy and B P Nigam (New Age Int.)
4. Nuclear Physics Experimental and Theoretical by H S Hans (New Age Int.).
M.Sc. Physics  
Semester-III  

NUCLEAR DETECTORS  

Paper No.-PHY-615 B  
04 Hrs /week  
Total: 60 Hrs.  
Credits: 04  
Max. Marks: 100+50  
Duration of Exam: 03 Hrs.  

Note: The Question Paper for end semester examination will consist of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.  

UNIT-I  

UNIT-II  
Features of Gas Ionization Detectors: Mobility of charge(ions and electrons) carriers, Electron attachment and recombination, Gas multiplication and modes of operation of gas detectors.  
Pulse-mode operated ionization chambers: Pulse formation in a parallel plate ionization chamber, Gridded ionization chambers and measurements of energy of heavily ionizing particles.  
Geiger-Muller Counters: The Geiger discharge, Development of pulse and quenching, Dead time, Geiger plateau, Counting efficiency.  

UNIT-III  
Interaction of heavy charged particles, electrons and photons with silicon and germanium. Production of electron-hole pairs. Semiconductor properties, Detector medium requirement and role of p-n junction, Working of p-n junction detector, Partially and totally depleted detectors, Charge collection and pulse shape. Diffused junction silicon detectors, Surface barrier detectors, Lithium-Drifted silicon detectors, Si(Li)., Lithium-Drifted Germanium detectors, Ge(Li).  

UNIT-IV  
Scintillation mechanism and classification of scintillation materials: Mechanism of scintillations in inorganic crystal scintillators, Mechanism of scintillations in organic crystal scintillators, Scintillation response, Time characteristics of scintillator output, Nobel gas scintillators, Detection efficiency of scintillation detectors, Energy resolution of scintillation detectors.  
REFERENCES:
1. Nuclear Radiation Detector by S S Kapoor and V S Ramamurthy (New Age Int.).
2. Techniques for Nuclear and Particle Physics Experiments by W R Leo (Springer-Verlag)
3. Nuclear Radiation Detection, Measurements and Analysis by K Muraleedhara Varier (Narosa)

M.Sc. Physics
Semester-IV
Condensed Matter Physics Lab-II

Paper No.-621 B
12 Hrs /week
Total: 180 Hrs.

Credits: 06
Max. Marks: 100+50
Duration of Exam: 03 Hrs.

Note: Students will be required to perform at least eight experiments in a semester.
1. Measurement of lattice parameter and indexing of powder photograph.
2. Identification of unknown sample using powder diffraction method.
3. To study the ferroelectric transitions in TGS crystal and measurement of Curie temperature.
4. To measure the superconductivity transition temperature and transition width of a high temperature superconductor.
5. Rotation/oscillation photograph and their interpretation.
6. To study the modulus of rigidity and internal friction in a metal as a functioning temperature.
7. To measure the cleavage step height of a crystal by multiple Fizeau Fringes.
8. To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
9. To find the ‘g’ factor of DPPH using electron spin resonance.
10. Determination of carrier concentration by optical method.
11. To study electric properties of thin films of metals & oxides.
13. To measure the superconductivity transition temperature and transition width of a high temperature superconductor.
LIST OF EXPERIMENTS

Note: Students are expected to perform at least ten experiments out of following list.

1. To study a 650nm fiber optic link for both analog signal and digital signal and also to observe the relationship between the input and received signal.
2. To obtain the intensity modulation of given sinusoidal optical fiber signal.
3. To obtain the intensity modulation of given digital optical fiber signal.
4. To measure numerical apertutre, propagation loss, bending loss and connector loss in optical fibre.
5. Study of the low pass, high pass and band pass filters using the passive elements and active elements.
6. (i) To study the power dissipation in the SSB and DSB side bands of AM wave. To Study the demodulation of AM wave. (ii) To study various aspects of frequency modulation and demodulation.
7. Design of Regulated power supply and study of its characteristics.
8. To study various displays and drivers on a bread-board – Assembling circuits on breadboard.
9. To study the effect of noise on various analog system, calculate signal to noise ratio, noise figure, noise power and noise power spectral density.
10. Microwave characteristics and measurements.
12. To study the characteristic, propagation modes, wavelength and phase velocity in a wave guide.
13. PLL characteristics and its applications.
14. PAM, PWM and PPM Modulation and demodulation.
Note: Students are expected to perform all these experiments.

1. To verify the inverse square law using gamma rays.
2. To estimate the efficiency of GM detector for (a) gamma source (b) beta source
3. To find the Linear & mass attenuation coefficient using gamma source.
4. To study the Solid State Nuclear Track Detector.
5. To determine the mass absorption coefficient for beta rays.
6. To study the counting statistics for radioactive decay using SSNTD.
7. To determine the operating voltage of a photomultiplier tube.
8. To find the photopeak efficiency of a NaI(Tl) crystal of a given dimensions for gamma rays of different energies.
M.Sc. Physics  
Semester-IV  
Electronics Laboratory-II

Paper No.-626B
06 Hrs/week
Total: 90 Hrs.

Credits: 06
Max. Marks: 100+50
Duration of Exam: 03 Hrs.

Note: Students are expected to perform at least ten experiments out of following list.

1. To study the magnetostriction property of the magnetic material.
2. To study the Electrical properties of the developed materials as a function of doping material.
3. To Study the variation of electrical/dielectric properties of different materials as a function of temperature.
4. To study the piezo-electric effect in materials.
5. To determine Hall Voltage, concentration of charge carrier and the type of semiconductor in the Hall effect experiment.
6. Design of a waveform generator using Comparator IC and study its characteristics.
7. D/A converter interfacing and frequency/temperature measurement with microprocessor 8085 / 8086
9. PPI 8251 interfacing with microprocessor for serial communication.
10. To setup logic conditions for the input and the output at the data bus port of BBC microcomputer.
11. To calibrate ADC of the BBC microcomputer.
12. Microprocessor kit: (a) hardware familiarization (b) programming for (i) addition and subtraction of numbers using direct and indirect addressing modes (ii) Handling of 16 bit numbers (iii) use of CALL and RETURN instructions and block data handling.
13. (a) Selection of port for I & O and generation of different waveforms (b) control of stepper motor.
14. Microcontroller kit: hardware familiarization of C and universal programmer and programming for four digit seven segment multiplexed upcounter upto 9999.
15. (a) EEPROM based 8 to 3 encoder using microcontroller (b) interfacing with ADC (temperature sensor) and DAC (variable voltage source).
STATISTICAL MECHANICS

UNIT - I
STATISTICAL BASIS OF THERMODYNAMICS
The microscopic and macroscopic states, Concept of equal a priori probability, contact between statistics and thermodynamics, classical ideal gas, Entropy of Mixing, Gibbs paradox and its solution, Phase space and Liouville's theorem, Ensemble and Ensemble average.

UNIT - II
ENSEMBLE THEORY
The microcanonical ensemble theory and its application to ideal gas of monatomic particles; canonical ensemble and its thermodynamics, partition function; classical ideal gas in canonical ensemble theory, energy fluctuations; equipartition and Virial theorems, a system of quantum harmonic oscillators as canonical ensemble; Statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory; density and energy fluctuations.

UNIT - III
QUANTUM STATISTICS OF IDEAL SYSTEMS
Quantum states and phase space; an ideal gas in quantum mechanical ensembles, Ideal Bose system, basic concepts and thermodynamic behaviour of an ideal Bose gas; Bose-Einstein condensation; gas of photons (the radiation fields) and gas of phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures; Pauli parameters, Boltzmann H-Theorem.

UNIT - IV
ELEMENTS OF PHASE TRANSITIONS & FLUCTATIONS
Introduction, a dynamical model of phase transitions, Critical indices, Ising model, Thermodynamic fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation.
REFERENCES:

M.Sc. Physics  
Semester-IV  

ADVANCE QUANTUM MECHANICS & ELEMENTS OF PARTICLE PHYSICS  

Paper No.-PHY-604 B  
Credits: 04  
04 Hrs /week  
Max. Marks: 100+50  
Total: 60 Hrs.  
Duration of Exam: 03 Hrs.  

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.  

UNIT - I  

UNIT - II  
Lagrangian field theory, Canonical Quantization, Classical field equation in terms of Lagrangian density and Hamiltonian formalism of a classical field, Quantization of field, Concept of second quantization and illustration with schrodinger field(Non-Relativistic field).  

UNIT - III  
Relativistic fields: Klein-Gorden field(Scalar field), Dirac(spinor) field and electromagnetic field. S-matrix, Feynman rules, Feynman diagrams for scattering of an electron by a potential, scattering of a photon by an electron, electron-electron scattering, electron-proton scattering, positron-positron scattering, pair creation, pair annihilation, Compton scattering by electrons.  

UNIT - IV  

REFERENCES:  
1. Quantum Mechanics by V.K. Thankappan (New Age Int.)  
6. Introduction to particle physics by M.P. Khanna (PHI).
M.Sc. Physics
Semester-IV

RENEWABLE ENERGY SOURCES

Paper No.-PHY-606 B
Credits: 04

04 Hrs /week
Max. Marks: 100+50
Total: 60 Hrs.
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT-I
SOLAR ENERGY: FUNDAMENTAL AND MATERIAL ASPECTS

UNIT-II
SOLAR ENERGY: DIFFERENT TYPES OF SOLAR CELLS

UNIT-III
HYDROGEN ENERGY: FUNDAMENTALS, PRODUCTION AND STORAGE

UNIT-IV
HYDROGEN ENERGY: SAFETY AND UTILIZATION
Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Various types of Fuel Cells, Applications of Fuel Cell, Elementary concepts of other Hydrogen- Based devices such as Hydride Batteries.
REFERENCE BOOKS:

1. Solar Cell Devices- Physics: Fonash
3. Phoptoelectrochemical Solar Cells: S.Chandra
5. Hydrogen as a Future Energy Carrier: Andreas Zuttel, Andreas Borgschulte and Louis Schlapbach
M.Sc. Physics
Semester-IV

NANO SCIENCE & TECHNOLOGY

Paper No.-PHY-608 B Credits: 04
04 Hrs /week Max. Marks: 100+50
Total: 60 Hrs. Duration of Exam: 03 Hrs.
Note: The Question Paper for end semester examination will consists of two questions
from each unit. The candidates will attempt five questions selecting at least one question
from each unit. All questions will carry equal marks.

Unit-I

Physics of Nanomaterials
Definition of nanotechnology, Nanomaterials, Novel combination of properties of materials of
nanoscale, Device miniaturization, Functional enhancement.
Nanoparticles as superatoms, Size dependence of melting point, vapour pressure, Nucleation,
Chemical reactivity, Intermolecular interactions, Surface tension of solid surfaces, Wetting
dewetting of rough and chemically inhomogeneous surfaces.
Quantum confinement & energy levels, Band structure, Density of states in 0D, 1D, 2D & 3D
materials, Quantum dots, wires, & wells, Parabolic, triangular, cylindrical & spherical wells,
Quantum corral, Band gap engineering, Heterostructures & superlattices, 2D electron gas,
Effective mass in heterostructures.

Unit-II

Nanofabrication Techniques
Nanoparticles- comminution & dispersion, Nucleation & growth, Ultrathin coatings, Molecular
beam epitaxy Atomic layer deposition, Self assembly of monolayers, Langmuir Blodgett films,
Thermodynamics of self organization, Crystallization and supramolecular interactions.
Top down and bottom up approaches to nanofabrication, Optical & electron beam lithography,
Dip pen lithography, Focussed ion beam technique, Thin films deposition, Evaporation,
Sputtering, Electrodeposition and sol Gel Tech, Plasma assisted chemical vapour deposition.

Unit-III

Characterization of Nanomaterials
Contact & Non contact methods of surface characterization, AFM, STM and Near field
microscopy, Ellipsometry, Surface plasma resonance techniques, Electron spectroscopy
techniques – AES, XPS, SIMS
Unit-IV

Nanomaterials & Devices
Carbon based nanomaterials, carbon nanotubes, Fullerens, Graphene, Metal matrix composites, Polymers- electroactive material blends, Semiconductor Nanoparticles, Nanowires, Nanoribbon and nanospring..

Issues of miniaturization, Digital information processing, Quantum computing, Ballistic transport, Coulomb blockade, Single electron devices, Molecular electronic devices, Coupled quantum dots, Spintronics, Ultra-sensitive magnetic sensors, Spin dependent transistors, Photonic devices, Mechanical and Fluidic devices, Chemical and bio-chemical sensors, energy conversion devices.

List of Books on Nanotechnology

1. The Physics of Low Dimensional Semiconductors—John H. Davies – Cambridge University Press


M.Sc. Physics
Semester-IV

NOVEL AND SMART MATERIALS

Paper No.-PHY-610 B
Credits: 04
04 Hrs /week
Max. Marks: 100+50
Total: 60 Hrs.
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT -I
PHYSICAL MECHANISM IN ELECTRONIC MATERIALS
Crystal Structures of Electronic materials (Elemental, III-IV and VI semiconductors), Energy band consideration in solids in relation to semiconductors, Direct and Indirect bands in Semiconductor, Electron/Hole concentration and Fermi energy in Intrinsic/Extrinsic semiconductor, continuity equation, Carrier mobility in Semiconductors, Carrier Trapping and recombination/generation in semiconductors, Shockley theory of recombination, Switching in electronic devices, Defect related electronics states characterization by C-V characteristics of electronic junction devices, temperature stimulated current and capacitance (TSC/TSCAP), Deep level transient spectroscopy (DTLS), Electron Beam Induced Current (EBIC) and Light Beam Induced Current (LBIC).

UNIT -II
INTEGRATED CIRCUIT FABRICATION
Introduction to IC technology, Basic monolithic integrated circuit epitaxial growth, diffusion of impurities, masking and etching, Fabrication of monolithic IC’s, Active and Passive components, advantages of IC’s, MSI, LSI , Application of IC, Optical & Photon Lithography and Clean Room Specification.

UNIT -III
SUPERIONIC CONDUCTORS
Introduction, Types of ionic solids, Superionic materials, Classification of superionic materials, Alkali metal ion conductors, silver ion conductors, Copper ion conductors, proton conductors, B-alumina composite electrolytes, ion conducting glasses and polymers. Basic concepts: jump mechanisms, ionic conductivity and diffusion coefficient. Defect concentration in pure crystals and doped crystals, impurity – vacancy association, Application of superionic conductors on solid state batteries, fuel cells, electrochromic display devices and gas sensors.

UNIT -IV
ENGINEERING MAGNETIC MATERIALS
Hard and soft Magnetic materials, ferrites, Rare earth compounds and bonded magnets. Materials for antenna, inductor and transformer cores. Magnetic recording fundamentals. Particulate and thin film

**TEXT AND REFERENCES BOOKS:**

1. Physics of Semiconductor Devices : S.M. Sze
2. Semiconductor Devices Basic Principles : Jaspreet Singh
4. Metal/Semiconductor Contact : Rhoderick
M.Sc. Physics
Semester-IV
MICROPROCESSOR AND INTERFACING

Paper No.-PHY-612 B
Credtis: 04
04 Hrs/week
Max. Marks: 100+50
Total: 60 Hrs.
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consist of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT -I

MICROPROCESSOR 8085
Introduction, Buffer registers, Bus organised computers, SAP-I, Microprocessor (μP) 8085 Architecture, memory interfacing, interfacing I/O devices. Assembly language programming: Instruction classification, addressing modes, op code and operand, fetch and execute cycle, timing diagram, machine cycle, instruction cycle and T states, Data transfer, Logic and Branch operations- Programming examples.

UNIT -II

MICROPROCESSOR 8086
Architecture, Pin description for minimum and maximum modes, Internal operation, Instruction execution timing diagram, Addressing modes, Instruction format for constructing machine, language codes for different instructions. Introduction to assembly language, Instruction set and directives, Stacks, Procedures, Macros and interrupts. Flow chart of standard programming structures, I/O interfacing and data transfer scheme.

UNIT -III

ADVANCED MICROPROCESSOR
Multitasking, Architecture and memory management of microprocessor 80286, Brief idea about architecture of microprocessor 80386, 80486 and Pentium, Introduction to microcontroller.

UNIT -IV

MICROPROCESSOR BASED MEASUREMENT/CONTROL CIRCUITS
Transducer, D/A and A/D Converters, PPI 8255 Data Acquisition and storage, Microprocessor based traffic light controller, Temperature and water level indicator/controller. DC and stepper motor speed measurements, Waveform generation and frequency measurement.

TEXT & REFERENCE BOOKS:
1. Fundamentals of Microprocessor and Microcomputer : B. Ram.
5. Microprocessor and Interfacing : D.V. Hall.
M.Sc. Physics  
Semester-IV

NUCLEAR MODELS

Paper No.-PHY-614 B  
Credits: 04  
04 Hrs /week  
Total: 60 Hrs.  
Max. Marks: 100+50  
Duration of Exam: 03 Hrs.

Note: The Question Paper for end semester examination will consists of two questions from each unit. The candidates will attempt five questions selecting at least one question from each unit. All questions will carry equal marks.

UNIT-I

Semi-empirical mass formula, Potential energy, Kinetic energy, Coulomb energy, Pairing energy, Shell effect. Nuclear fission, Spontaneous nuclear fission, Bohr and Wheeler theory of nuclear fission. Quantum treatment of nuclear fission or Barrier Penetration for fission. Statistical model of nuclear fission. Concept of photofission.

UNIT-II


UNIT-III

Need of introducing spin-orbit coupling to reproduce the magic numbers, Extreme single particle shell model and its predictions regarding ground state spin parity, magnetic moment and electric quadrupole moments, Schmidt lines, Nordheim’s rule for total angular momenta, Single particle model, Configuration mixing. Individual (independent) particle model.

UNIT-IV

Qualitative feature of collective model, Rotational mode, Rotational energy spectra and the nuclear wave function for even-even and odd-A nuclei. Vibrational mode, Potential energy and total Hamiltonian in vibration mode.

REFERENCES:

1. Theory of Nuclear Structure by M. K. Pal
2. Nuclear Physics: Theory and Experiment by R R Roy and B P Nigam (New Age Int.)
3. Nuclear Physics Experimental and Theoretical by H S Hans (New Age Int.).
5. Nuclear Structure Vol. 1& 2 by Aage Bohr and Ben R Mottelson (world Scientific)
NUCLEAR TECHNIQUES

UNIT-I

UNIT-II
Electrostatic and Heavy Ion Accelerators: Van de Graaff voltage generator, Cockcroft-Walton voltage generator, insulating column, voltage measurement, Acceleration of heavy ions, Tandem electrostatic accelerator, Production of heavy negative ions, Pelletron and Tandetron, Cluster beams, Superconducting Heavy Ion Linear Accelerators.

UNIT-III
Time of flight technique (TOF), Recoil distance measurement and concept of pulse shape discrimination. Data acquisition system (DAS),
Importance of coincidence techniques. Bothe type (series type) coincidence circuit, Rossi type (parallel type) coincidence circuit, Application of coincidence circuits: Slow-fast coincidence set up, Sum coincidence unit, Anti Compton gamma ray spectroscopy, Time to pulse height convertors (THPC) or time to amplitude convertors (TAC), Concept of time delays in timing channel. Basic idea of determination of half lives of nuclei.

UNIT-IV
Radiation applications and Protection: Dosimetric Units: The Roentgen, Absorbed dose, Relative Biological effectiveness (RBE), Equivalent dose, Effective Dose, Typical doses from sources (Natural, Environmental & Medical exposures), Radiation shielding and its safety (Gamma-rays, electrons, positrons, charged particles, Neutrons)
Radioisotopes, Practical uses of radioisotopes, Radioactive waste disposal applications of radioisotopes dating of archeological and other ancient object, Medical uses of radioisotopes and electron beams, radiotherapy, Carbon-14 and potassium-argon dating 39,40 method trace element studies.
REFERENCES:

1. Nuclear Radiation Detector by S S Kapoor and V S Ramamurthy (New Age Int.).
2. Techniques for Nuclear and Particle Physics Experiments by W R Leo (Springer-Verlag)
3. Nuclear Radiation Detection, Measurements and Analysis by K Muraleedhara Varier (Narosa)
M.Sc. Physics  
Semester-IV  
Condensed Matter Physics Lab-II

Paper No.: 622 B  
Credits: 04  
8 Hrs/week  
Max. Marks: 100+50  
Total: 180 Hrs.  
Duration of Exam: 03 Hrs.

Note: Students will be required to perform at least seven experiments in a semester.

1. Study of hysteresis loop of ferroelectric ceramics at different temperature & determination of phase transition.
2. Synthesis of nano-ferrites by chemical co-precipitation method.
4. Study of crystalline properties of materials using XRD
5. Thermo luminescence
6. Study of a sample using FTIR technique
7. Intensity measurement using UV Spectrum study
8. To determine the lattice constant of LIF crystal using X ray diffraction
9. Study of magneto resistance effect in metallic, semiconductor and amorphous sample
10. Study of Dielectric constant & curie temperature of ferroelectric ceramics.
11. Study of Thermo luminescence of F centres in all alkali Halides crystals/glasses.
LIST OF EXPERIMENTS

Note: Students will be required to perform at least eight experiments in a semester.

1. To study the magnetostriction property of the magnetic material.
2. To study the Electrical properties of the developed materials as a function of doping material.
3. To Study the variation of electrical/dielectric properties of different materials as a function of temperature.
4. To study the piezo-electric effect in materials.
5. To determine Hall Voltage, concentration of charge carrier and the type of semiconductor in the Hall effect experiment.
6. Design of a waveform generator using Comparator IC and study its characteristics.
7. D/A converter interfacing and frequency/temperature measurement with microprocessor 8085 / 8086
9. PPI 8251 interfacing with microprocessor for serial communication.
10. To setup logic conditions for the input and the output at the data bus port of BBC microcomputer.
11. To calibrate ADC of the BBC microcomputer.
12. Microprocessor kit: (a) hardware familiarization (b) programming for (i) addition and subtraction of numbers using direct and indirect addressing modes (ii) Handling of 16 bit numbers (iii) use of CALL and RETURN instructions and block data handling.
13. (a) Selection of port for I & O and generation of different waveforms (b) control of stepper motor.
14. Microcontroller kit: hardware familiarization of C and universal programmer and programming for four digit seven segment multiplexed upcounter upto 9999.
15. (a) EEPROM based 8 to 3 encoder using microcontroller (b) interfacing with ADC (temperature sensor) and DAC (variable voltage source).
Note: Students are expected to perform all these experiments.

1. To determine the range and energy of alpha particles using spark counter
2. To study Compton Scattering.
3. To study the Rutherford scattering.
4. To study Poisson and Gaussian distributions using a GM Counter.
5. To calibrate a gamma ray spectrometer and to determine the energy of a given gamma ray source.
6. To determine the beta ray spectrum of beta source (like Cs-137) and to calculate the binding energy of K-shell electron of given source.
7. To study the various modes in a multichannel analyser and to calculate the energy resolution, energy of gamma ray.
**Item No. :2** To consider and approve changes in the topic of Ph. D. candidates admitted in the Department of Physics during the session 2009-10.

**Note :**

During the comprehensive evaluation, the DRC in Physics considered and approved the minor changes in the topic of research of the candidates listed below. The PGBOS & Research in Physics in its meeting held on 28.4.12 approved the decision of DRC.

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Name</th>
<th>Existing Topic</th>
<th>Revised Topic</th>
<th>Name of supervisor/Co-supervisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Neetu Singh</td>
<td>A Study of physical technique, lithography used for fabrication and detection of nanostructure.</td>
<td>Modeling &amp; simulation of Bio-Nanomaterials using non-equilibrium green function approach</td>
<td>Prof. B.P. Malik/ Dr.V.K.Lamba</td>
</tr>
<tr>
<td>2.</td>
<td>Dinesh Kumar</td>
<td>Energy storage in PV system and PV design</td>
<td>Electric and thermal study of metal/CNT nanocomposites</td>
<td>Prof. S.K. Singh/ Dr. Vimal Kumar</td>
</tr>
</tbody>
</table>

The matter is placed before the Academic Council for consideration and approval.
Item No. 3  During the comprehensive evaluation based on the clearance of course work, the report of the PGBOS & Research in Physics is hereby put up before the Academic council for consideration and approval of the candidates for registration in Ph.D. course 2010-11 (photocopy of recommendation PGBOS & Research in Physics is attached). The list of successful students for Ph.D registration is as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Roll No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amarjeet</td>
<td>11001951001</td>
</tr>
<tr>
<td>Heena Dhanopia</td>
<td>11001951003</td>
</tr>
<tr>
<td>Naveen Kumari</td>
<td>11001951005</td>
</tr>
<tr>
<td>Preeti</td>
<td>11001951006</td>
</tr>
</tbody>
</table>