FACULTY OF SCIENCES

SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

Programme Code: MPHY

Programme Name: M.Sc. (Physics)

(Semester I-II)

Examinations: 2023-24

Department of Physics

Khalsa College, Amritsar

(An Autonomous College)

(b) Subject to change in the syllabi at any time.
(c) Please visit the college website time to time.

S.No.	PROGRAMME OBJECTIVES
1.	To prepare students to take up challenges as globally competitive physicists/researchers in diverse areas of theoretical and experimental physics.
2.	To impart quality education in physics to students through well designed courses of fundamental interest and of technological importance.
3.	To develop abilities and skills that encourages research and development activities and is useful in everyday life.
4.	To make the students technically and analytically skilled.
5.	To provide opportunity of pursuing high end research as seminar and assignment work.
6.	To prepare them to take up higher studies of interdisciplinary nature.

S.NO.	PROGRAMME SPECIFIC OUTCOMES (PSOs)
PSO-1	To train students in such a way that they can objectively carry out investigations, scientific and/or otherwise, without being biased or without having any preconceived notions.
PSO-2	As technology exploits the rules of Physics, students properly trained in Physics can be good researchers in the field of technology too.
PSO-3	To understand the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, electrodynamics and electronics to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws.
PSO-4	To apply advanced theoretical and/or experimental methods, including the use of numerical methods and simulations.
PSO-5	To get some research oriented experience by doing theoretical and experimental projects in the last semester under the supervision of faculty.
PSO-6	Students may get opportunities in higher education, research organizations, radiology and radiation oncology. Students can start their career in BARC, DRDO, IPR, ONGC etc.

ELIGIBILITY:

The candidate having passed B.Sc. Degree (10+2+3 system of education) (with Physics, Chemistry and Mathematics) or (Physics, Mathematics and Computer Sciences) or (Physics, Mathematics and Electronics) or who has studied Physics as compulsory subject in all the three years of the B.Sc. Degree class with at least 50% marks from Guru Nanak Dev University or any other equivalent examination from UGC recognized University/college.

COURSE DURATION:

The duration of the course is two years.

COURSE SCHEME												
SEMESTER-I												
Course Code	**Course Title**	**Teaching Hours/ Week**	**Credits**			**Total Credits**	**Max. Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total Marks**	
PHY-411	Electronics	4	3	1	0	4	75		25	100	4-5
PHY-412	Mathematical Physics	4	3	1	0	4	75		25	100	6-7
PHY-413	Classical Mechanics	4	3	1	0	4	75		25	100	8-9
PHY-414	Computational Physics	4	3	1	0	4	75		25	100	10-11
PHY-415	Electronics Lab	6	0	0	3	3		75	25	100	12-13
PHY-416	Computer Lab	6	0	0	3	3		75	25	100	14-15
PHY-417	Research Methodology-I	2	2	0	0	2	37	0	13	50	16-17
						24				650	

SEMESTER-II												
Course Code	**Course Title**	**Teaching Hours/ Week**	**Credits**			**Total Credits**	**Max. Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total Marks**	
PHY-421	Quantum Mechanics-I	4	3	1	0	4	75		25	100	18-19
PHY-422	Electrodynamics-I	4	3	1	0	4	75		25	100	20-21
PHY-423	Condensed Matter Physics-I	4	3	1	0	4	75		25	100	22-23
PHY-424	Atomic & Molecular Spectroscopy	4	3	1	0	4	75		25	100	24-25
PHY-425	Condensed Matter Lab-I	6	0	0	3	3		75	25	100	26-27
PHY-426	Spectroscopy Lab	6	0	0	3	3		75	25	100	28-29
PHY-427	Research Methodology-II	2	2	0	0	2	37	0	13	50	30-31
						24				650	

M.Sc. Physics Semester-I
PHY-411
ELECTRONICS

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60
Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The objective of this course is to impart knowledge about a variety of electronic devices, their structure and the underlying physical principles, understand the basics of Digital Electronics, design and construction of the basic and universal logic gates, study and construction of sequential logic circuits, understanding various designs of flip flops, shift registers, counters and various memory devices.

Course Contents:

UNIT-I

Electronic Devices: **Semiconductor Materials: Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors, MOSFETs: Types of MOSFETs, Circuit operation of Depletion type and Enhancement type MOSFETs,** Uni junction transistor (UJT), four layer (PNPN) devices, construction and working of PNPN diode, Semiconductor controlled rectifier (SCR) and Thyristor. **Structure and working of DIAC and TRIAC,** Gunn diode, Gunn Effect, two valley model.

Hours 15

UNIT-II

Electronic Circuits: Multivibrators (Bistable Monostable and Astable), Differential amplifier, Operational amplifier (OP-AMP) Ideal, Internal circuit & Practical, **Parameters of OP-AMP due to mismatch of transistors, Input Bias Current, Open loop Op-AMP, Difference and Common mode gain, Common Mode Rejection Ratio, Output voltage from OP-AMP, OP-AMP with negative feedback.** OP-AMP as inverting and non-inverting, instrumentation amplifier, summer, integrator, differentiator, logarithmic amplifier.

Hours 15

UNIT-III

Digital Principles: Binary and Hexadecimal number system, Binary arithmetic, **The transistor as a switch, OR, AND and NOT gates, NOR and NAND gates, Boolean algebra, Demorgan's theorems, Exclusive OR gate,** Boolean equation of logic circuits, Karnaugh map simplifications for digital circuit analysis, and design, Encoders & Decoders, Multiplexers and Demultiplexers, Parity generators and checkers, Adder-Subractor circuits.

Hours 15

UNIT-IV

Sequential Circuits: **The RS Flip – Flop, D Flip - Flop, JK Flip-Flop, JK Master Slave Flip - Flop, T Flip - Flop, Shift Register and its types,** Up/Down counters, Basics of semiconductor memories: ROM, PROM, EPROM, and RAM,D/A conversion using binary weighted resistor network, Ladder, D/A converter, A/D converter using counter, Successive approximation A/D converter. **Hours 15**

Books Prescribed:

1. Electronic Devices and Circuits- Millman and Halkias-Tata McGraw Hill, 1983.
2. Solid State Electronic Devices - Ben G Streetman-Prentice Hall, New Delhi, 1995.
3. Digital Principles and Applications- A.P.Malvino and D.P.Leach-Tata McGraw Hill, New Delhi, 1986.
4. Digital Computer Electronics- A P Malvino-Tata McGraw Hill, New Delhi, 1986
5. Microelectronics – Millman-Tata McGraw Hill, London, 1979.
6. Digital Electronics - W.H. Gothmann-Prentice Hall, New Delhi, 1975.
7. Microwave Devices and Circuits-Samuel Y Liao-PHI,1991
8. Principles of Electronics-V.K. Mehta, Rohit Mehta-S. Chand Publications.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Use techniques for analyzing analogue and digital electronic circuits
CO2	Formulate the concepts of operational amplifier and learn about basic operational amplifier characteristics, OPAMP parameters, applications as inverter, integrator, differentiator etc
CO3	Identify the major properties, types and applications of MOSFET, UJT, SCR and Multivibrators.
CO4	Learn digital electronics basics using logic gates and working of major digital devices like flip flops etc
CO5	Learn about Karnaugh maps, Flip Flops and counters in detail.

M.Sc. Physics Semester-I
PHY-412
MATHEMATICAL PHYSICS

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60

Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The objective of this course is to introduce the students to methods of mathematical physics and develop required mathematical skills to solve problems in quantum mechanics, electrodynamics and other fields of physics. It includes Fourier Series and transformations, Curvilinear coordinates, Basics of Tensors, Group Theory, Second order differential Equations, Special functions, Function of Complex variable and Calculus of residues etc.

Course Contents:

UNIT-I

Fourier Series: Dirichlet's Conditions, Coefficients of Fourier Series, Even & Odd Function, Half Range Series, Application of Fourier series: Full wave & Half wave rectifier, Square wave, Saw Tooth and Triangle wave. **Fourier transformations:** Fourier Integral Theorem, Fourier Sine & Cosine Integral, Fourier Complex Integral, Fourier Sine & Cosine transform, Convolution theorem, Properties of Fourier's Transform (Linearity theorem, Change of Scale, Shifting, and Modulation Theorem), Parsveal's Identity for Fourier transforms.

Hours 15

UNIT-II

Coordinate Systems and Group Theory: Curvilinear coordinates, differential vector operators in curvilinear coordinates. Spherical and cylindrical coordinate systems. General coordinate transformation, Tensors: covariant, contravariant and mixed, Algebraic operations on tensors, Illustrative applications. Definition of a group, multiplication table, conjugate elements and classes of groups, direct product. Isomorphism, homeomorphism, permutation group. Definitions of the three dimensional rotation group and SU(2).

Hours 15

UNIT-III

Special functions & Frobenius Method: **Gamma function: Transformation of Gamma Function, Beta Function Evaluation of beta Function, Relation between beta and Gamma Function, Duplicate Formula. Legendre polynomials, Rodrigues's Formula, Generating Function of Legendre's Polynomial, Orthogonality of Legendre's Polynomial, Recurrence Formulae of Legendre's.** Bessel functions of the first and second kind, Generating functions for Bessel, Recurrence Formulae of Beta. Wronskian and second solution, **Singular Points of Second Order Linear Differential equation, Frobenius method.**

Hours 15

UNIT-IV

Complex Analysis: Analytic Function, Harmonic Function, The Cauchy-Reimann conditions, **C-R equation in Polar Form,** Cauchy integral theorem, Cauchy integral formula, **Extension of Cauchy Theorem to multiple connected region, converse of Cauchy Theorem, Cauchy inequality,** Taylor and Laurent series, singularities and residues. Cauchy residue theorem. Calculation of real integrals.

Hours 15

Books Prescribed:

1. Mathematical Methods for Physicists: George Arfken-New York Academy, 1970.
2. Advanced Mathematical Methods for Engg. and Science Students: George Stephenson and P.M. Radmore-Cambridge Uni Press, 1990.
3. Applied Mathematics for Engineers & Physicists: Pipes and Harvil

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Expand a function in a Fourier series. They will also be aware of the integral transforms and be able to use this to solve mathematical problems relevant to the physical sciences.
CO2	Learn about Gradient, Divergence and Curl in orthogonal.
CO3	Solve ordinary second order differential equations which are important in the physical sciences.
CO4	Have a good grasp of the basic elements of complex analysis, including the important integral theorems. They will be able to determine the residues of a complex function and use the residue theorem to compute certain types of integrals.
CO5	Expand functions in Taylor's Series & Laurent Series.

M.Sc. Physics Semester-I
PHY-413
CLASSICAL MECHANICS

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP:310
Total Hours: 60

Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The main course objective of this subject to understand the basic concepts of constraint and advanced problems involving the dynamic motion, Newton's laws of motion, differential equations have developed in terms of Lagrangian with different examples, central force problems by equations of motion and different Kepler Laws , rigid body by Euler equations of motion and conservation laws on basis of symmetries of classical physics, Canonical transformations, Hamilton equations, Poisson brackets in a comprehensive way.

Course Contents:

UNIT-I

Lagrangian Mechanics: Newton's laws of motion, mechanics of a system of particles, constraints, D' Alembert's principle and Lagrange equations of motion for **Holonomic and Non-Holonomic constraints,** Velocity dependent potentials and dissipation function, Some applications of Lagrangian formulation, Hamiltons principle, derivation of Lagrange equations from Hamilton's principle. **Symmetry properties and conservation theorems**. **Hours 15**

UNIT-II

Central Force Problem: Two body central force problem and **Lagrangian analysis**, reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one dimensional problem, and classification of orbits. The differential equation for the orbit and integrable power-law potential. The Kepler problem and **different Kepler laws**, Scattering in a central force. **Hours 15**

UNIT-III

Rigid Body Dynamics: The independent coordinates of a rigid body, orthogonal transformation, the Euler's angles, Eulers's theorem on the motion of rigid body, finite and infinitesimal rotations, rate of change of a vector, angular momentum and kinetic energy about a point for a rigid body, the inertia tensor and moment of inertia, the eigen values of the inertia tensor and the principal axis transformation, Euler's equations of motion, torque free motion of a rigid body.

Hours 15

UNIT-IV

Canonical Transformations: Legendre transformation and Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamiltons equations from a variational principle, the principle of least action. The equations of canonical transformation, examples of canonical transformations, Poisson brackets and **their fundamental properties**. Equations of motion, **basic of infinitesimal canonical transformations** and conservation theorems in the Poisson bracket formulation.

Hours 15

Books Prescribed:

1. **Classical Mechanics: H. Goldstein, C. Poole and J. Safko, Pearson Education Inc. New Delhi, 3rd Edition, 2004.**
2. Mechanics : L.D. Landau-Pergamon Press, Oxford, 1982.
3. Classical Mechanics: Rana and Joag-Tata McGraw Hill, New Delhi, **2000**.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the basic concepts of constraint and advanced problems involving the dynamic motion.
CO2	Explain the Newton's laws of motion, differential equations have developed in terms of Lagrangian with different examples.
CO3	Analyse the central force problems by equations of motion and different Kepler Laws.
CO4	Understand the concept of rigid body by Euler equations of motion and conservation laws on basis of symmetries of classical physics.
CO5	Explain the concepts of Canonical transformations, Hamilton equations, Poisson brackets in a comprehensive way.

M.Sc. Physics Semester-I
PHY-414
COMPUTATIONAL PHYSICS

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60

Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The main objective of the course is to make the student acquainted with major computational techniques like Newton forward and Backward interpolation, Lagrange's interpolation, Simpson rule, Weddle rule, Trapezoidal rule, Euler method, modified Euler's method, Runga Kutta method, Bisection method, Regula Falsi method, Newton Raphson's Methodetc. for solving a broad range of complex problems related to the different fields of Physics. So the purpose of the course is to introduce the students to the main computational tools which permit to simulate and analyse the dynamic behaviour of wide range of physical problems in physics.

Course Contents:

UNIT-I

Programming (Fortran):

Flow chat symbol, higher level languages for computer, Representation of integers, reals, characters, constants and variables, arithmetic expressions and their evaluation using rules of hierarchy. Assignment statements, Logical constants, variables and expressions, control structures, sequencing alternation, arrays, Manipulating vectors and matrices, **Function** and Subroutines, I/O Statements **& format specifications**

Hours 15

UNIT-II

Interpolation:

Interpolation, **Finite difference's: Forward differences, Backward differences and Divided Differences,** Newton's formula for forward and backward interpolation, Divided differences, Symmetry of divided differences, Newton's general interpolation formula, **Newton's divided interpolation formula,** Lagrange's interpolation formula.

Hours 15

UNIT-III

Numerical Differentiation and Integration, Ordinary Differential Equation:

Numerical integration, A general quadrature formula for equidistant ordinates, **Simpson 1/3rd rule, Estimation of truncation error in Simpson's 1/3rd rule, Simpson's 3/8rd rule** Weddle and Trapezoidal rules, **Estimation of truncation error in Trapezoidal rule,** Monte- Carlo Method, **Differentiating a Tabulated Function at equal intervals using Newton's forward differences and backward differences interpolating polynomial and unequal intervals using Newton's divided differences interpolating polynomial** Euler's method, Modified Euler's method, **Runge-Kutta second and fourth order Method**.

Hours 15

UNIT-IV

Roots of Equation:

Types of Non-linear equations, Methods of finding solutions of Non-linear equations. Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method, **Concept of Synthetic Division, Synthetic division by quadratic factor,** Bairstow method. Simultaneous Linear Algebraic Equations: Solution of Simultaneous Linear equations, Gauss elimination method, Gauss-Jordon method, Matrix inversion.

Hours 15

Books Prescribed:

1. Ram Kumar-Programming with Fortran-77 (Tata McGraw Hill), 1995.
2. R.S. Dhaliwal - Programming with Fortran-77 (Wiley-Eastern Ltd)
3. James Scarborough-Numerical Mathematical Analysis (Oxford and IBH), 1966.
4. S.D. Conte - Elementary Numerical Analysis (McGraw Hill), 1965.
5. John. H. Methews, Numerical Methods for Mathematics, Science and Engineering (Prentice Hall of India).

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the basics of computers, their applications in solving common and scientific problems, scientific word processing and graphical analysis.
CO2	Learn the basic terms like constants, variables, structures, arrays etc. used in Fortran programming language and will learn its application in Numerical analysis.
CO3	Demonstrate the Newton's formula for forward and backward interpolation, divided differences, Newton's general and Lagrange's interpolation formula through Fortran programming.
CO4	Solve numerical integration and differentiation with the help of different methods like Simpson, Weddle and Trape rules, Monte- Carlo Method, Euler's method, Modified Euler's method, Runge-Kutta Method etc. These concepts are used in solving the problems in various research fields.
CO5	Find roots of equation with the help of Bisection Method, Regula-Falsi Method, Newton-Raphson method, Bairstow method etc.

M.Sc. Physics Semester-I
PHY-415
ELECTRONICS LAB.

Teaching Hours (per week): 6
Total Credits: 3
Credits LTP: 003
Time: 3 Hrs. **Max. Marks: 100**
(Practical Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:
I. The distribution of marks is as follows: **Max. Marks: 75+25 (Internal Assessment)**
i) One experiment **30 Marks**

ii) Brief Theory **15 Marks**

iii) Viva–Voce **15 Marks**

iv) Record (Practical file) **15 Marks**

II. There will be one sessions of 3 hours duration. The paper will have one session and will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: The objective of this course is to know the characteristics of diodes and transistors, MOSFET, SCR, UJT, DIAC, TRIAC, Multivibrator, Op Amps. Design simple circuits and mini projects, know the benefits of feedback in amplifier and can use op amps. as scalar, summer, differentiator and integrator. Study, Compare and classify oscillators and multivibrators as free running, monostable and bistable. Logic gates, half adder and full adder. Students can examine the basic structure of logic gates and can use them in half adder and full adder. Arithmatic Logic UnitStudents performs simple addition, subtraction, multiplication, division, and logic operations, such as OR and AND. The memory stores the program's instructions and data. The control unit fetches data and instructions from memory. DA convertor Students learn to convert the digital signal to analog signal using DA convertor.

Course Contents:
List of Experiments:
1. To Study the D C characteristics and applications of DIAC.
2. To study the D C characteristics and applications of SCR.
3. To study the D C characteristics and applications of TRIAC.
4. Investigation of the D C characteristics and applications of UJT.

5. Investigation of the D C characteristics of MOSFET.
6. Study of bi-stable, mono-stable and astable, multivibrators.
7. Study of Op-Amps and their applications such as an amplifier (inverting, non-inverting), scalar, summer, differentiator and integrator.
8. Study of logic gates using discrete elements and universal gates.
9. Study of encoder, decoder circuit.
10. Study of arithmetic logic unit (ALU) circuit.
11. Study of shift registers.
12. Study of half and full adder circuits.
13. Study of A/D and D/A circuits.
14. Study of pulse width and pulse position modulation.
15. Study of pulse width and pulse position demodulation.
16. Study of Demultiplexer Circuit.
17. Study of Parity Checker.
18. Study of 64-bit static RAM Circuit.

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Know the characteristics of diodes and transistors, design simple circuits and mini projects, know the benefits of feedback in amplifier and can use op amps as scalar, summer, differentiator and integrator. Study, compare and classify oscillators and multivibrators as free running, monostable and bistable.
CO2	Examine the basic structure of logic gates and use them in half adder and full adder.
CO3	Perform simple addition, subtraction, multiplication, division, and logic operations, such as OR and AND. The memory stores the program's instructions and data. The control unit fetches data and instructions from memory
CO4	Learn to convert the digital signal to analog signal using DA convertor.

M.Sc. Physics Semester-I
PHY-416
COMPUTER LAB.

Teaching Hours (per week): 6
Total Credits: 3
Credits LTP: 003

Time: 3 Hrs. **Max. Marks: 100**
(Practical Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:
I. The distribution of marks is as follows: **Max. Marks: 75+25 (Internal Assessment)**
i) One experiment **30 Marks**

ii) Brief Theory **15 Marks**

iii) Viva–Voce **15 Marks**

iv) Record (Practical file) **15 Marks**

II. There will be one sessions of 3 hours duration. The paper will have one session and will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: The main objective of this course is to make the students aware about the basics of Fortran programming and to develop the required programming skills to solve numerical problems on differentiation and integration using different methods like Simpson, Trapzodial rules, Monte- Carlo Method, Euler's method, Modified Euler's method, Runge-Kutta Method etc. They are also able to find roots of equation with the help of Bisection Method, Regula-Falsi Method, Newton-Raphson method etc.

Course Contents:

List of Experiments:

1. Determination of Roots:
(a) Bisection Method
(b) Newton Raphson Method
(c) False position method
(d) Secant Method
2. Matrix Manipulation
(a) Matrix Multiplication
(b) Determinant

(c) Gauss Elimination
(d) Matrix Inversion
(e) Gauss Jordan
3. Integration
(a) Trapezoidal rule
(b) Simpson 1/3 and Simpson 3/8 rules
(c) Simpson 1/3 and Simpson 3/8 rules with function
(d)Gaussian Quardrature
4. Differential Equations
(a) Euler's method
(b) Modified Euler's method
(c) RungeKutta second order Method
(d) RungeKutta fourth order Method
5. Interpolation
(a) Forward interpolation, Backward interpolation
(b) Lagrange's interpolation
6. Applications
(a) Chaotic Dynamics, logistic map
(b) One dimensional Schrondinger Equation
(c) Time period calculation for a potential
(d) Luminous intensity of a perfectly black body vs. temperature

Books Prescribed:
1. Ram Kumar-Programming with Fortran-77 (Tata McGraw Hill), 1995.
2. R.S. Dhaliwal - Programming with Fortran-77 (Wiley-Eastern Ltd)

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Write programs in FORTRAN to solve numerical analysis programme.
CO2	Write the Newton's formula for forward and backward interpolation, divided differences, Newton's general and Lagrange's interpolation formula through FORTRAN programming.
CO3	Apply Fortran programming to analyze the numerical integration and differentiation with the help of different methods like Simpson, Trap rules, Monte- Carlo Method, Euler's method, Modified Euler's method, Runge-Kutta Method etc. These concepts are used in solving the problems in various research fields.
CO4	Find roots of equation with the help of Bisection Method, Regula-Falsi Method, Newton-Raphson method, Bairstow method etc and develop ability to write programmes in Fortran.

M.Sc. Physics Semester-I

PHY-417

RESEARCH METHODOLOGY-I

Teaching Hours (per week): 2
Total Credits: 3
Credits LTP:200
Total Hours: 30

Time: 3 Hrs. **Max. Marks: 50**

(Theory Marks: 37+ Internal Assessment: 13)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The objective of this course is to impart knowledge about the significance of research quality and not in quantity. The need, therefore, is for those concerned with research to pay due attention to designing and adhering to the appropriate methodology throughout for improving the quality of research.

Unit-I

Research Methodology: An Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done , Research Process ,Criteria of Good Research.

Unit-II

Defining the Research Problem, What is a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, Meaning of Research Design Need for Research Design Research Methodology Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs.

Unit-III

Methods of Data Collection, Collection of Primary Data, Observation Method, Interview Method Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection,

Unit-IV

Processing and Analysis of Data, Processing Operations, Some Problems in Processing, Elements/Types of Analysis, Statistics in Research, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression , Partial Correlation.

References:

1) Research methodology (http://www.newagepublishers.com/samplechapter/000896.pdf)

2) Research Methodology C. R. Kothari, New Age International, New Delhi, 2004
3) Data reduction and error analysis for physical sciences by Philip R. Bevington and D. Keith Robinson

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	have information about the objectives of research.
CO2	Learn the way to define or select the research problem
CO3	Learn the various methods of data collection
CO4	Learn the ways to process the analysis of data

M.Sc. Physics Semester-II
PHY-421
QUANTUM MECHANICS – I

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60

Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The main objective of this course is to make students aware about the basic formulations in quantum mechanics. To acquire mathematical skills require to develop theory of quantum mechanics. To develop understanding of postulates of quantum mechanics and to learn to apply them to solve some quantum mechanical systems. To offer systematic methodology for the application of Schrodinger equation to solve quantum mechanical systems. There are many different types of representations of state and operators that are very useful in studying the subject deeply. It teaches about various commutation and uncertainty relations. Students will be given knowledge about unitary transformations, dirac delta function, matrix representation of operators and their applications. Main focus is on angular momentum operator and their representation in spherical coordinates. Addition of angular momenta is also taught.

Course Contents:

UNI T-I

Basic Formulation and quantum Kinematics: Stern Gerlach experiment as a tool to introduce quantum ideas, **description of the experiment, sequential Stern Gerlach experiment,** analogy of two level quantum system with polarisation states of light. Complex linear vector spaces, properties of ket space and bra space, inner/scalar product, operators and properties of operators. **Hermitian adjoint**, **Projection operator**, **commutator algebra,** compatible, incompatible observable, **General Uncertainty relation between two operators** Eigen kets of an observable, eigenkets as base kets, matrix representations of ket, bra and operators, Measurement of observable, and Change of basis and unitary transformations, **transformation of ket, bra and operators**, **matrix representation of the eigen value problem eigen values and eigen vectors of an operator.** **Hours 15**

UNIT-II

Continuous spectra, **position eigen kets and position measurement**, translation, momentum as a generator of translations, canonical commutation relations. Wave functions in position space, Momentum operator in position representation, momentum space wave function. **Matrix and wave mechanics,** Time evolution operator, Schrodinger equation for time evolution operator, special role of the Hamiltonian operator, Energy eigenkets, time evolution of expectation values, spin precession

Hours 15

UNIT-III

Correlation amplitude and the energy time Uncertainty relation Schrodinger vs. Heisenberg picture, unitary operators, state kets and observable in Schrodinger and Heisenberg pictures, Heisenberg equations of motion, **Base kets and transition amplitude,** Simple harmonic oscillator, energy eigen states, energy, **eigen kets, energy eigenstates in position space**, **matrix representation and expectation values of various harmonic oscillator operators,** coherent states

Hours 15

UNIT-IV

Spherical Symmetric Systems and Angular momentum: Schrodinger equation for a spherically symmetric potential. Orbital angular momentum commutation relations. **general formalism of angular momentum**, **eigen states and eigen values of the angular momentum operator**, **matrix representation of the angular momentum operator, Spin ½ and the Pauli matrices,** Addition of angular momentum and calculation of Clebsch-Gordan (C.G.) coefficients.

Hours 15

Books Prescribed:

1. Modern Quantum Mechnics: J.J. Sakurai-Pearson Educaton Pvt. Ltd., New Delhi, 2502.
2. Quantum Mechanics :L I Schiff-Tokyo McGraw Hill, 1968.
3. Feynmann lectures in Physics Vol. III-Addison Wesly, 1975.
4. Quantum Mechanics :Powel and Craseman-Narosa Pub. New Delhi, 1961.
5. Quantum Mechanics :Merzbacher-John Wiley & Sons, New York, 1970.

Sr. No.	On completing the course, the students will be able to:
CO1	Explain the basic formulation of Quantum mechanics developed by Dirac.
CO2	Understand quantum dynamics of states using time evolution operator.
CO3	Understand the quantum mechanical analysis of few one dimensional potential systems.
CO4	Understand the quantum mechanical analysis of few three dimensional potential systems.
CO5	Understand and use the concept of addition of angular momenta and evaluation of Clebsch Gordan coefficients.

M.Sc. Physics Semester-II
PHY-422
ELECTRODYNAMICS-I

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60

Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The main objective of this course to introduce about the basic mathematical concepts related to electromagnetic vector fields. To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications. To impart knowledge on the concepts of Magnetostatics, magnetic flux density, scalar and vector potential and its applications. To impart knowledge on the concepts of Faraday‘s law, induced emf and Maxwell‘s equations. To impart knowledge on the concepts of Concepts of electromagnetic waves etc.

Course Contents:

UNIT-I

Electrostatics: Coulomb's law, Gauss’s law, Poisson's equation, Laplace equation. Solution of boundary value problem: Green's function, method of images: **A point charge near an infinite conducting Plane, A point charge in front of conducting sphere,** Laplace equation, Uniqueness theorem. multipole expansion, Electrostatics of dielectric media, **Gauss Law in dielectrics,** Boundary value problems in dielectrics; molecular polarizability, **Local or Polarizing Field in dielectric, Clausius-Mosotti Formula**, electrostatic energy in dielectric media.

Hours15

UNIT-II

Magnetostatics: Biot and Savart's law. The differential equation of Magnetostatics and Ampere's law, vector potential and magnetic fields of a localised current distribution, Magnetic moment, force and torque on a magnetic dipole in an external field. Magnetic materials, Magnetisation and microscopic equations.

Hours15

UNIT-III

Time-varying fields: Time varying fields, Maxwell's equations, conservation laws, **Self Induction, Mutual Inductance, Neumann Formula, Reciprocity Theorem,** Faraday's law of induction, Energy in a magnetic field. Maxwell's displacement current, vector and scalar potential, Gauge transformations; Lorentz gauge and Coulomb gauge. Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation.

Hours 15

UNIT-IV

Electromagnetic Waves: **Boundary Conditions at surface of Discontinuity, Wave Equation in Conducting and Non Conducting Medium, Wave Propagation in Conducting Medium, Propagation Characteristics of EM waves in Conducting Medium (Attenuation Constant, Phase Shift Constant, Phase Velocity), Propagation Characteristics of EM waves in Dielectric Medium, Depth of Penetration,** Polarisation, Linear Circular and **Elliptical** polarisation. Group velocity. Reflection and refraction of electromagnetic waves at a plane surface between dielectrics. **Brewster's Law and Degree of Polarisation**, total internal reflection. Simple model for conductivity.

Hours 15

Books Prescribed:

1. Classical Electrodynamics - J.D. Jackson-John & Wiley Sons Pvt. Ltd. New York, 2504.
2. Introduction to Electrodynamics - D.J. Griffiths-Pearson Education Ltd., New Delhi, 1991.
3. Classical Electromagnetic Radiation - J.B. Marion-Academic Press, New Delhi, 1995.

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Understand basics of Electrostatic and Magnetostatics.
CO2	Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.
CO3	Understand conservation laws for a system of charged particles and electromagnetic field.
CO4	Describe Maxwell equations and its physical consequences.
CO5	Describe the nature of electromagnetic wave and its propagation through different media and interfaces.

M.Sc. Physics Semester-II
PHY-423
CONDENSED MATTER PHYSICS-I

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60
Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The main objective of this course to introduce about the basics of magnetic materials and their properties. Acquire knowledge of the behavior of Lattice Vibrations and phonons theory in crystals. To become familiar with the Superconductivity and Properties of superconductors using different theories. Familiar with defects in crystal etc.

Course Contents:

UNIT-I

Dia-Para and Ferromagnetism:

Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, classical theory of para magnetism, Quantum theory of paramagnetism, Quenching of orbital angular momentum, cooling by adiabatic demagnetization. Paramagnetic susceptibility of conduction electrons. Ferromagnetism, the Weiss molecular field, Heisenberg interpretation of the Weiss field, Exchange integral, Ferromagnetic domains, **Domain Wall, Anisotropy Energy,** Spin waves, quantization of spin waves,Thermal excitations of magnons. **Antiferromagnetism, The two sub lattice model, super exchange interaction, the structure of ferrites, saturation magnetisation, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets.** **Hours 15**

UNIT-II

Superconductivity:

Superconductivity, zero resistivity, critical temperature, Effect of magnetic field, Meissner effect, Type I andType II superconductors, isotope effect, specific heat and thermal conductivity, **London**

Equations, Penetration depth, Coherence Length, BCS theory, Ginzsburg-Landou theory, Josephson effect: dc Josephson effect, ac Josephson effect, high temperature superconductivity (elementary).

Hours 15

UNIT-III

Defects and Diffusion in Solids:

Point defects: Impurities, Vacancies- Schottky and Frankel vacancies, Color centers and coloration of crystals, F-centres, Line defects (dislocations), Edge and screw dislocations, BergerVector, Planar (stacking) Faults, Grain boundaries, Low angle grain boundaries, the Hydration energy of ions, Ionic conductivity in pure alkali halides. **Hours 15**

UNIT-IV

Lattice Vibrations and Phonons:

Vibrations of one dimensional linear monoatomic lattice, Normal modes of vibrations in a finite length of the lattice, The linear diatomic lattice, Excitation of optical branch in ionic crystals –the infra-red absorption, Quantization of lattice vibrations – concept of phonons, Phononmomentum, Inelastic scattering of photons by phonons, **Specific heat of metals, The various theories of lattice specific heat of solids, Einstein model of the Lattice Specific heat, Successes and failures of Einstein model, Density of modes of vibration, Debye model of Lattice specific heat, Drawbacks of Debye model.** **Hours 15**

Books Prescribed:

1. An Introduction to Solid State Physics: C. Kittel-Wiely Estem Ltd., New Delhi, 1979.
2. Condensed Matter Physics, Vol I and II, T.S. Bhatia, Rajesh Khatri, Vishal Publishing House, Jallandhar, 2018.
3. Solid State Physics-A.J. Dekkar-Maemillan India Ltd., New Delhi, 2004.
4. Principles of Solid State Physics-R.A. Levy-New York Academy, 1968.
5. Introduction to Solids-Azaroff-Tata McGraw Hill, New Delhi, 1992.
6. Elementary Solid State Physics-Omar, Addison Wesly, 1975.
7. Solid State Physics-Aschroft and Mermin-New York Holt, 1976

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the basics of Magnetic properties of solids and able to explain diamagnetism, paramagnetic susceptibility and ferromagnetism on the basis of classical & quantum theory.
CO2	Learn about the Superconductivity, properties of superconductors, Meissner effect, BCS Theory etc.
CO3	Understand about the different types of defects in solids.
CO4	Understand about the Lattice Vibrations and Phonons theory in crystals

M.Sc. Physics Semester-II
PHY-424
ATOMIC AND MOLECULAR SPECTROSCOPY

Teaching Hours (per week): 4
Total Credits: 4
Credits LTP: 310
Total Hours: 60

Time: 3 Hrs. **Max. Marks: 100**
(Theory Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The purpose of the course is to introduce the students to Atomic and Molecular Spectroscopy and to develop required skills to solve problems of atomic spectra of one and two valance electrons, Molecular Spectra. To understand Spectroscopy terminology, structural determination of molecules, Fourier Series and transformations in quantum mechanics. It includes knowledge of interaction energies involving L-S and J-J interactions and selection rules governing transitions, effect of magnetic field on spectral lines and broadening of lines. molecular spectra pertaining to rotational and vibrational motion, Raman and electronic spectroscopy, analytical techniques and Frank-Condon principle etc..

Course Contents:

UNIT-I

Spectra of one and two valance electron systems:
Magnetic dipole moments, Larmor's theorem, **Fine structure: basic facts and Sommerfeld theory** Space quantization of orbital, spin and total angular momenta; Vector model for one and two valance electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Spectroscopic notations for L-S and J-J couplings; Spectra of alkali and alkaline earth metals; Interaction energy in L-Sand J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets**. Exchange symmetry of wave function and Pauli's exclusion principle.**

Hours 15

UNIT-II

Effects of external fields:
Natural breadth of spectral line, Line broadening mechanism (Qualitative) **Experimental study of Zeeman Effect**, The Zeeman Effect for two valance electron systems, Intensity rules for the

Zeeman effect, The calculations of Zeeman patterns, Paschen-Back effect for two valance electron system, Lande's factor in LS and JJ coupling, **Transitions in Zeeman and Paschen-Back effect** Stark effect.

Hours 15

UNIT-III

Microwave and Infra-Red Spectroscopy:

Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, The vibrating diatomic molecule as a simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Outline of technique and instrumentation, Fourier transform spectroscopy. **FTIR Spectrometer**

Hours 15

UNIT-IV

Raman and Electronic Spectroscopy:

Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation- The Franck-Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, **Raman Spectrometer, Electron spin resonance, Nuclear spin resonance**

Hours 15

Books Prescribed:

1. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934
2. Fundamentals of Molecular spectroscopy: C.B. Banwell-Tata McGraw Hill, 1986.
3. Spectroscopy Vol. I, II & III: Walker &Straughen
4. Introduction to Molecular Spectroscopy: G.M.Barrow-Tokyo McGraw Hill, 1962.
5. Spectra of Diatomic Molecules: Herzberg-New York, 1944.
6. Molecular Spectroscopy: Jeanne L McHale-NewJersy Prentice Hall, 1999.
7. Molecular Spectroscopy: J.M. Brown-Oxford University Press, 1998.
8. Spectra of Atoms and Molecules: P.F. Bermath-New York, Oxford University Press,

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Understand the basic information about atomic spectra of one and two valance electrons, interaction energies involving L-S and J-J interactions and selection rules governing transitions.
CO2	Understand the effect of magnetic field on spectral lines and broadening of lines.
CO3	Explain the applications of molecular spectra pertaining to rotational and vibrational motion of different types of molecules
CO4	Understand the Raman and electronic spectroscopy of diatomic molecules.
CO5	Understand about intensity of spectral lines and the Frank-Condon principle.

M.Sc. Physics Semester-II
PHY-425
CONDENSED MATTER LAB-I

Teaching Hours (per week): 6
Total Credits: 3
Credits LTP:003

Time: 3 Hrs. **Max. Marks: 100**
(Practical Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:

I. The distribution of marks is as follows: **Max. Marks: 75+25 (Internal Assessment)**

i) One experiment **30 Marks**

ii) Brief Theory **15 Marks**

iii) Viva–Voce **15 Marks**

iv) Record (Practical file) **15 Marks**

II. There will be one sessions of 3 hours duration. The paper will have one session and will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: The objective of this course is to experimentally study some of the fundamental concepts in condensed matter physics like free electron theory of metals, semiconductor transport, crystal structure determination, magnetism and electron spin resonance.The students are expected to study lab manuals in advance and perform the experiments on their own with minimal help from instructors.

Course Contents:

List of Experiments:

1. To determine Hall coefficient by Hall Effect.
2. To determine the band gap of a p-n junction diode.
3. To determine the magnetic susceptibility of a material using Quincke's method.
4. To determine the energy gap and resistivity of the semiconductor using four probe method.
5. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
6. **To determine the lattice dynamics and dispersion relation for the monatomic and diatomiclattices.**
7. **To determine Curie temperature of ferrites.**
8. **To determine the energy loss in the ferrites at room temperature**.

9. To study the series and parallel characteristics of a photovoltaic cell.
10. To study the spectral characteristics of a photovoltaic cell.

Books Prescribed:

1. An Introduction to Solid State Physics: C. Kittel-Wiely Estem Ltd., New Delhi, 1979.
2. Solid State Physics-A.J. Dekkar-Maemillan India Ltd., New Delhi, 2504.
3. Principles of Solid State Physics-R.A. Levy-New York Academy, 1968.
4. Practical Physics, Vol III, T.S. Bhatia, G.Kaur and I. Singh, Vishal Publishing House, Jalandhar
5. Advanced Practical Physics by S.P.Singh, Pragati Prakashan, Meerut – 250001 (India).

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Determine Hall coefficient by Hall Effect.
CO2	Understand the dielectric constant of liquids.
CO3	Study the spectral characteristics of a photovoltaic cell.
CO4	Calculate the band gap of a semiconductor using p-n junction diode.
CO5	Find out the magnetic susceptibility of a material using Quink's method

M.Sc. Physics Semester-II
PHY-426
SPECTROSCOPY LAB

Teaching Hours (per week): 6
Total Credits: 3
Credits LTP:003
Time: 3 Hrs. **Max. Marks: 100**
(Practical Marks: 75+ Internal Assessment: 25)

Instructions for paper setter and students:
I. The distribution of marks is as follows: **Max. Marks: 75+25 (Internal Assessment)**
i) One experiment **30 Marks**

ii) Brief Theory **15 Marks**

iii) Viva–Voce **15 Marks**

iv) Record (Practical file) **15 Marks**

II. There will be one sessions of 3 hours duration. The paper will have one session and will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: The purpose of the course is to introduce students to methods of Spectroscopy analysis and to develop required skills to study spectra of Atoms and Molecules. Lab work will help the students to work with Michelson and Febry-Perot interferometer to determine Wavelength of source. It includes how a deviation spectrometer helps to find unknown wavelengths of light, wavelength determination of the source with the help of diffraction experiment using laser, experimental confirmation of Bohr energy levels and how Zeeman pattern appear when source is placed in external magnetic field.

Course Contents:

List of Experiments:

1. To find the wavelength of monochromatic light using Febry Perot interferometer.
2. To find the wavelength of sodium light using Michelson interferometer.
3. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
4. To find the grating element of the given grating using He-Ne laser light.
5. To find the wavelength of He-Ne laser using Vernier calipers.

6. To verify the existence of Bohr's energy levels with Frank-Hertz experiment.
7.To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect.
8.To determine the g factor using ESR spectrometer.
9.To find the refractive index of given liquid samples using Abbe refractometer

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Get basic information about confirmation of existence of Bohr energy levels atom by Frank Hertz Experiment
CO2	Understand how a deviation spectrometer helps to find unknown wavelengths of light using Constant deviation spectrometer
CO3	Explain the wavelength determination with the help of Michelson and Febry-Perot interferometer.
CO4	Understand how Zeeman pattern appear when source is placed in external magnetic field.
CO5	Get an idea about wavelength determination of the source with the help of diffraction experiment.

M.Sc. Physics Semester-II
PHY-427

RESEARCH METHODOLOGY-II

Teaching Hours (per week): 2
Total Credits: 3
Credits LTP: 200
Total Hours: 30
Time: 3 Hrs. **Max. Marks: 50**
(Theory Marks: 37+ Internal Assessment: 13)

Instructions for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any six questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III &IV respectively and will consist of two questions of 15 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-Programmable Scientific calculator is allowed.**

Course Objectives: The objective of this course is to impart knowledge about the error analysis error propagation, the use of elementary statistics and curve fitting to improve research quality.

Unit-I

Error as uncertainties, importance of knowing uncertainty, estimation of uncertainty, significant figures, discrepancy, fractional uncertainties, propagation of uncertainties.

Unit-II

Statistical analysis of random uncertainties, random and systematic errors, mean and standard deviation, normal distribution.

Unit-III

Least square fitting, covariance and correlation, the binomial distribution, the Poisson distribution, the Chi squared test for a distribution,

Unit-IV

Basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and installing LATEX packages.

References:

1) Research methodology (http://www.newagepublishers.com/samplechapter/000896.pdf)
2) The not so short introduction to LATEX by Tobian Oetiker, Hubert Partl, Hrene Hyna

and Elisabeth Schlegl, Version 4.16, May 08, 2005 (http://tobi.oetiker.ch/lshort/lshort.pdf)
3) An introduction to error analysis John R. Taylor, University Science books California 1982
4) Data reduction and error analysis for physical sciences by Philip R. Bevington and D. Keith Robinson

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	have information about the type and estimation of uncertainties
CO2	Learn the way to do statistical analysis in data
CO3	Learn the various methods of curve fitting
CO4	Learn the way to create a document in Latex