Syllabus

M.Sc. Physics

Duration: Two Year

Part A Introduction			
Program: PG	**Class: M.Sc.**	**Year:I(I Sem)**	**Session: 2025-26**

Subject: Physics			
1	**Course Code**		
2	**Course Title**	**Mathematical Physics**	
3	**Course Type (Core Course/ Discipline Specific Elective)**	Core Course (CC-11)	
4	**Pre-requisite (if any)**	**To study this course, a student must have UG Degree in Physics.**	
5	**Course Learning outcomes (CLO)**	On successful completion of this course, the students will be able to: 1. Understand the early life, education, and historical context of Aryabhata and Bhaskaracharya II. 2. Develop a strong foundation in mathematical methods such as curvilinear coordinates, probability, group theory, special functions, complex analysis and tensor. 3. Apply mathematical techniques to solve physics problems, translating real-world situations into mathematical formulations. 4. Solve quantitative problems by applying mathematical models to predict or analyse physical behaviour.	
6	**Credit Value**	6	
7	**Total Marks**	Max. Marks: 60+40= 100	Min. Passing Marks:24+16= 40

Part B- Content of the Course

Total No. of Lectures (in hours): 90

Unit	Topics	No. of Lectures (1 hour each)
I	**Curvilinear Coordinates, probability and Group theory** 1. A brief biography of Aryabhata and Bhaskaracharya II with their major contribution to science and society. 2. Introduction to Curvilinear Coordinates, Orthogonal curvilinear coordinates, differential of an arc length, differential operators, spherical and cylindrical coordinates and their unit vectors. 3. Elementary probability theory, Conditional Probability, Bayes theorem, random variables, binomial, Poisson and normal distributions. Central limit theorem. 4. Group theory: Introductory group theory, Special unitary group of degree two SU(2), Special orthogonal group of degree three SO(3). ***Activity:*** *1. Ask students for a group discussion on contributions of Indian mathematicians.* *2. Ask students to make charts on group theory (SU(2), SO(3)).* *3. Organize debate on historical time units (e.g. Yuga, kalpa) and ask them to convert in modern unit.*	**18**
II	**Special Functions** 1. Legendre function: Legendre's equation, Legendre's polynomial and its generating function, Recurrence formula, General solution of Legendre equation, Rodrigue's formula, Orthogonality of Legendre Polynomials.	**18**

	2. Bessel functions: Bessel equation and its solution, Bessel functions Jn(x), Recurrence formula and generating function, Orthogonality of Bessel function. 3. Hermite's Function: Hermite's equation, Generating function of Hermite polynomials, Orthogonal property of Hermite polynomials, Recurrence formula for Hn(x) of Hermite equation.	
III	**Complex Analysis** 1. Introduction to Complex Numbers and their Graphical Representation, Functions of Complex Variables, Analyticity of complex function, Cauchy-Riemann equation, 2. Singularities: poles, removable singularity, essential singularity, branch points, Cauchy theorem, Cauchy integral formula, Laurent and Taylor's expansion. Residues and Residue Theorem. Application of Contour Integration in solving Definite Integrals.	**18**
IV	**Fourier and Laplace transform:** **1. Fourier:**FourierTransforms, Integrals Transforms, Fourier Integral theorem (Statement only),Fourier sine and cosine transform, Fourier transform of single pulse, trigonometric, exponential functions, Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem, Properties of Fourier transforms. **2. Laplace:**Laplacetransforms, Laplace transform of Elementary functions, Properties of Laplace transforms, Change of Scale Theorem, Shifting Theorem, Laplace transforms of derivatives, Derivatives and Integrals of Laplace transforms, Laplace transform of Unit Step functionand Periodic Functions, Convolution Theorem, Inverse Laplace transforms, Solution of heat flow along semi-infinite bar using Laplace transform.	**18**
V	**Tensor Analysis** 1. Tensors- Notations and Conversions, Contravarient tensors, Rank of the Tensors 2. Properties of the Tensors e.g. Addition, Subtraction and Product , Contraction, Cartesian tensors and their transformation properties 3. Eigen values of second rank tensors, Quotient law, Higher Rank Tensors with examples from piezoelectricity, stiffness and compliance.	**18**

Keywords/Tags: Curvilinear Coordinates, generatingfunction, ComplexVariables, Laplacetransforms, tensors

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. K. V. Sarma (1997), Aryabhata, National Book Trust, India.
2. Boas M. L., " Mathematical Methods in the Physical Sciences", Wiley, Third edition.
3. Arfken G.B., Weber H.J., Harris F.E., " Mathematical Methods for Physicists", Elsevier,7th edition.
4. Spiegel M.R., " Fourier Analysis", Tata McGraw-Hill, 2004.
5. Fokas A. S. &Ablowitz M.J., "Complex Variables", Cambridge Univ. Press,2011, 8th edition.
6. Dass H.K. &Verma R., " Mathematical Physics", S. Chand, Eighth Edition.

Suggested equivalent online courses:

https://www.youtube.com/watch?v=s-_3v3xEvHU
https://www.youtube.com/watch?v=WBF5hyrHStw
https://www.youtube.com/watch?v=peZWarEjk44
https://www.youtube.com/watch?v=B2VrnJsceW0
https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/video_galleries/video-lectures/
https://www.youtube.com/playlist?list=PLhSp9OSVmeyJ5N-JUEZj7uS6IAT9a79nD
https://www.youtube.com/playlist?list=PLhSp9OSVmeyIYLVvSJ8m6KvVwJs7M9QBm
https://www.youtube.com/playlist?list=PLp0hSY2uBeP-O0PDasx0dkQle779r8hqq

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40 Marks University Exam (UE):60 Marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE)	Class Test Assignment/Presentation	20 20
External Assessment : University Exam Section Time : 03.00 Hours	**Section(A)** : Very Short Questions **Section (B) :** Short Questions **Section (C) :**Long Questions	5x1=5 5x4=20 5x7=35

Any remarks/ suggestions:

Part A Introduction				
Program: PG	**Class: M.Sc.**		**Year:I (I Sem)**	**Session: 2025-26**
Subject: Physics				
1	**Course Code**			
2	**Course Title**	**Classical Mechanics**		
3	**Course Type (Core Course/ Discipline Specific Elective)**	**Core Course (CC-12)**		
4	**Pre-requisite (if any)**	**To Study this course a student must have graduation with physics as major or minor subject.**		
5	**Course Learning outcomes (CLO)**	On successful completion of this course, the students will be able to: 1. Understand the historical background and contributions of C.V. Raman and Meghnad Saha. 2. Formulate Lagrange's and Hamilton's equations of motion and understand their applications. 3. Apply the variational principle and principle of least action to solve physical problems. 4. Define and apply canonical transformations and generating functions. 5. Analyze small oscillations and determine normal modes of vibration. 6. Understand the motion of rigid bodies.		
6	**Credit Value**	6		
7	**Total Marks**	Max. Marks: 100 (40 + 60)	Min.Passing Marks:16+24=40	

Part B- Content of the Course		
Total No. of Lectures (in hours): 90		
Unit	**Topics**	**No. of Lectures (1 hour each)**
I	**Lagrangian and Hamiltonian Dynamics** 1. Historical background and contributions of C.V. Raman (regarding study of elastic vibrations, wave mechanics), Meghnad Saha ionization equation (statistical mechanics, thermodynamics – classical roots). 2. Newtonian mechanics of a system of particles, Constraints and their classification, Generalized coordinates, Principle of virtual work, D'Alembert's Principle in generalized coordinates, Langrange's equation from D- Alembert principle, Generalized Potential, Lagrangian for a charged particle moving in EM field, Application: Single particle in Space, Simple pendulum, Atwood's machine, Bead sliding on rotating wire. 3. Generalized momentum and cyclic coordinates, Hamiltonian function and conservation of energy, Hamilon's equations, Hamilon's equations in different coordinate systems. ***Activities:*** *1. Ask students to study about Indian scientists and their work related to classical mechanics.* *2. Poster on evolution from classical mechanics to quantum mechanics.*	**18**

	3. *Organize debate on various contributions of Indian Scientist (MeghnadSaha, C.V. Raman, SatyendraNath Bose, J.C. Bose)).*	
II	**Central forces and Variational principles** 1. Variational principle, Euler-Lagrange's equation from variational principle, Applications: shortest distance between two points and Brachistochrone problem, Deduction of Hamilton principle from D- Alembert principle, Lagrange's equations of motion for Non-Holonomic system and Lagrange's Multipliers, Principle of least action.	**18**
III	**Canonical transformation and Brackets** 1. Canonical Transformation, Legendre transformation, Generating functions, Application of canonical transformation. 2. Poisson's Brackets and their properties, Lagrange Brackets and their properties, Invariance of Poisson's Bracket with respect to canonical transformation, Jacobi's Identity, Phase space and Liouville's Theorem.	**18**
IV	**Hamilton- Jacobi formulation and Small oscillation** 1. Hamilton- Jacobi equation, Solution by Hamilton- Jacobi method: Harmonic oscillator, Kepler's Problem, Action and angle variables. 2. One-dimensional oscillator, Two coupled oscillators, Normal Coordinates and Normal Modes, Kinetic and potential energy in normal coordinates, General theory of small oscillation, Secular equation and Eigen value equation,	**18**
V	**Non-inertial systems** 1. Euler's angles, Infinitesimal rotations as vectors (Angular velocity), Angular Momentum and Inertia tensor. 2. Euler's equations of motion for a rigid body, Torque- free motion of a rigid body, Motion of a heavy Symmetrical top, Gyroscope. 3. Non-inertial Frame of reference, Fictitious Force, Uniformly rotating frames, Coriolis force, Free fall of a body on Earth's Surface.	**18**

Keywords/Tags: Generalized coordinates,Variational principle, Poisson's Brackets, Hamilton- Jacobi equation, Coriolis force.

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Goldstein H., Poole C.P., Safko J.L., " Classical Mechanics", Pearson Education,2002, 3rd Edition.
2. Landau L. D., Lifshitz E. M., " Mechanics", Pergamon,1976.
3. Upadhyaya J. C., "Classical Mechanics", Himalaya Publishing House.
4. Gupta S.L., Kumar V., Sharma, "Classical mechanics", PragatiPrakashan.

Suggested equivalent online courses:

https://ocw.mit.edu/courses/8-03sc-physics-iii-vibrations-and-waves-fall-2016/pages/part-i-mechanical-vibrations-and-waves/
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/4-4-non-inertial-reference-frames/
https://www.youtube.com/watch?v=NE73aD0ELtI&t=361s
https://www.youtube.com/watch?v=0DHNGtsmmH8
https://www.youtube.com/watch?app=desktop&v=pB-aleLeKL0&t=0s
https://www.youtube.com/watch?v=nFpC1s1joRU
https://www.youtube.com/watch?v=z-dGZgq-6jg
https://www.youtube.com/watch?v=qYnvc4rKeuA
https://www.youtube.com/watch?v=3iuBKOxAIWg

Part D-Assessment and Evaluation		
Suggested Continuous Evaluation Methods: Maximum Marks : 100 Continuous Comprehensive Evaluation (CCE) : 40 Marks University Exam (UE):60 Marks		
Internal Assessment : Continuous Comprehensive Evaluation (CCE)	Class Test Assignment/Presentation	20 20
External Assessment : University Exam Section Time : 03.00 Hours	**Section(A)** : Very Short Questions **Section (B) :** Short Questions **Section (C) :**Long Questions	5x1=5 5x4=20 5x7=35
Any remarks/ suggestions:		

Part A Introduction				
Program: Degree (PG)		**Class: M.Sc.**	**Year:I(I Sem)**	**Session: 2025-26**
Subject:Physics				
1	**Course Code**			
2	**Course Title**	**Lab - I**		
3	**Course Type (Core Course/ Discipline Specific Elective)**	**Core Course (PC-11)**		
4	**Pre-requisite (if any)**	**To Study this course a student must have UG degree in physics.**		
5	**Course Learning outcomes (CLO)**	On successful completion of course, students will be able to: 1. Determine the value of Rydberg's constants. 2. Calculate energy loss per cycle (hysteresis). 3. Measure variation of resistivity with temperature. 4. Compare self Inductance of two coils. 5. Calculate the thermoelectric voltage vs temperature.		
6	**Credit Value**	4		
7	**Total Marks**	Max. Marks: 100	Min. Passing Marks:40	

Part B- Content of the Course		
Total numbers of Lectures - Practical (in hours per week): 02 hours per credit per week		
Unit	**Topics**	**No. of Lectures** (Per week in hours.)
1.	Determine the value of Rydberg's constants with the diffraction grating and hydrogen tube.	**02 hours per credit per week**
2.	To determine the hysteresis loss of a given transformer by CRO.	
3.	To find the maximum power and efficiency of a solar cell.	
4.	Study the temperature dependence of resistivity of a semiconductor and to determine the band gap of the material.	
5.	To verify Fresnel's formula for the reflection of light	
6.	To compare Self-inductance of two coils L1 and L3 with Maxwell Bridge.	
7.	To determine the frequency of an electric tuning fork by Melde's experiment and verify λ2–T law.	
8.	Determination of Lande's 'g' factor of paramagnetic materials using electron spin resonance method.	
9.	To determine the self inductance of a coil by Anderson bridge.	
10.	Study of different thermocouples for temperature measurement.	

Part C-Learning Resources
Text Books, Reference Books, Other resources
Suggested Readings: 1."B.L. Worsnop and H.T. Flint – Advanced Practical Physics for Students" 2."C.L. Arora – Practical Physics" 3."V.K. Mehta – Principles of Electronics"

4.“AjoyGhatak – Optics”
5.“Melissinos & Napolitano – Experiments in Modern Physics”
6.“S. O. Pillai – Solid State Physics”
7.“G.F. Knoll – Radiation Detection and Measurement”
8.“S.M. Sze – Physics of Semiconductor Devices”

Suggested equivalent online courses:

https://vlab.amrita.edu/?sub=1&brch=75&sim=332&cnt=1
https://vlab.amrita.edu/?sub=1&brch=281&sim=1487&cnt=1
https://vlab.amrita.edu/?sub=1&brch=195&sim=720&cnt=1https://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1
https://vlab.amrita.edu/?sub=1&brch=75&sim=340&cnt=1
https://www.bhavansvc.ac.in/naac/c3/3.1.3/19%20PC%20201.pdf
https://vlab.amrita.edu/?sub=1&brch=282&sim=1520&cnt=1

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Lab Record/Class Interaction /Quiz	15	Viva Voce on Practical	30
Attendance in the lab	10		
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	15	Table work / Experiments	30
TOTAL	**40**		**60**

Any remarks/ suggestions:

Part A Introduction				
Program: Degree (PG)		**Class: M.Sc.**	**Year:I (I Semester)**	**Session: 2025-26**
Subject:Physics				
1	**Course Code**			
2	**Course Title**	**Lab - II**		
3	**Course Type (Core Course/ Discipline Specific Elective)**	**Core Course (PC-12)**		
4	**Pre-requisite (if any)**	**To Study this course a student must have UG degree in physics.**		
5	**Course Learning outcomes (CLO)**	On successful completion of course, students will be able to: 1. Understand basic principles of optics. 2. Analyze dispersion phenomena and evaluate the refractive index variation using Cauchy's dispersion formula. 3. Understand the behaviour of light through optical setups, such as prisms, wedges, and interferometers. 4. Understand the phenomena of photoelectric effect and blackbody radiation. 5. Identify Explore rotational spectrum of iodine vapor.		
6	**Credit Value**	4		
7	**Total Marks**	Max. Marks: 100	Min. Passing Marks:40	

Part B- Content of the Course		
Total Number of Lectures (Hours per week): 02 hours per credit per week		
S.N.	**Topics**	**No. of Lectures** (Per week in hours.)
1.	To calibrate of drum of constant deviation spectrograph.	**02 hours per credit per week**
2.	To study the variation of refractive index of the material of prism with wavelength and Cauchy's dispersion formula.	
3.	To determine the wavelength of monochromatic light by diffraction at a straight edge.	
4.	To find out the wavelength of the given light source with the help of Michelson interferometer.	
5.	To determine the angle of a given wedge using given laser beam.	
6.	To determine the refractive index of water using hollow prism.	
7.	To determine the Plank's constant using Black Body Radiation and Photo-Detector.	
8.	To determine the absorption lines in the rotational spectrum of Iodine vapour.	
9.	Determination of Wavelength of different colours using LED.	
10.	Photo-electric effect: photo current versus intensity and wavelength of light.	

Part C-Learning Resources
Text Books, Reference Books, Other resources
Suggested Readings: 1. AjoyGhatak – Optics

2. E. Hecht – Optics
3. B.L. Theraja – Modern Physics
4. Practical Physics by S. P. Singh
5. Advanced Practical Physics for Students by B.L. Worsnop and H.T. Flint

Suggested equivalent online courses:

https://vlab.amrita.edu/?sub=1&brch=282&sim=1507&cnt=1
https://vlab.amrita.edu/?sub=1&brch=281&sim=1515&cnt=1
https://vlab.amrita.edu/index.php?sub=1&brch=189
https://vlab.amrita.edu/?sub=3&brch=195&sim=840&cnt=4

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	**Marks**	**External Assessment**	**Marks**
Lab Record/Class Interaction /Quiz	15	Viva Voce on Practical	30
Attendance in the lab	10		
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	15	Table work / Experiments	30
TOTAL	**40**		**60**

Any remarks/ suggestions:

Part A Introduction			
Program: PG	**Class: M.Sc.**	**Year:I(II Sem)**	**Session: 2025-26**
Subject: Physics			

1	**Course Code**		
2	**Course Title**	**Condensed Matter Physics**	
3	**Course Type (Core Course/ Discipline Specific Elective/)**	**Core Course (CC-21)**	
4	**Pre-requisite (if any)**	**To Study this course a student must have graduation with physics as major or minor subject.**	
5	**Course Learning outcomes (CLO)**	**On successful completion of this course, the students will be able to:** 1. Understand the concept of Panchamahabhuta. 2. Analyze and classify crystal structures using point and space group symmetries. 3. Understand the Electronic and Thermal Properties of materials. **4.** Describe the mechanical behavior of crystalline solids through stress-strain tensors. **5.** Understand the phenomena of superconductivity and important effects such as Meissner effect and Josephson effect.	
6	**Credit Value**	**6**	
7	**Total Marks**	Max. Marks: 40 + 60= 100	Min. Passing Marks:16+24=40

Part B- Content of the Course

Total No. of Lectures (in hours): 90

Unit	Topics	No. of Lectures
I	**Crystallography** 1. Indian philosophy on the five basic elements Panchamahabhuta. 2. Point and Space group, Crystal structures- Hexagonal closed packed, Diamond, cubic structure and Perovskite structures, Reciprocal lattice. 3. Brillouin Zone, X- ray diffraction, Bragg's law, Lau's equation, Reciprocal lattice vector. 4. Fourier analysis of the basis, Scattered wave amplitude, Structure and form factors. Activities: *1. Organize a debate on Indian condensed matter physicists and their contributions.* *2. Group brief discussion of the Panchamahabhuta.* 3. *Prepare a chart on different types of crystal structure*	**18**
II	**Mechanical Properties** 1. Mechanics of deformed bodies for cubic crystals, stress strain tensors, Compliance and stiffness constants. 2. Elastic constants and energy density of cubic crystals, elastic waves in crystals and elastic isotropy. **Lattice Dynamics** 1. Normal modes of mono atomic and diatomic lattice vibrations, Dispersion relations, Phonon density of states. 3. Quantum theories of specific heats, An-harmonic effect, Equation of state of solid s, Thermal expansion, Gruneisen relation	**18**
III	**Electronic and Thermal Properties**	**18**

	1. Sommerfeld free electron model, Density of states, Application of electronic specific heat, Wiedermann Franz Law, Boltzmann Transport equation. 2. Relaxation time approximation and application to electrical conductivity, Hall Effect.	
IV	**3D lattice vibrations** 1. Vibration of three dimension lattice, coupling parameter approach in variance relations. 2. Phonon dispersion curves and its experimental method of determination. Neutron scattering	**18**
V	**Superconductivity** Superconductivity characteristic features, Critical current, Persistent current and Meissner effect,Critical Magnetic fields, Magnetic Susceptibility, flux quantization, specific heat, Thermal conductivity,Isotope effect, Optical energy gap, Quasi particle tunneling and Josephson effects (d.c. & a.c.),Electron phonon interaction, cooper pairs, BCS theory, Type I and II superconductivity, Introduction to high temperature superconductivity.	**18**

Keywords/Tags: Cubic crystal structure, Stress strain tensors, Mono atomic and diatomic lattice, Density of states, Vibration of three dimension lattice

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Essence of Panchamahabhuta. V.D.N. Rao
2. Introduction to Solid State Physics C. Kittel
3. Introduction to Solids R. A. Levy
4. Principles of theory of Solids J. M. Zeeman
5. Solid State Physics L. V. Azaroff
6. Solid State Physics N. W. Asheroff and N. D. Mermin
7. Solid State Physics A. J. Dekker

Suggested equivalent online courses:

https://www.youtube.com/watch?v=Nwfz99SCoEM
https://archive.nptel.ac.in/courses/115/106/115106127/
https://archive.nptel.ac.in/courses/115/105/115105131/
https://www.youtube.com/watch?v=yIr3NZM7N3A
https://www.classcentral.com/course/youtube-noc-jan-2020-electronic-theory-of-solids-prof-arghya-taraphder-47339
https://www.youtube.com/watch?v=DHEamYwGY0Y
https://www.youtube.com/watch?v=NxzEedNGThE
https://nptel.ac.in/courses/117103063
https://www.youtube.com/watch?v=PXY1GZbmU8I

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40 Marks University Exam (UE):60 Marks

Internal Assessment :40 marks		
Continuous Comprehensive Evaluation (CCE)	Class Test	20
	Assignment/Presentation	20
External Assessment : 60 marks	**Section(A)** : Very Short Questions	5x1=5

University Exam Section Time : 03.00 Hours	**Section (B) :** Short Questions **Section (C) :**Long Questions	5x4=20 5x7=35	
Any remarks/ suggestions:			

Part A Introduction				
Program: PG		**Class: M. Sc.**	**Year:I (II Sem)**	**Session: 2025-26**
Subject: Physics				
1	**Course Code**			
2	**Course Title**	**Advanced Quantum Mechanics**		
3	**Course Type (Core Course/ Discipline Specific Elective/)**	Core Course (CC-22)		
4	**Pre-requisite (if any)**	**To Study this course a student must have graduation with physics as major or minor subject.**		
5	**Course Learning outcomes (CLO)**	On successful completion of this course, students will be able to understand: 1. The concept of vibrations and sound by vedic philosophy. 2. Hilbert space, operators as matrices and Dirac's BRA and KET notations. 3. Three - dimensional Schrödinger equation in terms of spherical coordinates and its applications. 4. Quantum theory of scattering and scattering amplitude. 5. Different approximation methods and their applications.		
6	**Credit Value**	6		
7	**Total Marks**	Max. Marks: 40+60=100	Min. Passing Marks:16+24=40	

Part B- Content of the Course		
Total No. of Lectures (in hours): 90		
Unit	**Topics**	**No. of Lectures**
I	**Review and formulation of Quantum Mechanics** 1. The concept of "Nada Brahma" from Vedic philosophy and its significance in the Indian Knowledge System. 2. Introduction of Schrodinger wave equation and wave function, linear vector space, time dependent and time independent vectors, inner product, concept of Hilbert space. 3. Operators and wave functions as matrices, unitary transformation: change of basis, Dirac's BRA and KET notations and their properties. 4. Linear harmonic oscillator (solution by ladder or algebra method), energy eigenvalue, creation and annihilation operator, matrices for x and P_x. *Activities:* 1. *Organize a group discussion on "How do Indian philosophical ideas like Nada Brahma help us understand the wave nature of reality?"* 2. *Arrange debate on "understanding ancient ideas for scientific concepts like the Schrödinger wave equation or the dual nature of particles".* 3. *Prepare a char on Different Operators and wave functions.*	**18**
II	**Three - dimensional Schrödinger equation and Angular Momentum**	**18**

	1. Three - dimensional Schrödinger equation in terms of spherical coordinates, Applications for the determination of eigen functions and eigen values: (a) Rigid rotator (free axisand fixed plane), (b) Hydrogen atom. 2. Angular momentum operators and its representation in spherical coordinates, commutation relations, eigen values and eigen functions of Lz and L^2. 3. Ladder operators and eigen values, Spherical harmonics and its expressions, Spin angular momentum, Pauli's spin matrices.	
III	**Theory of Scattering** 1. Scattering cross section, differential scattering cross section, total scattering cross section, scattering amplitude, relation between scattering cross section and scattering amplitude, quantum theory of scattering. 2. Born Approximation, condition for the validity of Born approximation. 3. Method of partial waves analysis, optical theorem, phase shift, dependence of phase shift on potential, application: scattering by a perfectly rigid sphere.	**18**
IV	**Approximation methods** 1. Time-independent perturbation theory for non-degenerate and degenerate systems up to first and second order and its application for He-atom and Stark effect in hydrogen atom. 2. Variational (Rayleigh-Ritz) method and its application to the ground state He atom. 3. JWKB approximation, condition of validity, connection formulae, probabilityof penetration of a potential barrier. 4. Time dependent perturbation theory **(**Constant perturbation).	**18**
V	**Many -electron atoms and Schrödinger relativistic equation** 1. The central field approximation, Thomas-Fermi statistical model, Hartree's method of self- consistent field. 2. Klein Gordon equations, probability and current density, Klein Gordon equation in electromagnetic field, Hydrogen atom, short comings of Klein Gordon equation. **3.** Dirac's relativistic equation for free electron, Dirac's matrices, Dirac's equation in electromagnetic field, Hydrogen atom and hyperfine splitting, Negative energy.	**18**

Keywords: Schrodinger wave equation, Rigid rotator, Scattering amplitude, Perturbation theory, Klein Gordon equation**.**

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Joachim-Ernst Berendt, The World Is Sound: Nada Brahma
2. GhatakAjoy and Lokenathan S., "Quantum mechanics (theory and applications)" (6^{th} edition)–, McMillan India Ltd.
3. Griffiths David J. and Schroeter Darrel F., "Introduction to quantum Mechanics" (Third edition), Cambridge university press.
4. Schiff Leonard I., "Quantum mechanics", McGRaw-Hill Book company.
5. Satya Prakash, "Adv. Quantum Mechanics" ,KedarNath Ram Nath& Co.
6. Rajput B.S., "Adv. quantum mechanics", PragatiPrakashan.

7. Agrawal B.K. and Hariprakash, “Quantum Mechanics”, Prentie Hall of India, Pvt. Limited, New Delhi.
8. Sakurai Jun John and Napolitano Jim, “Modern Quantum Mechanics”, Addison-Wesley, 2011.
9. NouredineZettili, “Quantum Mechanics: Concepts and Applications” Wiley India, 2016

Suggested equivalent online courses:

https://www.youtube.com/watch?v=Ijk5dIrYip8
https://iqti.iisc.ac.in/wp-content/uploads/2021/06/QM_Griffiths.pdf
https://nptel.ac.in/courses/115106066
https://archive.nptel.ac.in/courses/115/108/115108074/
https://www.youtube.com/watch?v=liQoSIaYBJk
https://www.youtube.com/watch?v=UVkTuOwfOh0
https://www.youtube.com/watch?v=KicQaMC9pG8
https://www.youtube.com/watch?v=ZLP-EQ9lsU8

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40 Marks University Exam (UE):60 Marks

Internal Assessment:40 Marks Continuous Comprehensive Evaluation (CCE)	Class Test Assignment/Presentation	20 20
External Assessment: 60 Marks University Exam Section Time : 03.00 Hours	**Section(A)** : Very Short Questions **Section (B) :** Short Questions **Section (C) :**Long Questions	5x1=5 5x4=20 5x7=35

Any remarks/ suggestions:

Part A Introduction

Program:PG	**Class:**M.Sc.	**Year:**I(II Semester)	**Session:**2025-26

Subject: Physics Practical

1	**Course Code**		
2	**Course Title**	**Lab-I**	
3	**Course Type (Core Course/ Discipline Specific Elective)**	**Core Course (PC-21)**	
4	**Pre-requisite (if any)**	**To Study this course a student must have UG degree in physics.**	
5	**Course Learning outcomes (CLO)**	On successful completion of this course, the students will be able to: 1. Understand the phonon dispersion in solids. 2. Analyze the V-I characteristics of semiconductor diodes. 3. Understand the characteristics of digital circuits including flip-flops, adders, and subtractors. 4. Determine type of charge carrier of semiconductors using Hall Effect. 5. Verify laws of Boolean algebra.	
6	**Credit Value**	**4**	
7	**Total Marks**	Max. Marks: 100	Min. Passing Marks:40

Part B- Content of the Course

Total number Practical (in hours per week): 02 hours per credit per week

S. N.	**List of experiments**	**No. of Lectures** (per week)
1.	Study of phonon dispersion curves of linear mono and diatomic lattice vibrations in crystal.	**02 hours per credit per week**
2.	To study the V-I characteristics of a tunnel diode and to determine its negative resistance region.	
3.	Study of photoconductivity of cadmium sulphide (CdS) photo register at constant irradiation and voltage.	
4.	Identification of charge in P-type and N-type semiconductor using Hall effect.	
5.	Study of V-I characteristic curveof UJT and their use as relaxation oscillator.	
6.	Study of V-I characteristic curve of Gunn diode.	
7.	To verify De Morgan's theorem.	
8.	Verification of the truth tables of Half adder circuit.	
9.	Verification of the truth tables of Half subtractor circuit.	
10.	To verify laws of Boolean algebra.	

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Solid State Electronic Devices, Ben G. Streetman, Sanjay Banerjee for Semiconductor theory, V-I characteristics
2. Electronic Devices and Circuit Theory, Robert L. Boylestad for UJT, Tunnel diode, photoconductivity
3. Electronic Principles, Albert Malvino, David Bates for Practical electronics, diode characteristics.
4. Digital Logic and Computer Design, M. Morris Mano for Flip-flops, adders, subtractors
5. Introduction to Solid State Physics, Charles Kittel for Phonon dispersion, crystal lattice theory

Suggested equivalent online courses:

1. https://vlab.amrita.edu/index.php?sub=59&brch=165
2. **https://vlab.amrita.edu/?sub=3&brch=81&sim=399&cnt=1**
3. https://de-iitr.vlabs.ac.in/exp/truth-tables-flip-flops/simulation.html
4. https://me-iitr.vlabs.ac.in/exp/gunn-diode/simulation.html

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Lab Record/Class Interaction /Quiz	15	Viva Voce on Practical	30
Attendance in the lab	10		
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	15	Table work / Experiments	30
TOTAL	**30**		**60**

Any remarks/ suggestions:

Part A Introduction			
Program: PG	**Class: M.Sc.**	**Year:I (II Semester)**	**Session: 2025-26**
Subject:Physics			

1	**Course Code**		
2	**Course Title**	**Lab -II**	
3	**Course Type (Core Course/ Discipline Specific Elective)**	**Core Course (PC-22)**	
4	**Pre-requisite (if any)**	**To Study this course a student must have UG degree in physics.**	
5	**Course Learning outcomes (CLO)**	On successful completion of course, students will be able to: 1. Calculate e/m ratio using Zeeman principle. 2. Determine Young's modulus and Poisson's ratio. 3. Explore optical dispersion and quantify refractive index variation using Cauchy's formula. 4. Determine Curie temperature and dielectric constants of ferromagnetic material. 5. Study the characteristics of thermistors.	
6	**Credit Value**	**4**	
7	**Total Marks**	Max. Marks: 100	Min. Passing Marks:40

Part B- Content of the Course

Total Number of Lectures (hours per week): 02 hours per credit per week

S.N.	Topics	No. of Lectures (per week)
1.	Determination of e/m of electron by Zeeman principle using Febry Perot interferometer.	**02 hours per credit per week**
2.	To determine Young's modulus and Poisson's ratio of a glass plate using Cornu's method of interference.	
3.	To study the variation of refractive index of the material of prism with wavelength and Cauchy's dispersion formula.	
4.	To determine dielectric constant and Curie temperature of ferromagnetic material ($BaTiO_3$).	
5.	Study the characteristic curves of Thermistor.	
6.	Determination of Magnetic susceptibility of Paramagnetic solution by Quincke's method.	
7.	To generate a sinusoidal waveform using a function generator and measure its frequency and voltage amplitude using a Digital Storage Oscilloscope (DSO).	
8.	To determine the components of circuit using LCR meter.	
9.	Study of different thermocouples for temperature measurement.	
10.	To Compare the capacitances of two condensers by De-sauty's Bridge.	

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

9. Advanced Practical Physics, B.L. Worsnop& H.T. Flint for Interference, optical constants
10. B.Sc. Practical Physics, C.L. Arora for All listed experiments
11. Elements of Solid State Physics, J.P. Srivastava for Magnetic susceptibility, dielectric constant
12. Introduction to Electrodynamics, David J. Griffiths for e/m of electron, magnetic fields
13. Engineering Physics Lab Manual, S. P. Singh for Dielectrics, thermistors, bridges
14. Modern Experimental Physics, A.C. Melissinos for Fabry-Perot, Zeeman effect

Suggested equivalent online courses:

https://ph1-nitk.vlabs.ac.in/exp/zeeman-effect/procedure.html
https://vlab.amrita.edu/index.php?sub=1&brch=282&sim=1005&cnt=1
https://asnm-iitkgp.vlabs.ac.in/exp/de-sauty-bridge/
https://sl-coep.vlabs.ac.in/exp/temperature-sensor/

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Lab Record/Class Interaction /Quiz	15	Viva Voce on Practical	30
Attendance in the lab	10		
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TOTAL	**40**		**60**

Any remarks/ suggestions: