ST. ALOYSIUS COLLEGE(AUTONOMOUS), JABALPUR

Reaccredited 'A++ 'Grade by NAAC(CGPA:3.58/4.00)
College with Potential for Excellence by UGC
DST-FIST Supported & STAR College Scheme by DBT

Faculty of Science

Master of Science (M.Sc.)

SUBJECT: PHYSICS

M.Sc. II Semester

Under CBCS System

Paper-I

CONDENSED MATTER PHYSICS (CC-21)

Course Outcomes

	Course Outcomes After completing the course students will be able to	**Cognitive Level**
CO-I	Understand the concept of Panchamahabhuta.	U
CO-II	Analyze and classify crystal structures using point and space group symmetries	An
CO-III	Understand the Electronic and Thermal Properties of materials	U,R
CO-IV	Describe the mechanical behavior of crystalline solids through stress-strain tensors	E
CO-V	Understand the phenomena of superconductivity and important effects such as Meissner effect and Josephson effect	U,An,Ap,E

R-Recall, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Content of the Course

Theory

Maximum Marks: 60

Units	Topics
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
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
III	**Electronic and Thermal Properties** 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
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

References

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-taraphder47339

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

Faculty of Science

Master of Science (M.Sc.)

SUBJECT: PHYSICS

M.Sc. II Semester

Under CBCS System

Paper-II

ADVANCED QUANTUM MECHANICS (CC-22)

Course Outcomes

	Course Outcomes After completing the course students will be able to	**Cognitive Level**
CO-I	Understand the concept of vibrations and sound by vedic philosophy..	U,R
CO-II	Understand Hilbert space, operators as matrices and Dirac's BRA and KET notations	U,E
CO-III	Solve three - dimensional Schrödinger equation in terms of spherical coordinates and its applications.	U, Ap,An, E,C
CO-IV	Understand Quantum theory of scattering and scattering amplitude.	E
CO-V	Solve Different approximation methods and their applications.	U, Ap,An, E,C

R-Recall, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Content of the Course
Theory

Maximum Marks: 60

Units	Topics
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 Px. **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.
II	**Three - dimensional Schrödinger equation and Angular Momentum** 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 L2 . 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.
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)
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.

References

Suggested Readings:

1. Joachim-Ernst Berendt, The World Is Sound: Nada Brahma
2. . GhatakAjoy and Lokenathan S., "Quantum mechanics (theory and applications)" (6th 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

PRACTICALS

LAB – 1 (PC-21)

1. Study of phonon dispersion curves of linear mono and diatomic lattice vibrations in crystal.
2. To study the V-I characteristics of a tunnel diode and to determine its week 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.

Text Books, Reference Books, Other resources

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.

LAB – 2 (PC-22)

1. Determination of e/m of electron by Zeeman principle using Febry Perot interferometer.
2. To determine Young's modulus and Poisson's ratio of a glass plate using Cornu's per week 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 (BaTiO3).
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

Text Books, Reference Books, Other resources

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