Semester 8th

Course Code	Course Title	Credit	CIA	MSE	ESE	Max Marks
Core Courses						
ICPHY8C001T	Statistical Mechanics	4	25	25	50	100
ICPHY8C002T	Quantum Mechanics – II	4	25	25	50	100
ICPHY8C003T	Electrodynamics	4	25	25	50	100
ICPHY8C001L	General Physics Lab – II	4	25	25	50	100
ICPHY8C004T	Mathematical Physics – II	4	25	25	50	100
Foundation Course						
ICPHY8F001T	Computational Physics	4	25	25	50	100
Total		24	-	-	-	600

जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया–सूचानी (बागला), जिला: सांबा–181143, जम्मू (जम्मू एवं कश्मीर), भारत
Rahya-Suchani (Bagla), District: Samba – 181143, Jammu (J&K), India
Department of Physics & Astronomical Sciences

Program Outcomes of Semester 8th of Integrated B.Sc. (Hons.) – M.Sc. Physics

Course Objectives:

To understand the modern day Physics, present technology in the field of Particle Physics to Nano-materials students require adequate knowledge in Quantum Mechanics. The basics of the subject are designed here to grow the concept amongst the students.

Course Name	Program Outcomes
Quantum Mechanics - II (ICPHY8C002T)	The course provides an understanding of the behaviour of the systems at microscopic (atomic and nuclear) scale and even smaller. Students would learn basic postulates and formulations of quantum Mechanics. The course, in fact, plays an important role in explaining the behaviour of all physical systems in the universe. The course includes the study of a brief review of foundations of quantum mechanics, matrix formulation of quantum mechanics, symmetry in quantum mechanics and approximation methods for bound states.

Program Specific Outcomes

- The concept of Schrodinger equation creates analytical power of students. The knowledge of quantization is clarified by studying energy levels. The study of different potentials nourish them to think about system and its function with the help of mathematical tools. Students get skilled by studying the formalism of quantum mechanics in describing the systems mathematically and this knowledge becomes very useful for their study of particle physics, spectroscopy and research.
- By learning the symmetry principles, the visualization about the system gets stronger. Concept of linear vector space help them to write the systems in proper way. By studying angular momentum, the conceptual clarity regarding the calculations of the eigen-value and eigen vector. Learning the calculations of CG coefficients students get ready to solve analytical and mathematical problems.

Five years Integrated M.Sc. Physics			
Semester :	VIII	Type:	Core
Course Name:	Quantum Mechanics-II	Course Code:	
Credits:	4	L T P:	3-1-0

Unit I: Identical Particles

Indistinguishability, symmetric and anti-symmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle.

Unit II: Time-independent Approximation Methods

Non-degenerate and degenerate perturbation theory. Stark effect, Zeeman effect and other examples. Variational methods. WKB approximation. Tunnelling. Numerical perturbation theory, comparison with analytical results.

Unit III: Time-dependent Problems

Schrödinger and Heisenberg pictures. Time-dependent perturbation theory. Transition probability calculations, Fermi's golden rule. Adiabatic and sudden approximations. Beta decay. Interaction of radiation with matter. Einstein A and B coefficients, introduction to the quantization of electromagnetic field.

Unit IV: Scattering Theory

Differential scattering cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

Unit V: Relativistic Quantum Mechanics:

Klein Gordon equation, Dirac equation, negative energy solutions, antiparticles, Dirac hole theory, Feynman interpretation of antiparticles, Gamma matrices and their properties, Covariance of Dirac equation, Charge conjugation, Parity & Time reversal invariance, Spin & Helicity.

Text Books and References:

1. C. Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics (Vol. II), Wiley.
2. A. Messiah, Quantum Mechanics (Vol.II), Dover.
3. S. Flügge, Practical Quantum Mechanics, Springer.
4. J. J. Sakurai, Modern Quantum Mechanics, Pearson.
5. K. Gottfried and T.-M. Yan, Quantum Mechanics: Fundamentals, Springer.

जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया–सूचानी (बागला), जिला: सांबा–181143, जम्मू (जम्मू एवं कश्मीर),भारत
Rahya-Suchani (Bagla), District: Samba – 181143, Jammu (J&K), India
Department of Physics & Astronomical Sciences

Program Outcomes of Semester 8th of Integrated B.Sc. (Hons.) – M.Sc. Physics

Course Objectives:

To have in-depth knowledge in thermodynamics and quantum statistics etc. this course is needed.

Course Name	Program Outcomes
Statistical Mechanics (ICPHY8C001T	The course includes the study of Basic postulates, application of classical distribution to ideal gases, imperfect gases, quantum statistics and black body radiation. The course is helpful for the students to understand the dynamics of the bulk material in macroscopic as well as microscopic levels. It is also useful to understand the relation between microscopic and macroscopic systems.

Program Specific Outcomes

- Understand the process of thermal conductivity, viscosity and diffusion in gases.
- Understand the basic statistical methods and concepts like probability, random variables, expected value, variance, estimators and common probability distributions.
- Understand the relation between microscopic and macroscopic description through statistical mechanics; know and can apply the laws of thermodynamics and principles of free energy; describe thermodynamic processes and heat engines and master the use of the chemical potential to describe diffusive equilibrium, phase equilibrium and chemical processes.
- Understand the efficiency of Carnot's engine and the significance of first law and second of thermodynamics and implications of the second law of thermodynamics and limitations placed by the second law on the performance of thermodynamic systems.

Five years Integrated M.Sc. Physics			
Semester :	VIII	**Type:**	Core
Course Name:	Statistical Mechanics	**Course Code:**	
Credits:	4	**L T P:**	3-1-0

Unit I: Preliminary Concepts

Mean values; standard deviation; various moments and generating functions; Random walk problem; Binomial distribution; Poisson distribution; Gaussian distributions; Central Limit Theorem; Diffusion Equation;

Unit II: Review of Thermodynamics

Laws of thermodynamics and their consequences; Extensive and intensive variables; Thermodynamic potentials and Legendre transformations; Maxwell relations; chemical potential; phase equilibrium; Free energy and connection with thermodynamic variables; the classical ideal gas.

Unit III: Classical Statistical Mechanics

Phase space; Liouville's theorem; ergodic hypothesis, micro- and macro-states; Basic postulates of statistical mechanics- micro-canonical, canonical and grand canonical ensembles; partition functions, Relation to thermodynamic variables in terms of partition function; Fluctuations. Ideal gas; Gibbs paradox; Maxwell-Boltzmann gas velocity and speed distribution; Equation of state for a non-ideal gas; Van der Waals' equation of state; Meyer cluster expansion; virial coefficients.

Unit IV: Quantum Statistical Mechanics-I

Density Matrix, ensembles in quantum statistical mechanics, simple applications of density matrix. Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics.

Unit V: Quantum Statistical Mechanics-II

Bose system: Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation and derivation of Planck's distribution law, Bose- Einstein condensation. Fermi System: Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat, white dwarf stars.

Text Books and References:

1. Walter Greiner, Ludwig Neise, Horst Stocker, Thermodynamics and Statistical Mechanics, Springer.
2. Kerson Huang, Introduction to Statistical Physics, Taylor and Francis.
3. R. K. Pathria, Statistical Mechanics, 2nd Ed.
4. J K Battacharjee, Statistical Physics; Allied Publishers (India).
5. F Reif, Statistical and Thermal Physics, McGraw Hill.
6. C Kittel, Thermal Physics, CBS Indian edition.
7. J. P. Sethna, Statistical Mechanics: Entropy, Order Parameter and Complexity, Oxford University Press.

जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया–सूचानी (बागला), जिला: सांबा–181143, जम्मू (जम्मू एवं कश्मीर),भारत
Rahya-Suchani (Bagla), District: Samba – 181143, Jammu (J&K), India
Department of Physics & Astronomical Sciences

Program Outcomes of Semester 8th of Integrated B.Sc. (Hons.) – M.Sc. Physics

Course Objectives: Students completing this subject should be able to: explain classical electrodynamics based on Maxwell's equations including its formulation in covariant form.

Course Name	Program Outcomes
Electrodynamics (ICPHY8C003T)	The study of electromagnetic theory provides basic foundation for the students to understand advanced courses of physics. The astrophysics part of the course opens scope for students seeking research opportunities in space, atmospheric and planetary sciences etc. The course involves the study of electromagnetic theory, Maxwell's equations and electromagnetic waves, radiations from moving charges, solar and stellar systems.

Program Specific Outcomes

Students will have achieved the ability to:

- Use Maxwell equations in analysing the electromagnetic field due to time varying charge and current distribution.
- describe the nature of electromagnetic wave and its propagation through different media and interfaces.
- explain charged particle dynamics and radiation from localized time varying electromagnetic sources

Five years Integrated M.Sc. Physics			
Semester :	VIII	Type:	DSE
Course Name:	Electrodynamics	Course Code:	
Credits:	4	L T P:	3-1-0

Unit I: Review of Electrostatics

Coulomb's law & its applications; action-at-a distance vs. concept of fields; Poisson and Laplace equations; formal solution for potential with Green's functions; boundary value problems; multipole expansion; dielectrics, polarization of a medium.

Unit II: Review of Magnetostatics

Biot-Savart law; differential equation for static magnetic field; vector potential; magnetic field from localized current distributions; Ampere's theorem.; Faraday's law of induction; energy densities of electric and magnetic fields.

Unit III: Maxwell's Equations

Maxwell's equations in vacuum; Vector and Scalar potentials in electrodynamics; gauge invariance and gauge fixing, Coulomb and Lorentz gauges; displacement current; Electromagnetic energy and momentum; conservation laws; inhomogeneous wave equation and its solutions using Green's function method; covariant formulation of Maxwell's equations.

Unit IV: Electromagnetic Waves

Plane waves in a dielectric medium; reflection and refraction at dielectric interfaces; Frequency dispersion in dielectrics and metals; dielectric constant and anomalous dispersion; wave propagation in one dimension; group velocity; metallic wave guides; boundary conditions at metallic surfaces; propagation modes in wave guides; resonant modes in cavities; Dielectric waveguides; Plasma oscillations.

Unit V: Radiations and wave guides

EM Field of a localized oscillating source; Fields and radiation in dipole and quadrupole approximations; antenna; radiation by moving charges; Lienard-Wiechert potentials; total power radiated by an accelerated charge; Lorentz formula; transmission lines and wave guides-TE, TM and TEM modes; rectangular and cylindrical wave guides; resonant cavities; energy dissipation; Q of a cavity.

Text Books and References:

1. D.J. Griffiths, Introduction to Electrodynamics, Prentice Hall.
2. J.D. Jackson, Classical Electrodynamics, Wiley.
3. A. Das, Lectures on Electromagnetism, Hindustan Book Agency.
4. J.R. Reitz, F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory, Addison-Wesley.
5. W.K.H. Panofsky and M. Phillips, Classical Electricity and Magnetism, Dover.
6. R.P. Feynman, Feynman Lectures on Physics (Vol. II), Addison-Wesley.
7. A. Zangwill, Modern Electrodynamics, Cambridge University Press.

Five years Integrated M.Sc. Physics

		Type:	Core
Semester :	VIII	Course Code:	
Course Name:	General Physics Lab-II	L T P:	0-0-8
Credits:	4		

1. To measure Planck's constant using photoelectric effect.
2. To study the dielectric constant of given materials (polystyrene, glass and PCB sheet etc.).
3. To determine the thickness of mica sheet using Michelson Interferometer.
4. To Study the B-H curves of given specimen and estimate the Hysteresis loss.
5. To determine the numerical aperture of an optical fiber.
6. To study Frank-Hertz phenomenon using Neon lamp.
7. To demonstrate the Faraday Effect using flint glass.
8. To determine the phase shift between the normal and extraordinary light beam produced by given dielectric fluid (nitrobenzene) and to plot a graph between the phase shift and square of electric field or square of voltage. (Kerr effect)
9. To measure the wavelengths of the Balmer Series of visible emission lines from hydrogen tube.
10. To study Zeeman effect.
11. To study of superconducting properties in high-T_c superconductor.
12. To plot the current –voltage characteristics of a CdS photoresister at constant irradiance.
13. To design D/A and A/D Converters using IC.
14. To design and verify the truth table for Half Adder and Full Adder Logic Circuits.
15. To design active filter circuits.
16. To study regulated power supply Using IC LM 317.
17. To study constant current source Using IC 741 and LM 317.
18. To study of Multiplexer and De-multiplexer.
19. To design Serial in, Serial out and Parallel in, Parallel out Shift Registers.
20. To study of 8085 Microprocessor and Execution of Simple Programs.

Note: Each student is required to perform at least 8 of the above experiments.

जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया–सूचानी (बागला), जिला: सांबा–181143, जम्मू (जम्मू एवं कश्मीर),भारत
Rahya-Suchani (Bagla), District: Samba – 181143, Jammu (J&K), India
Department of Physics & Astronomical Sciences

Program Outcomes of Semester 8th of Integrated B.Sc. (Hons.) – M.Sc. Physics

Course Objectives: To make students expert in the subjects like Partial Differential Equations (PDE), Green's Functions, Integral Equations, Group Theory and Numerical Techniques and C Programming this course in designed

Course Name	Program Outcomes
Mathematical Physics – II (ICPHY8C004T)	Students would be able to understand the mathematical methods essential for solving the advanced problems in physics. It would be helpful in the development of the ability to apply the mathematical concepts and techniques to solve the problems in theoretical and experimental physics. The knowledge of mathematical physics would be beneficial in further research and development as it serve as a tool in almost every branch of science and engineering.

Program Specific Outcomes

- Mathematical Methods of Physics-II deals with Partial Differential Equations (PDE), Green's Functions, Integral Equations, Group Theory and Numerical Techniques.
- Students learn to set the mathematical scenario of different physical system by writing the PDE's and reveal the underlying sense by solving them. Thus PDE help to develop their analytical skill.
- Knowledge of Green's function assist students to solve the non- homogeneous differential equations. Learning of methodology and application of the Green's function clarifies the basics of calculus and analytical skill.

Five years Integrated M.Sc. Physics			
Semester :	VIII	Type:	ID
Course Name:	Mathematical Physics-II	Course Code:	
Credits:	4	L T P:	3-1-0

Unit I: Calculus of variations

Extremization problems (with and without constraints). Euler-Lagrange equations and Lagrange's multipliers. Functional derivatives for real and complex fields (with applications in classical and quantum physics). Noether's theorem.

Unit II: Partial Differential Equations

Laplace and Poisson equation (with particular emphasis on solving boundary value problems in Electrostatics and Magnetostatics); Wave equation. Heat Equation. Green's function approach. Separation of variables and solution in different coordinates.

Unit III: Group Theory-I

Definition and properties. Discrete and continuous groups; Subgroups and cosets; Products of groups; Matrix representation of a group. (Ir)reducible representations.

Unit IV: Group Theory-II

Characters. Representations of finite groups.Examples of continuous groups, SO(3), SU(2) and SO(n) and SU(n). Generators of SU(2) and their algebra. Representations of SU(2).

Unit V: Tensor

Coordinate transformations, scalars, contravariant and covariant vectors; mixed and covariant tensor of second rank, addition, subtraction and contraction of tensors, quotient rule. Christoffel symbols; transformation of Christoffel symbols; covariant differentiation, Ricci's theorem, divergence, Curl and Laplacian tensor form; Stress and strain tensors, Hook's law in tensor form.

Text Books and References:

1. P. Dennery and A. Krzywicki, Mathematics for Physicists, Dover.
2. S.D. Joglekar, Mathematical Physics: Advanced Topics (Vol. II), Universities Press.
3. P.M. Morse and H. Feshbach, Methods of Theoretical Physics (Vol. I & II), Feshbach Publishing.
4. A.W. Joshi, Matrices and Tensors in Physics, New Age Publishers.
5. W.-K. Tung, Group Theory in Physics, World Scientific.
6. A. Das and S. Okubo, Lie Groups and Lie Algebras for Physicists, Hindustan Book Agency
7. I. Gelfand and S. Fomin, Calculus of Variations, Dover.
8. W. Yourgrau and S. Mandelstam, Variational Principles in Dynamics and Quantum Theory, Dover.

जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया–सूचानी (बागला), जिला: सांबा–181143, जम्मू (जम्मू एवं कश्मीर), भारत
Rahya-Suchani (Bagla), District: Samba – 181143, Jammu (J&K), India
Department of Physics & Astronomical Sciences

Program Outcomes of Semester 8th of Integrated B.Sc. (Hons.) – M.Sc. Physics

Course Objectives: In this course the probability, statistics, experimental measurements, error, numerical methods and use of computational approach in Physics.

Course Name	Program Outcomes
Computational Physics (ICPHY8F001T)	The course provides an opportunity to the students to learn about the fundaments of computer applications in solving the problems in different branches of Physics and Mathematics. They would learn basics of programming languages and their applications which can useful in their future carrier in the field of research and technology.

Program Specific Outcomes

- In this course the probability, statistics, experimental measurements, error, numerical methods and use of computational approach in Physics.
- Studying probability and statistics students get acquainted with statistical calculation that can be used in real applications.
- Understanding of the error, data fitting assist students to get practised with error analysis.
- The knowledge of numerical methods functions as advantage to the students as they realize the numerical steps of calculus.
- Finally applications of computational approach in Physics make students ready for the research and development.

Five years Integrated M.Sc. Physics			
Semester :	VIII	Type:	F
Course Name:	Computational Physics	Course Code:	
Credits:	4	L T P:	3-1-0

Unit I: An overview of Programming

Overview of computer organization, hardware, software, scientific programming in FORTRAN and/or C, C++.

Unit II: Stochastic Processes

Theory of random walks and simulation of random walks in one, two and three dimensions. Elementary ideasand simulations of self-avoiding walks, additive and multiplicative stochastic processes, Brownian motion.

Unit III: Percolation theory

Percolation theory and simulation by Hoshen-Kopelman algorithm; Application to simple lattice models in Physics.

Unit IV: Simulations-I

Elementary ideas of Molecular dynamics; Dynamical equations and physical potentials; Verlet algorithm.

Unit V: Simulations-II

Time-average and Ensemble average; Monte Carlo methods; Metropolis algorithm. Introduction to the simulations: (a) Ising model in magnetism (b) Bak-Tang-Wiesenfeld model in studies of Self Organized Criticality.

Text Books and References:

1. D. Frenkel& B. Smit, Understanding Molecular Simulation, Academic Press.
2. D. Stauffer, Introduction to Percolation Theory, Taylor-Francis.
3. M. Plischke & B. Bergersen,Equilibrium Statistical Physics, World Scientific.
4. W.H. Press, B.P. Flannery, S.A. Teukolsky and W.T. Vetterling, Numerical Recipes in C/C++: The Art of Scientific Computing, Cambridge University Press.
5. V. Rajaraman, Computer Programming in Fortran 90, Prentice Hall.
6. J.M. Thijssen, Computational Physics, Cambridge University Press.
7. H. Gould and J. Tobochnik, An Introduction to Computer Simulation Methods, Addison Wesley.