INVERTIS
UNIVERSITY BAREILLY

Scheme of Instruction & Syllabi

For

Master of Science

In

Physics

Two Years CBCS M.Sc. Course in Physics

(Academic Session: 2020-21)

Department of Applied Sciences & Humanities INVERTIS UNIVERSITY

Invertis Village

Bareilly-Lucknow NH-24, Bareilly-243123, India

15/10/21

VICE CHANCELLOR
INVERTIS UNIVERSITY
BAREILLY

Head
Department of Applied Science
Invertis University, Bareilly (U.P.)

15/10/20

15-10-2020

S. P. Gautam 15/10/2020

15/10/2020

Dean

INVERTIS
UNIVERSITY BAREILLY

M.Sc. (Physics)

This program provides an ability to identify and solve significant problems across a broad range of application areas, to develop the aptitude to apply the principles of Physics and to articulate an in depth understanding of advanced knowledge on various areas of Physics. It is designed to help students understand the importance of physical advancements in industry and the role of these in improving the quality of human life.

Head
Department of Applied Science
Invertis University, Bareilly (U.P.)

VICE CHANCELLOR

Dean
Faculty of Science
Invertis University, Bareilly (U.P.)

INVERTIS UNIVERSITY BAREILLY

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The program acts as the advanced degree and helps to develop critical, analytical and problem-solving skills at advanced level. The foundation degree makes the students employable in scientific organizations and also to assume administrative positions in various types of organizations. It also helps the students to pursue a career in academics or scientific organizations as a researcher.

The Program Educational Objectives are to prepare the students to:

PEO-1. **Work independently or in team with engineering, medical, ICT professionals and scientists in scientific problem solving.**

PEO-2. **Act as administrators in public, private and government organizations or business administrator with further training and education.**

PEO-3. **Pursue Doctoral research degrees to work in colleges, universities as professors or as scientists in research establishments.**

Head
Department of Applied Science
Invertis University, Bareilly (U.P.)

VICE CHANCELLOR
INVERTIS UNIVERSITY
BAREILLY

Dean
Faculty of Science
Invertis University, Bareilly (U.P.)

15/10/2020

15/10/2020

M.Sc. Previous (PHYSICS)
Proposed Course Structure

Semester – I

S.No	Paper	Code	Subjects	Teaching Scheme			Marks Distribution			Credit
				L	T	P	CA	EE	Total	
1	Paper 1	MPY -101	Mathematical Physics	3	1	0	30	70	100	4
2	Paper 2	MPY -102	Classical Mechanics	3	1	0	30	70	100	4
3	Paper 3	MPY -103	Advanced Quantum Mechanics	3	1	0	30	70	100	4
4	Paper 4	MPY -104	Electromagnetic Theory	3	1	0	30	70	100	4
5	Lab 1	MPY -151	Physics Lab I	-	-	6	50	100	150	6
	Total			**12**	**4**	**6**	**170**	**380**	**550**	**22**
L-Lecture, T-Tutorial, P- Practical, CA-Continuous Assessment, EE-Examination Evaluation.										

Semester – II

S.No	Paper	Code	Subjects	Teaching Scheme			Marks Distribution			Credit
				L	T	P	CA	EE	Total	
1	Paper 1	MPY -201	Condensed Matter Physics	3	1	0	30	70	100	4
2	Paper 2	MPY -202	Atomic and Molecular Physics	3	1	0	30	70	100	4
3	Paper 3	MPY -203	Nuclear and Particle Physics	3	1	0	30	70	100	4
4	Paper 4	MPY -204	Thermodynamics and Statistical Physics	3	1	0	30	70	100	4
5	Lab 2	MPY -251	Physics Lab II	-	-	6	50	100	150	6
	Total			**12**	**4**	**6**	**170**	**380**	**550**	**22**
L-Lecture, T-Tutorial, P- Practical, CA-Continuous Assessment, EE-Examination Evaluation.										

Head
Department of Applied Science
Invertis University, Bareilly (U.P.)

VICE CHANCELLOR
INVERTIS UNIVERSITY
BAREILLY

Dean
Faculty of Science
Invertis University, Bareilly (U.P.)

INVERTIS
UNIVERSITY BAREILLY

Program Outcomes of M.Sc. (Physics)

PO1: Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in different areas of Physics.

PO2: Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO3: Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO4: Students will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

PO5: Students will be able to explore new areas of research in both physics and allied fields of science and technology.

PO6: Students will appreciate the pivotal role of physics in our society and use this as a basis for ethical behavior.

PO7: Students will be able to function as a member of an interdisciplinary problem-solving team.

PO8: The graduate has specific skills in planning and conducting advanced experiments and applying structural-physical characterization techniques.

PO9: Are able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.

PO10: Are able to use modern library searching and retrieval methods to obtain information about a topic, techniques, or an issue relating to physics.

PO11: Students should be able to communicate scientific results in writing and in oral presentation.

PO12: Students should become proficient in their specialized area of physics and acquire the basic tools needed to carry out independent cutting-edge research in physics.

Head
Head ... Science
Department of Applied Science
...sity, Bareilly (U.P.)

Dean
Faculty of Science
Invertis University, Bareilly (U.P.)

15-10-2020

15/10/2020

Semester-I

MPY-101: Mathematical Physics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - None

Course Objectives:

1. To equip the M.Sc. students with the mathematical techniques that he/she needs for understanding theoretical treatment in different courses taught in this class.
2. To developing a strong background if he/she chooses to pursue research in physics as a career.

Detailed Syllabus:

Unit-1

Matrices - Definitions and types of matrices; Solution of linear algebraic equations, Characteristic equation and diagonal form, Eigen values and Eigen vectors, Cayley - Hamilton theorem, Functions of matrices, Application in solving linear differential equation.

Unit-2

Differential Equations - Linear Differential equation of first order, linear differential equations with constant coefficient, Summary of Frobenius method, Exact equation, Inhomogenous linear equation, Differential equation with exact solution.

Unit-3

Complex Analysis - Function of complex variables, Cauchy-Riemann differential equations, Cauchy's integral theorem, Cauchy's integral formula, Taylor's Series, Laurent series, Cauchy residue theorem, Singular points of an analytical function, Evaluation of residues & definite integrals.

Unit-4

Special Functions Differential Equations - Differential Equations and Special Functions, Beta and Gamma functions, Second ordered linear differential equations with variable coefficients, Solution of Hyper-geometric, Legendre, Bessel, Hermite and Laguerre equations, Physical applications, Generating functions, Recursion relations.

Unit-5

Fourier series and Transforms - Fourier series, Fourier integrals and transform, FT of Delta functions, Convolution theorem, Parseral's identity, Applications to the solution of differential equations, Laplace Transform and its properties, Applications to the solution of differential equations

Text and Reference Books:
Artken & Weber, Mathematical methods for Physicist, Academic Press- N.Y.
E. Kreyszig, 7th Edition, Advanced Engineering Mathematics, New Age International.
J.W. Brown, R.V .Churchill, Complex Variables and Applications, Mc-Graw Hill.
A. W. Joshi, Matrices and Tensors in Physics, New Age International

Course Outcomes:

After completing the course, students will be able to:

CO1.	Describe the basics of differential equations and complex analysis in problems of Physics.
CO2.	Develop the understanding of the basic properties of Legendre's function and Bessel's function by solving Legendre's & Bessel's equations.
CO3.	Interpret the role of differential equations and solution of differential equations using Laplace & Fourier transformation
CO4.	Apply the knowledge of Legendre's function and Bessel's function for computation of generating functions, recurrence relations, orthogonality relations.
CO5.	Evaluate complex analysis for evaluation of residues & definite integrals.
CO6.	Classify the electrical and mechanical problems on the basis of differential equations

.

MPY -102: Classical Mechanics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - None

Course Objectives:

1. To train the students of M.Sc. students in the Lagrangian and Hamiltonian formalisms and to impart knowledge about the limitations of Newtonian Mechanics and alternate formalism of Lagrange and Hamilton.
2. To introduce the fundamental concepts of Lagrangian, and Hamiltonian Formalism, Planetary motion and motion in a central force field.
3. To enable the students to understand the advantages of using Hamilton's principle, Lagrangian formalism and canonical transformations

Unit-1

Preliminaries of classical mechanics - Newtonian mechanics- single and many particle systems, Conservation principles (laws)-linear momentum, Angular momentum & energy, Constrained motion, constraints, Degree of freedom, Generalised coordinates and notations.

Unit-2

Variational principle and Lagrangian formulation - Introduction and techniques of calculation of variations, Hamilton's variational principle, D' Alembert principle, Lagrange's equation, Application of Lagrange equations of motion-linear harmonic oscillator, Simple pendulum, Compound pendulum, Particle moving under central force, Superiority of Lagrangian approach over Newtonian approach.

Unit-3

Hamiltonian formulation of mechanics - Phase space and the motion of the system, Hamiltonian with physical significance, Hamiltonian canonical equations of motion, Hamiltonian canonical equations of motion in different coordinate systems, Applications of Hamiltons equation of motion- simple pendulum, compound pendulum, Linear harmonic oscillator, Principle of least action, Canonical transformations, Poisson bracket, Poisson's theorem, Poisson brackets in quantum mechanics.

Unit-4

Motion under central forces: two body problem - Equivalent one body problem, General features of central force motion, Motion under inverse square law - kepler problem, Virial theorem, Unbound motion Rutherford scattering, Centre of mass and laboratory coordinates

Text and Reference Books:

H. Goldstein, *Classical Mechanics*, Narosa Publishing Home.
L.D. Landau & E.M. Lifschz, Mechanics, Pergamon**:**
P.V. Panat, *Classical Mechanics*, Narosa Publishing Home.
R. G. Takawale and P.S.Puranik, *Introduction to Classical Mechanics,* TMH
J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publishing House.
N. C. Rana & P. S. Joag, *Classical Mechanics*, TMH.

Course Outcomes:

CO1.	Define or describe all the introductory level of Preliminaries of classical mechanics, Variational principle and Lagrangian formulation, Hamiltonian formulation of mechanics, Motion under central forces: two body problem, Special relativity in classical mechanics
CO2.	Develop the understanding of the basic Concepts, laws, theorems required for the study of Variational principle, Lagrangian, Hamiltonian Motion under central, Special relativity in classical mechanics**.**
CO3.	Apply the different methods(formulas), theorem to solve the numerical problems in**,** Lagrangian, Hamiltonian Motion under central, Special relativity
CO4.	Analyze the Lagrangian, Hamiltonian, Special relativity.
CO5.	Evaluate the numerical problems in, Lagrangian, Hamiltonian, Motion under central forces. Special relativity
CO6.	Classify the Lagrangian and Hamiltonian on the basis different methods

MPY -103: Advanced Quantum Mechanics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - Wave mechanics

Course Objectives:

1. To introduce the students of M.Sc. class to the formal structure of the subject.
2. To equip them with the techniques of vector spaces, angular momentum, perturbation theory, and scattering theory so that they can use these in various branches of physics as per their requirement.

Detailed Syllabus:

Unit-1

Schrödinger Equation - Empirical basis, de-Broglie hypothesis of matter waves, Heisenberg's uncertainty relation, Schrödinger's wave equation, Physical interpretation and conditions of wave function, Eigen values and Eigen-functions, Particle in a square-well potential, Tunnelling through a barrier.

Unit-2

Angular Momenta and their Properties - Angular momentum operator in position representation, the rotation operator and angular momentum, Spin angular momentum, Total angular momentum operators, Commutation relations of total angular momentum with components, Addition of angular momenta: Clabsch-Gordan coefficients.

Unit-3

Stationary perturbation theory - Stationary perturbation theory (non-degenerate case), Physical applications of non-degenerate perturbation theory: Normal He-atom, Perturbed Harmonic oscillator.

Unit-4

Variation method - The variation (Rayleigh-Ritz) method, Physical applications of variation method: Ground state of helium, Zero-point energy of one-dimensional harmonic oscillator.

Unit-5

W. K. B. Method - The W.K.B. method, Connection formulae for penetration of a barrier, Application of W.K.B. method: Probability of penetration of a barrier, Theory of α- decay, Geiger-Nuttel law.

Unit-6

Scattering Theory- Introduction, Scattering cross-section; Differential and total cross sections, Stationary scattering wave: Scattering amplitude, Born Approximation, Partial wave analysis.

Text and Reference Books:

L. I. Schiff, *Introductory Quantum Mechanics*, Pearson Education Ltd.

R. P. Feynman, *Feynman Lectures on Physics (Volume 3),* Narosa.

J. J. Sakurai, *Modern Quantum Mechanics*, Addison-Wesley.

P. M. Mathews and K. Venkatesan, *A Text-book of Quantum Mechanics,* Tata mcgraw- Hill.

A. Ghatak and S. Lokanathan, *Quantum mechanics: Theory and Applications,* Kluwer

Academic.

Course Outcomes:

After completing the course, students will be able to:

CO1.	Define or describe Schrödinger Equation, Angular Momenta and their Properties, Stationary perturbation theory, Variation method, W. K. B. Method, Scattering Theory
CO2.	Apply the different methods or theorem to solve Problems of Angular moments, Variation method
CO3.	Analyze the W. K. B. Method, Scattering Theory
CO4.	Evaluate numerical of Schrödinger Equation, Angular Momenta and their Properties
CO5.	Classify the Stationary perturbation theory

MPY -104: Electromagnetic Theory

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - Electrostatics, Magneto-statics, Maxwell's Equations, Electromagnetic Waves, Radiation

Course Objectives:

1. To introduce students with different coordinate systems.
2. To familiarize the students with the different concepts of electrostatic, magneto static and time varying electromagnetic systems.
3. To expose the students to the ideas of electromagnetic waves and structure of transmission line.

Detailed Syllabus:

Unit-1

Electrostatics - Differential equation for electric field, Gauss's law, Poisson and Laplace equations, formal solution for potential with Green's functions, examples of image method, Solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, Dielectrics, polarization of a medium, electrostatic energy; Boundary value problems.

Unit-2

Magneto-statics - Magnetic Induction, Biot - Savart law, Ampere's law and applications, Magnetic flux, Magnetization, Magnetic intensity, energy density, Linear and
nonlinear media.

Unit-3

Maxwell's Equations - Displacement current, Maxwell's equations, Boundary conditions on the fields at interfaces, Electromagnetic energy and momentum, Conservation laws, Inhomogeneous wave equation and Green's function solution, Poynting Theorem, Poynting vector.

Unit-4

Electromagnetic Waves - Electromagnetic wave equation, Solution and propagation of monochromatic waves in non-conducting media, Polarization and energy density, Reflection and transmission at oblique incidence, Waves in conducting media, Wave guides, TE, TM and TEM waves in rectangular wave guide.

Unit-5

Radiation - Vector and scalar potentials, Field and radiation in dipole, Radiation by moving charges, Lienard-Wiechert potentials, Total power radiated by an accelerated charge, Lorentz formula, application to antenna, Types of antennas.

Text and Reference Books:

J.D. Jackson, *Classical Electrodynamics,* John Wiley & Sons.

D. J. Griffiths, *Introduction to Electrodynamics,* Prentice Hall of India.

F.J. Milford and R.W. Christy, *Foundations of Electromagnetic Theory,* Narosa

publishing house.
E.C. Jordon and K.G. Balmain, *Electromagnetic Waves and Radiating Systems*, Prentice-Hall of India.

Course Outcomes:

After completing the course, students will be able to:

CO1.	Define or describe Electromagnetic Theory.
CO2.	Develop the understanding of the different laws of electricity and magnetism.
CO3.	Apply the different laws of electricity and magnetism for Maxwell equations.
CO4.	Analyze the behavior of Maxwell equations for electromagnetic waves.
CO5.	Evaluate the electromagnetic waves in different media.

Physics Lab I (MPY -151)

Teaching Scheme	Examination Scheme
Lectures: 9hrs./Week	Intenal-50
Credits: 2	End Semester Exam – 100 marks

Course Objectives:

1. To make students aware of instrument handling.
2. To make students learn experimental skills.
3. Make students capable to work in groups

List of Experiments:

Note: *Minimum 8 experiments should be performed. (Experiments may be added /deleted subject to availability of time and facilities)*

1. Study of e/m by Magnetron valve method or Bush method.
2. Study of B.H. Curve.
3. To trace V~I characteristic curves of diodes and transistors on a CRO and learn their uses in electronic circuits.
4. Verification of Fresnel's formula for reflection
5. Study of Half wave and Full wave rectifier.
6. To determine Planck's constant using photocell.
7. To determine the velocity of ultrasonic waves in given liquid using interferometer.
8. Study of uncertainty principle using Laser.
9. Study of the regulated power supply.
10. Study of IC 555 Timer.
11. Study of G.M. Counter.
12. Michelson's Interferometer.
13. Study of Adders and Substractors.
14. To determine wavelength of given light source using bi-prism.
15. Study of the existence of atomic energy levels using Franck – Hertz Experiment.

Reference Books:

Experimental Physics: Modern Methods, R.A. Dunlap, Oxford University Press.
B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall.
Basic Electronics: A Text-Lab Manual, P.B. Zbar and A.P. Malvino, Tata Mc-Graw Hill, New Delhi.

Course Outcome:

After completing the course, students will be able to achieve the following:

CO1.	Make correct measurements using laboratory instruments
CO2.	Align and setup the instrument for performing the experiment.
CO3.	Diagnose any errors in arrangement
CO4.	To analyze the observations by calculating the related physical quantities.
CO5.	Evaluate the percentage and maximum probable error.
CO6.	Minimize the sources of error and design additional related experiments

Semester-II

MPY -201: Condensed Matter Physics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - Crystal Structure, X-rays and Crystal Diffraction, Thermal properties of solids, Theory of Conductors, Superconductivity

Course Objectives: The aim and objective of the course on Condensed Matter Physics is to expose the students of M.Sc. class to the topics like elastic constants, lattice vibrations, dielectric properties, energy band theory and transport theory so that they are equipped with the techniques used in investigating these aspects of the matter in condensed phase.

Detailed Syllabus:

Unit-1

Crystal Structure - Introduction, Lattice point and space lattice, Unit cell, Primitive cell, Bravais lattices, Metallic crystal structure(sc, bcc, fcc, hcp, Diamond, zinc blende), Atomic packing fractions, Directions plane and Miller Indices, Separation between lattice plane in a cubic crystal, Reciprocal lattice, Crystal defects: Schottky and Frenkel defects.

Unit-2

X-rays and Crystal Diffraction - Production of X-rays, Properties of X-rays, X-ray diffraction, Bragg's law, Bragg's spectrometer, Powder crystal method, Comparison of X-rays, Electron and Neutron diffraction

Unit-3

Thermal properties of solids - Specific heat, Einstein's and Debye's theory of specific heat, Thermal expansion, Thermal conductivity.

Unit-4

Theory of Conductors - Free electron theory of metals, Electron heat capacity, Bloch functions, Formation of energy Bands, Kroning -Penny Model, Brillouin zone, Effective mass, Concept of Holes, Fermi surface

Unit-5

Superconductivity - Concept of superconductivity, Meissner effect, Type-I and type-II superconductors, London equations, Penetration depth, Coherence length, BCS theory, Introduction to high temperature superconductors, Applications of superconductors.

Text and Reference Books:

Charles Kittel, *Introduction to Solid State Physics,* Wiley Eastern.
A.J. Dekker, *Solid State Physics,* Prentice Hall of India.
Ali Omar, *Elementary Solid-State Physics,* Narosa Publishing House.
J.S. Blakemore, *Solid State Physics*, Cambridge University Press.
S.O. Pillai, *Problems and Solutions in Solid State Physics,* New Age International.

Course Outcomes:

CO1.	Define the structure of different types of materials; amorphous, crystalline.
CO2.	Develop the understanding of systematically the basic methods used for the structural analysis of materials
CO3.	Apply the different methods for solving numerical questions on structural determination.
CO4.	Analyze the behavior of structural changes on the properties of the materials exhibiting different crystal structure.
CO5.	Evaluate the structure of materials using different experimental techniques such as X- ray diffraction and electron microscopy.
CO6.	Gain knowledge of condensed matter physics and create their own discretion for finding new structure-specific application of various materials

.

MPY -202: Atomic and Molecular Physics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1hrs./Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Atomic Spectra, Molecular spectra

Course Objectives: The aim and objective of the course on Atomic and Molecular Physics for the students of M.Sc. Physics is to equip them with the knowledge of Atomic, Rotational, Vibrational, Raman, and Electronic spectra.

Detailed Syllabus:

Unit-1

Atomic Spectra - Bohr's atomic model, Sommerfield's quantization rules, Sommerfield's extension of Bohr's model, Relativistic corrections for energy levels of hydrogen atom, Magnetic dipole moments: Orbital magnetic dipole moment, Bohr magneton, Larmor Precession, Space quantization, Electron spin, Vector model of the atom: coupling of angular momenta, Spectroscopic terms and their notations, Stern-Gerlach experiment. L-S couplings, Lande interval rule, Selection rules for L-S coupling, j-j coupling, Selection rules for j-j coupling

Unit-2

Molecular spectra - Normal and Anomalous Zeeman Effect and Paschen Back Effect, Stark effect: Weak field effect and Strong field effect in hydrogen atom, Electronic spectra, Intensity distribution (vibrational) in band system: Frank-Condon principle, Rotational spectra of diatomic molecules, Rigid rotator - effect of isotropic substitution, Non rigid rotator, Isotope effect, Vibrational-rotational spectra: molecule as a harmonic oscillator

Text and Reference Books:

G M Barrow, *Introduction to molecular spectroscopy,* Tata McGraw
Hill. Arthur Beiser, *Concepts of Modern Physics,* McGraw Hill.
Manas Chanda, *Atomic Structure and Chemical Bond,* Tata McGraw Hill.
G .Aruldhas, *Molecular Structure and Spectroscopy,* Prentice Hall of India Ltd.

Course Outcomes:

CO1. Describe the basics of atomic spectra (Bohr's atomic model, Sommerfield's quantization rules, angular moments and larmor's precession) and Molecular spectra

CO2. Develop the understanding atomic spectra (space quantisation and Vector modal in terms of the angular momentum, Stern-Gerlach experiment. and Molecular spectra (Vibration and Rotational spectra. electronic spectra) Frank-Condon principle
CO3. Determine the Sommerfield's extension of Bohr's model, Relativistic corrections for energy levels of hydrogen atom, To Determine the L-S and j-j Coupling and effect of external magnetic field (Zeeman effect) Numerical problems on the basis of space quantisation and Vector modal, to estimate Rigid Rotator and harmonic Oscillator And electronic spectra
CO4. Differentiate the L-S and j-j Coupling and Vibrational and Rotational spectra.
CO5. Evaluate the Numerical problems of space quantisation and Vector modal L-S coupling and j-j coupling. Numerical problems of molecular spectra.
CO6. Classify the atomic and molecular spectra, Isotope effect

MPY -203: Nuclear and Particle Physics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - Basic Nuclear Properties and Forces, Nuclear Models, Nuclear Decay, Nuclear Reactions, Elementary Particle Physics

Course Objectives:

1. To impart knowledge about the Nuclear Physics.
2. To introduce the fundamental concepts of Nuclear theory involving nuclear models.
3. To expose the students of M.Sc. students to experimental aspects of different equipment and methods used in the fields of nuclear physics and particle physics.
4. To enable the students to understand the Nuclear forces and different nuclear models used to investigate nuclei and nuclear properties.

Detailed Syllabus:

Unit-1

Structure and properties of Nucleus – Introdution, Nuclear size and its determination, Binding energy, Semi-empirical mass formula, Spin and parity, Magnetic diploe moments, Electric quadrupole moments

Unit-2

Nuclear Forces – Nature of the nuclear Force**,** Deuteron, Neutron-proton scattering at low energy, Effective range theory of neutron-proton scattering, Proton-proton scattering at low energy, Effective range theory of proton-proton scattering, Neutron-neutron scattering

Unit-3

Nuclear Models – Evidence of shell structure, Liquid drop model, Single-particle shell model, its validity and limitations, Magic number

Unit-4

Nuclear Reactions – Types of Nuclear reactions, Conservation laws, Nuclear cross section, Classical analysis of cross section, Partial wave analysis of reaction cross section, Compound nucleus, Compound nucleus reaction, Disintegration of compound nucleus

Unit-5

Elementary Particle Physics – Introduction; Classification of elementary particles and their anti-particles, Fundamental interaction (Gravitational, Electromagnetic, Strong and Weak), Conservation laws, Invariance; charge and parity, Elementary particle symmetry, Quarks model, Isospin of quarks

Text and Reference Books:

R.R. Roy and B.P. Nigam, Nuclear Physics, New Age International.

Kaplan, Nuclear Physics Narosa

B.L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill.

Course Outcomes:

CO1.	Define or describe all the introductory level of Nuclear Physics as well as Particle Physics.
CO2.	Develop the understanding of the basic theorems required for the Structure and Properties of Nucleus, Nuclear Forces, Nuclear Models, Nuclear Reactions and Elementary Particles.
CO3.	Apply the different theories or methods to solve various questions.
CO4.	Analyse the behaviour/different properties of nuclear aspects as well as the uses of different physical phenomena
CO5.	Evaluate numerical results of all concern theories of different sections of Nuclear /Particle Physics.
CO6.	Create some new problems based on some theories of Nuclear & Particle physics

MPY 204: Thermodynamics and Statistical Physics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./Week	Class Test -12 Marks
Tutorials: 1 hrs./Week	Teachers Assessment – 6 Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - Thermodynamics, Formalism of Equilibrium: Statistical Mechanics, Fermi- Dirac Statistics, Bose -Einstein Statistics

Course Objectives:

1. To impart knowledge about the fundamentals of thermodynamics and statistical mechanics.
2. To introduce the fundamental concepts relevant to thermodynamic potentials, probability, classical and quantum statistics.
3. To enable the students to understand the statistical basis of thermodynamics and its applications to magnetism, black body radiation and phase transition

Detailed Syllabus:

Unit-1

Thermodynamics - Concept of entropy, Change in entropy, Principle of increase of entropy, Thermodynamic variables, Thermodynamic potentials U, H, F and G: their definitions, properties and applications, Derivations of Maxwell's relations, Applications of Maxwell's relations: (i) Clausius- Clapeyron equation, (ii) values of Cp-Cv, (iii) T-dS equations, (iv) Joule-Thomson coefficient for ideal and Real gases (v) Change of temperature during an adiabatic process.

Unit-2

Formalism of Equilibrium: Statistical Mechanics - Concept of phase space, Liouville's theorem, Basic postulates of statistical mechanics, Ensembles: micro-canonical, Canonical, Grand canonical, Connection to thermodynamics, Fluctuations, Applications of various ensembles, Equation of state for a non-ideal gas, Vander Waal's equation of state, Meyer cluster expansion, Virial coefficients.

Unit-3

Fermi-Dirac Statistics - Fermi-Dirac, Ideal Fermi gas, properties of simple metals, Pauli Para magnetism, Electronic specific heat and white dwarf stars.

Unit-4

Bose-Einstein Statistics - Bose-Einstein statistics, Applications of the formalism to: Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation, Bose-Einstein condensation, Experiments on atomic BEC, BEC in a harmonic potential.

Text and Reference Books:

F. Reif, *Fundamentals of Statistical and Thermal Physics,* Tata McGraw-Hill.
Mark Waldo Zemansky, Richard Dittman, Heat and Thermodynamics: An Intermediate Textbook (McGraw-Hill, 1981)
Francis W. Sears & Gerhard L. Salinger, Thermodynamics, Kinetic Theory, and Statistical Thermodynamics (Narosa, 1986).
B.B.Laud, *Fundamentals of Statistical Mechanics*, New Age International Publication.

Lokanathan and Gambhir, *Statistical and Thermal Physics*, Prentice Hall of India Ltd.

Course Outcomes:

CO1.	Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular the entropy and to evaluate change of entropy in different phases of matter.
CO2.	Apply the concept of thermodynamically potentials & Maxwell's equations for solving thermodynamical problems.
CO3.	Interpret the concept of phase space for understanding the role of ensembles in statistical mechanics.
CO4.	Understanding of classical and quantum statistics and use the statistical physics methods, such as Maxwell-Boltzmann distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems
CO5.	Apply the knowledge of Fermi-Dirac Statistics for estimation of thermal and magnetic properties of metals**.**
CO6.	Analysis of Bose-Einstein Statistics for understanding of physical problems in particular: Debye theory of specific heat, properties of black-body radiation, Bose- Einstein condensation.

.

MPY 251-Physics Lab II

Teaching Scheme	Examination Scheme
Lectures: 9hrs./Week	Intenal-50
Credits: 2	End Semester Exam – 100 marks

Course Objectives:

1.To make students aware of instrument handling.

2.To make students learn experimental skills

3. Make students capable to work in groups

List of Experiments:

Note: *Minimum 8 experiments should be performed. (Experiments may be added /deleted subject to availability of time and facilities)*

1. Study of Zeeman Effect.
2. Study of Hall Effect.
3. Study of elastic constant of cubic crystal.
4. Study of Modulation and Demodulation.
5. To determine the conductivity of semiconductor at various temperatures by four-Probe method.
6. To determine crystal structure of different material using X-ray diffraction.
7. To determine the Curie temperature of a given ferroelectric material.
8. Study of Susceptibility of paramagnetic material by Gouy method.
9. Study of Characteristics, inverse square law, absorption coefficient by using GM Counter.
10. To determine the wavelength, separation of wavelengths of sodium light and to determine the thickness of thin mica sheet using Michelson interferometer.
11. Study of Electron Spin Resonance (ESR).
12. To demonstrate the wave nature of the electron by Electron Diffraction.
13. Study of Thermionic Emission.
14. Study of transistor biasing.
15. Determination of "e" by Millikan oil drop method.
16. To determine the molecular field in a dielectric and verify Clausius – Mossotti equation.

Reference Books:

G.Aruldas, *Molecular structure and Spectroscopy*, Prentice-hall of India Pvt. Ltd.

S.O. Pillai (3rd Edition), *Solid State Physics*, New age International Publisher.

D.R. Behekar, Dr. S. T. Seman, V.M. Gokhale, P. G. Kale, Practical Physics, (Kitab Mahal Publication

Course Outcomes:

CO1.	Make correct measurements using laboratory instruments
CO2.	Align and setup the instrument for performing the experiment.
CO3.	Diagnose any errors in arrangement
CO4.	To analyze the observations by calculating the related physical quantities.
CO5.	Evaluate the percentage and maximum probable error.
CO6.	Minimize the sources of error and design additional related experiments