Shri Rawatpura Sarkar University, Raipur

Examination Scheme & Syllabus

of CBCS Pattern for

Master of Science in Physics

Semester-II

(Effective from the session: 2022-2023

Shri Rawatpura Sarkar University, Raipur
Faculty of Science
Department of Physics

Two Years Master of Science Program
Scheme of Teaching & Examination
M. Sc. in Physics Semester-II
Outcome Based Education (OBE) & Choice Based Credit Systems (CBCS)
(Effective from the Academic Year: 2022-2023)

S. No.	Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1.	SMS10201T	Quantum Mechanics -II	4	-	-	4	30	70	100	3.0
2.	SMS10202T	Statistical Mechanics	4	-	-	4	30	70	100	3.0
3.	SMS10203T	Electrodynamics & Plasma Physics	4	-	-	4	30	70	100	3.0
4.	SMS10204T	Atomic and Molecular Physics	4	-	-	4	30	70	100	3.0
5.	SMS10205T	Research Methodology	2	-	-	2	15	35	50	2.0
6.	SMS10291P	Physics Lab Course III (Programming in C)	-	-	4	2	15	35	50	5.0
7.	SMS10292P	Physics Lab Course IV (Digital Electronics)	-	-	4	2	15	35	50	5.0
	Total teaching hrs/week: 26		**Total Credits**			**22**	**Total Marks**		**550**	

Master of Science in Physics
Semester-II
2022-2023

<table>
<tr><td>Course Title</td><td colspan="5">Quantum Mechanics -II</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS10201T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Student must have the knowledge of Quantum Mechanics-I.</td></tr>
<tr><td>Course Objective</td><td colspan="5">• To study Quantum Mechanics in advance and establish foundation to research in the respective domain.</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT-I
Vibrational method, expectation value of energy, application to excited states, ground state of He-atom, Zero point energy of one dimensional harmonic oscillator, Vander-waal interaction, the W.K.B. approximation, approximate solutions, asymptotic nature of the solution, solution near turning point, connection formulae, energy levels of a potential well and quantization rule.
UNIT–II
Theory of scattering: differential and total scattering cross section, wave mechanical picture of scattering & the scattering amplitude, Green's functions and formal expression for scattering amplitude, The Born approximation and its validity, Partial wave analysis, asymptomatic behavior of partial waves and phase shifts, optical theorem, scattering by a square well potential, scattering by a hard sphere, scattering by a Coulomb potential.
UNIT – III
Time-dependent perturbation theory, first order perturbation, Harmonic perturbation, Fermi`s Golden rule, Ionization of a H-atom, absorption and induced emission, Selection rules. Identical particles, symmetric and anti-symmetric wave functions
UNIT –IV
Relativistic quantum mechanics, formulation of relativistic quantum theory, the Klein Gordon equation; plane wave solutions, charge and current densities, The Dirac equation for a free particle, matrices alpha and beta, Lorentz covariance of the Dirac equation, free particle solutions and the energy spectrum, charge and current densities.
UNIT-V
The spin of the Dirac particle, Dirac particle in electromagnetic fields and the significance of the negative energy state, Dirac equation for a central field: Spin angular momentum, approximate reduction, spin –orbit energy, separation of equation, the hydrogen atom, classification of energy levels and negative energy states.</td></tr>
</table>

Course Outcome	• On the completion of this course, successfully student will be able to understand the development of the Quantum Mechanics. 1. The purpose of the course is to introduce students to knowledge about Vibrational method & W.K.B. approximation. 2. The purpose of the course is to introduce students to learning about Theory of scattering & Green's functions. 3. The purpose of the course is to introduce students to introduction about Time-dependent perturbation theory. 4. The purpose of the course is to introduce students to information about Relativistic quantum mechanics. 5. The purpose of the course is to introduce students to knowledge about Dirac particle in electromagnetic fields.
Text Books	1. L. I. Schiff: Quantum Mechanics (McGraw-Hill). 2. S. Gasiorowicz: Quantum Physics (Wiley). 3. Landau and Lifshitz: Quantum Mechanics. 4. B. Craseman and Z. D. Powell: Quantum Mechanics (Addison Wesley) 5. A.P. Messiah: Quantum Mechanics.
Reference Books	1. J. J. Sakurai: Modern Quantum Mechanics. 2. Mathews and Venkatesan: Quantum Mechanics. 3. Bjorken and Drell: Relativstic Quantum Mechanics.

Master of Science in Physics
Semester-II
2022-2023

Course Title	**Statistical Mechanics**				
Course Code	**SMS10202T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisite	Student must have the knowledge of Physics.				
Course Objective	• To study Statistical Mechanics in advance and establish foundation to research in the respective domain.				
Course Content	**UNIT-I** **Foundation of statistical mechanics:** macroscopic and microscopic states, contact between statistics and thermodynamics, physical significance of Ω (N, V, E), the classical gas, entropy of mixing and Gibb's paradox, phase space of classical system, Liouville`s theorem and its consequences, quantum states and phase space. **UNIT- II** **Elements of ensemble theory:** A system in microcanonical, canonical, and grand canonical ensembles, partition functions, physical significance of statistical quantities, example of classical system, energy and energy-density fluctuations and mutual correspondence of various ensembles. **UNIT –III** **Formulation of quantum statistics:** Quantum mechanical ensemble theory, density matrix, statistics of various quantum mechanical ensembles, system composed of indistinguishable particles. Theory of simple gases –Ideal gas in various quantum mechanical ensemble, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions, statistics of occupation number. **UNIT - IV** **Ideal Bose and Fermi gases:** Thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation and, elementary excitations in liquid helium II, Thermodynamic behavior of an ideal Fermi gas, the electron gas, nonrelativistic and relativistic degenerate electron gas, theory of white dwarf stars. **UNIT -V** **Statistical Mechanics of interacting systems:** The method of cluster expansion for a classical gas, Virial expansion of the equation of state. Theory of phase transition – general remark on the problem of condensation, Fluctuations: thermodynamic fluctuations, Spatial correlation in a fluid Brownian motion: Einstein Smoluchowski theory of Brownian motion.				
Course Outcome	• On the completion of this course successfully student will be able to				

	understand the development of the Statistical Mechanics. 1. The purpose of the course is to introduce students to knowledge about Foundation of statistical mechanics. 2. The purpose of the course is to introduce students to learning about Elements of ensemble theory. 3. The purpose of the course is to introduce students to introduction about Formulation of quantum statistics. 4. The purpose of the course is to introduce students to information about Ideal Bose and Fermi gases. 5. The purpose of the course is to introduce students to knowledge about Statistical Mechanics of interacting systems.
Text books	1. R.K. Pathria, Statistical Mechanics (Pergamon Press). 2. L.D. Landau & E.M. Lifshitz (Butter worth and Heinemann Press).
References Books	1. Federick Reif, Fundamental of statistical and thermal physics (McGraw-Hill publishers). 2. Kerson Huang, Statistical Mechanics (Wiley Eastern).

Course Title	**Electrodynamics & Plasma Physics**
Course Code	**SMS10203T**
Course Credit	**L** | **T** | **P** | **TC** **4** | **-** | **-** | **4**
Prerequisite	Student must have the knowledge of Physics.
Course Objective	• To study Electrodynamics & Plasma Physics in advance and establish foundation to research in the respective domain.
Course Content	**UNIT-I** Maxwell's equations, vector and scalar potentials and the wave equation, Gauge transformations, Lorenz gauge, Coulomb gauge, Green function for the wave equation, four-vectors, mathematical properties of the space-time in special relativity, matrix representation of Lorentz transformation, covariance of electrodynamics, transformation of electromagnetic fields. **UNIT-II** Radiation by moving charges, Lienard - Wiechert potential and fields for a point charge, total power radiated by an accelerated charge- Larmor's formula

	and its relativistic generalization, angular distribution of radiation emitted by an accelerated charge, radiation emitted by a charge in arbitrary extremely relativistic motion, distribution in frequency and angle of energy radiated by accelerated charge. **UNIT -III** Bremsstralung: emission from single-speed electrons, thermal Bremsstralung emission and absorption, Synchrotron radiation: spectrum of synchrotron radiation, spectral index for power law electron distribution, transition from Cyclotron to Synchrotron emission, Cherenkov radiation **UNIT-IV** Plasma: definition, Debye shielding phenomenon and criteria for plasma motion of charged particles in electromagnetic field; Uniform E & B fields, Electric field drift, Non-uniform magnetostatic field, Gradient B drift, Parallel acceleration and magnetic mirror effect, Curvature drift, adiabatic invariants. **UNIT-V** Elementary concepts of plasma kinetic theory, the Boltzmann equation, the basic plasma phenomena, plasma oscillations. Fundamental equations of magneto- hydrodynamics (MHD), Hydrodynamics Waves; Magneto sonic and Alfven waves, Magnetic viscosity and magnetic pressure, plasma confinement schemes.
Course Outcome	• On the completion of this course, successfully student will be able to understand the development of the Electrodynamics & Plasma Physics. 1. The purpose of the course is to introduce students to knowledge about Maxwell’s equations & Green function for the wave equation. 2. The purpose of the course is to introduce students to learning about Radiation by moving charges & Lienard - Wiechert potential. 3. The purpose of the course is to introduce students to introduction about Bremsstralung. 4. The purpose of the course is to introduce students to information about Plasma & Debye shielding phenomenon. 5. The purpose of the course is to introduce students to knowledge about Elementary concepts of plasma kinetic theory.
Text Books	1. Jackson, classical electrodynamics. 2 Rybicki & Lightman: Radiative Process in Astrophysics
References Books	1. Panofsky and Phillips: Classical electricity and magnetism. 2. Bittencourt, Plasma Physics. 3. Chen: Plasma Physics.

Master of Science in Physics
Semester-II
2022-2023

<table>
<tr><td>Course Title</td><td colspan="5">Atomic and Molecular Physics</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS10204T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Student must have the knowledge of Physics.</td></tr>
<tr><td>Course Objective</td><td colspan="5">• To study atomic and molecular physics in advance and establish foundation to research in the respective domain</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT-I
Quantum states of one electron atoms-atomic orbitals, Hydrogen spectrum, spin- orbit(l-s) interaction energy, fine structure of hydrogen spectrum including l-s interaction and relativistic correction, spectra of alkali elements, fine structure in alkali spectra, penetrating and non-penetrating orbits, intensity rules.
UNIT-II
Pauli’s principle, equivalent and non-equivalent electrons, ground state (basic level of different elements), two electron systems, interaction energy in L-S and J-J Coupling, Hyperfine structure, line broadening mechanisms (general ideas).
UNIT–III
Normal and anomalous Zeeman effect, early discoveries and developments, vector models of one electron system in a weak magnetic field, magnetic moment of a bound electron, magnetic interaction energy, selection rules, intensity rules, Paschen-Back (PB) effect – principal series effect, Zeeman and PB effects in hydrogen, Stark effect- discovery, Stark effect in Hydrogen, orbital model, weak and strong effect in Hydrogen.
UNIT-IV
Types of molecules: linear diatomic molecules, symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules: rigid rotator model, energy levels, selection rule, spectrum, comparison with observed spectrum and non-rigid rotator model, Intensities of spectral lines, microwave spectrometer, Raman spectrum; classical and quantum theory of Raman Effect, pure rotational Raman spectrum.
UNIT-V
Vibrational spectra of diatomic molecules: simple harmonic model, energy levels and spectrum, comparison with observed spectrum and harmonic model, Vibrating rotators, Interaction of rotations and vibrations, fine structures and P-Q-R branches, IR spectrometer, Vibrational Raman spectrum, Vibrational rotational Raman spectrum.</td></tr>
</table>

Course Outcome	• On the completion of this course successfully student will be able to understand the development of the atomic and molecular physics. 1. The purpose of the course is to introduce students to knowledge about Hydrogen spectrum & intensity rules. 2. The purpose of the course is to introduce students to learning about Pauli's principle & interaction energy in L-S and J-J Coupling. 3. The purpose of the course is to introduce students to introduction about anomalous Zeeman effect. 4. The purpose of the course is to introduce students to information about Types of molecules & Raman Effect. 5. The purpose of the course is to introduce students to knowledge about Vibrational spectra of diatomic molecules.
Text Books	1. Introduction to atomic spectra - H.E. White(T). 2. Fundamentals of molecular spectroscopy – C.N. Banwell and E. M McCash (T). 3. Spectroscopy vol. I, II and III – Walker and Straughner. 4. Introduction to Molecular spectroscopy – G.M. Barrow.
References Books	1. Spectra of diatomic molecules –Herzberg. 2. Molecular spectroscopy – Jeanne L. Mc-Hale. 3. Molecular spectroscopy – J.M. Brown. 4. Spectra of atoms and molecules–P.F. Bemath. 5. Modern spectroscopy, J.M. Hollas.

<table>
<tr><td>Course Title</td><td colspan="5">Research Methodology</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS10205T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>2</td><td>-</td><td>-</td><td>2</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Student must have the knowledge of Physics.</td></tr>
<tr><td>Course Objective</td><td colspan="5">• To study Research methodology skills in advance and establish foundation to research in the respective domain.</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT I
Introduction, Biological data, Collection of data, Processing of data, Primary and Secondary data, Frequency distribution – Discrete and Continuous. Cumulative frequency distributions.
UNIT II
Diagrammatic and graphic representation of data: Advantages, Disadvantages; Types: Line diagram, Bar diagram, Pie Chart, Histogram, Frequency polygon, Frequency Curve.
UNIT III
Central tendency: Mean, Median, and Mode. Measures of dispersion – Standard Error, Standard deviation and Coefficient of Variations. Random Variable: Expectation and variance.
UNIT IV
Research Methodology: Introduction, Meaning, Objectives of Research, Motivation in Research, Types of Research, Significance of Research, Research Methods versus Research Methodology.
UNIT V
Research and Scientific Method, Process of Research, Criteria of Good Research, Limitations of Research, Research Problem: Definition, Selection and Techniques; Interpretation, Technique of Interpretation, Report writing.</td></tr>
<tr><td>Course Outcome</td><td colspan="5">• On the completion of this course, successfully student will be able to understand the development of the Research methodology skills.</td></tr>
<tr><td>Text Books</td><td colspan="5">1. Research Methodology: Methods and Techniques: C R Kothari</td></tr>
<tr><td>Reference Book</td><td colspan="5">1. Research Methodology: Dr. V. Upagade and Dr. Arvind Shend</td></tr>
</table>

	2. Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co. 3. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi (1999) 4. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning 5. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

Course Title	**Physics Lab Course III (Programming in C)**				
Course Code	**SMS10291P**				
Course Credit	**L**	**T**	**P**	**TC**	
	-	**-**	**4**	**2**	
Prerequisite	Student must have the knowledge of Physics.				
Course Objective	• To enable the students to develop skills of programming.				
Course Content	1. To solve simultaneous Linear equation by Gauss Elimination method. 2. To calculate the root of a transcendental equation by Newton – Raphson method. 3. Solving the system of linear simultaneous equation by Gauss Seidel method. 4. Numerical Integration by Simpson's 1/3Rule. 5. Solving simultaneous Linear equation by Gauss-Jordon method. 6. Solution of Differential equation by Euler's Method. 7. To invert a given matrix by Gauss-Jordon Method. 8. Solution of Differential equation by Runge Kutta Method. 9. To fit the given data in a straight line by linear regression Method. 10. WAP to find the Largest of 'n' number of series. 11. To calculate the standard deviation of a given set of data. 12. To write a program to compute the complex roots of a given polynomial of N^{th} degree by Grafffe's Method. 13. To write a program to compute the Eigen values of a given matrix. 14. To integrate a given function by: (a) Trapezoidal method or by (b) Gauss Quadrature. 15. To find solutions of 1st order, ordinary differential equation by Taylor				

	method.
Course Outcome	• On the completion of this course lab, successfully student will be able to understand the development of the programming.
Text Books	1. Introduction to Physics Lab - H.E. White(T). 2. Fundamentals of Physics Lab – C.N. Banwell and E.M. McCash (T).
References Books	1. Introduction to Physics Lab – J.M. Brown. 2. Fundamentals of Physics Lab – P.F. Bemath.

Course Title	**Physics Lab Course IV (Digital Electronics)**				
Course Code	**SMS10292P**				
Course Credit	**L**	**T**	**P**	**TC**	
	-	**-**	**4**	**2**	
Prerequisite	Student must have the knowledge of Physics.				
Course Objective	• To enable the students to develop skills of digital electronics.				
Course Content	1. Study of R-S, D/T, J-K Flip-Flops. 2. Study of counters: Ripple, Mode 3, Mode 5counters. 3. Study of Shift Register. 4. Study of R-2R D/A Converter. 5. Study of Random Access Memory (RAM) Read Only Memory (ROM) 6. Study of A/D Converter. 7. Experiment with Microprocessor:-I (a) Convert BCD in to HEXADECIMAL (b) To transfer group of date blocks from one location to another location. 8. Experiment with microprocessor: -II (a) To write programs for addition of two 1 byte data giving results of 2 bytes. (b) To write programs for multiplication of two 1 byte data giving results of 2 bytes. 9. (a) To add 2 16-BIT numbers stored in locations from x xxx to x xxx + 3				

	and add them store the results from x xxx + 4 to x xx x+6 memory location (b) To find the largest of numbers of a series. 10. To arrange N numbers in an ascending order. 11. Experiments with Microprocessor. (a) Convert BCD in to binary and vice-versa. (b) To transfer group of data blocks from one location to another location. (c) To write programs for addition of two 1byte data giving result of 2 byte data (d) To write programs for multiplication of two 1 byte data giving result of 2 byte data. 12. Logic gate study DTL and RTL. 13. Study of adder/Subtractor.
Course Outcome	• On the completion of this course lab, successfully student will be able to understand the development of the digital electronics.
Text Books	1. Introduction to Physics Lab - H.E. White(T). 2. Fundamentals of Physics Lab – C.N. Banwell and E.M McCash(T).
References Books	1. Introduction to Physics Lab – J.M. Brown. 2. Fundamentals of Physics Lab –P.F. Bemath.

Master of Science in Physics
Semester-II
2022-2023