भारत 2023 INDIA

SYLLABUS

for

MASTER OF SCIENCE (M.Sc.)

PHYSICS

(To be implemented from June-2023)

VEER NARMAD SOUTH GUJARAT UNIVERSITY,
UDHNA MAGDALLA ROAD,
SURAT-395007. (GUJARAT)

Structure for MSc Physics – Semester - II							
Course Type	Course Code	Course Name	Teaching hours/week	Credit	Internal Marks	External Marks	Total Marks
Core	PH-421	Quantum Mechanics I	04	04	30	70	100
	PH-422	Solid State and Condensed Matter Physics	04	04	30	70	100
	PH-423	Classical Electrodynamics and Plasma Physics	04	04	30	70	100
Elective (Any one course can be taken)	PH-424	Elective 1: Electronic Communication	04	04	30	70	100
		Elective 2: Thin Film Technology and Non Destructive Testing	04	04	30	70	100
		Elective 3: Numerical Techniques and Fortran Programing	04	04	30	70	100
		Elective 4: Nuclear and Particle Physics	04	04	30	70	100
	PH-425	Practical	12	06	50	100	150
Skill based course	PH-426	Electronic and Biomedical Instrumentation	02	02	20	30	50
		Total	30	24	190	410	600

Course Name	**PH-421: Quantum Mechanics I**
Course Code	PH-421
Course Type	Core
Course Outcome (CO)	(1) By studying this course students will be able to learn advanced level of conceptual and numerical problems in quantum mechanics. (2) Students will be proficient in the basic mathematical tools and matrix representation involved in solving quantum mechanics. (3) Students will be able to understand the basic postulates of quantum mechanics. (4) Students will be studied the application of the Schrödinger equation to one-dimensional problems. (5) Student will be able to apply angular momenta formalism to examine various properties of angular momentum and also to determine eigen values and eigenvectors of spin and orbital angular momentum.

Course Content	
Unit 1	**<u>Mathematical Tools of Quantum Mechanics:</u>** The Hilbert Space and Wave Functions: The Linear Vector Space, The Hilbert Space, Dimension and Basis of a Vector Space, Square-Integrable Functions: Wave Functions, Dirac Notation, Operators: General Definitions, Hermitian Adjoint, Projection Operators, Commutator Algebra, Uncertainty Relation between Two Operators, Functions of Operators, Inverse and Unitary Operators, Eigenvalues and Eigenvectors of an Operator, Infinitesimal and Finite Unitary Transformations, Representation in Discrete Bases: Matrix Representation of Kets, Bras, and Operators, Change of Bases and Unitary Transformations, Matrix Representation of the Eigen value Problem, Representation in Continuous Bases: General Treatment, Position Representation, Momentum Representation, Connecting the Position and Momentum Representations, Parity Operator, Matrix and Wave Mechanics: Matrix Mechanics, Wave Mechanics.
Unit 2	**<u>Postulates of Quantum Mechanics:</u>** The Basic Postulates of Quantum Mechanics, The State of a System: Probability Density, The Superposition Principle, Observables and Operators, Measurement in Quantum Mechanics: How Measurements Disturb Systems, Expectation Values, Complete Sets of Commuting Operators (CSCO), Measurement and the Uncertainty Relations, Time Evolution of the System's State: Time Evolution Operator, Stationary States: Time-Independent Potentials, Schrödinger Equation and Wave Packets, The Conservation of Probability, Time Evolution of Expectation Values, Symmetries and Conservation Laws: Infinitesimal Unitary Transformations, Finite Unitary Transformations, Symmetries and Conservation Laws, Connecting Quantum to Classical Mechanics: Poisson Brackets and Commutators, The Ehrenfest Theorem, Quantum Mechanics and Classical Mechanics.
Unit 3	**<u>One-Dimensional Problems:</u>** Properties of One-Dimensional Motion: Discrete Spectrum (Bound States), Continuous Spectrum (Unbound States), Mixed Spectrum, Symmetric Potentials and Parity, The Free Particle: Continuous States, The Potential Step, The Potential Barrier and Well: The Case $E > V_0$, The Case $E < V_0$, The Tunneling Effect, The Infinite Square Well Potential: The Asymmetric Square Well, The Symmetric

	Potential Well, The Finite Square Well Potential: The Scattering Solutions ($E > V_0$), The Bound State Solutions ($0 < E < V_0$), The Harmonic Oscillator: Energy Eigen values, Energy Eigen states, Energy Eigen states in Position Space, The Matrix Representation of Various Operators, Expectation Values of Various Operators, Numerical Solution of the Schrödinger Equation: Numerical Procedure, Algorithm
Unit 4	**Angular Momentum:** Orbital Angular Momentum, General Formalism of Angular Momentum, Matrix Representation of Angular Momentum, Geometrical Representation of Angular Momentum, Spin Angular Momentum: Experimental Evidence of the Spin, General Theory of Spin, Spin 1/2 and the Pauli Matrices, Eigen functions of Orbital Angular Momentum: Eigen functions and Eigen values of L_z, Eigen functions of L^2, Properties of the Spherical Harmonics.

Reference Books	
1.	Quantum Mechanics: Concepts and Applications: Nouredine Zettili, (2nd Ed.), A John Wiley and Sons Ltd., 2004.
2.	A text book of Quantum Mechanics: P. M. Mathews and K. Venkatesan, (2nd Ed.), Tata McGraw Hill Education Private Limited, 2011.
3.	Quantum Mechanics: L. I. Schiff, (3rd Ed.) McGraw-Hill Inc., US, 1968.
4.	Introduction to Quantum Mechanics: David Griffiths, (2nd Ed.), Pearson Education; 2015.
5.	Quantum Mechanics: A. K. Ghatak and S. Lokanathan (5th Ed.) Macmillan-India, 2004.
6.	Quantum Mechanics: Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe Vol. I & II, Wiley-CH, 1997.

Course Name	**PH-422: Solid State and Condensed Matter Physics**
Course Code	PH-422
Course Type	Core
Course Outcome (CO)	(1) Post completion of the course, student will understand why different materials have different properties. (2) At the end of the course, students will be able to differentiate the 'Perfect' and 'Imperfect' materials and also the role of imperfection in their applications. (3) Students will be able to understand about basic properties of materials like Magnetism, Colour centres and Anisotropy etc. (4) After finishing this course, students understand the importance of organic crystals in technological development and industries. (5) Student will be able to understand starchier – property- performance relationship.

Course Content	
Unit 1	**Crystal Structure:** Crystal, Single Crystal, Poly Crystals, Amorphous, Importance of Single Crystal, Applications of Single Crystal, Crystal Structure, Crystal Structure determination-Bragg's law. Experimental methods of X-Ray Diffraction, Reciprocal Lattice.
Unit 2	**Imperfections in Solids:** Perfect and Imperfect Crystals, Point Imperfection, Concentration of Point Imperfection, Line Imperfections, Berger Vector and Berger circuit, Presence of Dislocations, Energy of a Dislocation, Slip Planes and Slip Directions, Surface Imperfections, Effect of Crystal Imperfections.
Unit 3	**Properties of Solids:** Classification of Magnetic Materials, Dia, Para, and Ferro magnetic materials and their theory, Anti Ferro magnetism, Ferri magnetism, Hard and Soft magnetic materials. Photoconductivity, Photovoltaic Effect, Photoluminescence, Colour Centres, Types of Colour Centres, Generation of Colour Centres, Anisotropic properties of Materials.
Unit 4	**Free Electrons in Crystal and Organic Crystal:** Three dimensional Potential Well, The Density of states, Effect of Temperature on Fermi Distribution Function, The Electronic Specific Heat, Conductivity and Resistivity of Metals, Hall effect, Materials and Solid State Chemistry: Introduction, Amorphous Semiconductor, Liquid Crystal Polymers. Dielectric, Piezoelectric and Ferro electric properties.

Reference Books	
1.	Solid State Physics: Structure and Properties of Material: M. A. Wahab, (3rd Ed.), Narosa Publishing House, 2015.
2.	Solid State Physics: K. Ilangovan C., MJP Publishers, 2013.
3.	Solid State Physics, Solid State Devices and Electronics: C.M. Kachhava , New Age International Publishers.
4.	Solid State Physics : Neil W. Ashcroft, N. David Mermin Harcourt Asia Pvt. Ltd., 2001.

Course Name	**PH-423: Classical Electrodynamics and Plasma Physics**
Course Code	PH-423
Course Type	Core
Course Outcome (CO)	(1) The students will study multipole expansions, scalar and vector potentials and gauge transformations. (2) The students will learn about electromagnetic waves in different media, their absorption and dispersion and they will be introduced to wave guides. (3) The students will have in depth study of electromagnetic radiation. (4) The students will learn about plasma and its properties, establish magneto hydrodynamic equations, pinch effect and instabilities of plasma.

Course Content	
Unit 1	**Multipole Expansion, Potentials and Fields:** Multipole expansions for a localised charge distribution in free space, linear quadrupole potential and field, static electric and magnetic fields in material media, Boundary conditions, Scalar and vector potentials, Gauge transformations, Coulomb and Lorentz gauge, Retarded potentials and Lienard-Wiechert potentials.
Unit 2	**Electromagnetic Waves:** Waves in One Dimension: The Wave equation, Sinusoidal waves, Boundary conditions: Reflection and Transmission, Polarization, Electromagnetic Waves in Vacuum: The Wave Equation for **E** and **B**, Monochromatic plane waves, Energy and momentum in electromagnetic waves, Electromagnetic Waves in Matter: Propagation in Linear Media, Reflection and Transmission at Normal Incidence, Reflection and Transmission at Oblique Incidence, Absorption and Dispersion: Electromagnetic Waves in Conductors, Reflection at a Conducting Surface, The Frequency Dependence of Permittivity, Wave Guides: Waves in a Rectangular Wave Guide.
Unit 3	**Radiation:** Introduction of radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, power radiated by a point charge, radiation reaction, radiation from external sources, electric dipole radiations, magnetic dipole and electrical quadrupole radiation, centre-fed linear antenna, Hertzian dipole antenna, Rayleigh scattering at long wavelength and blueness of sky, scalar diffraction theory.
Unit 4	**Plasma Physics and Magneto-Hydrodynamics:** Introduction of plasma physics and magneto-hydrodynamics, magneto-hydrodynamic equations, magnetic diffusion, viscosity and pressure, magneto-hydrodynamic flow between boundaries with crossed electric and magnetic fields.

Reference Books	
1.	Classical Electrodynamics: J. D. Jackson, Wiley Eastern Ltd., 1975.
2.	Introduction to Electrodynamics: David J. Griffiths, PHI, 2002.
3.	Electromagnetics: B. B. Laud, New Age International Publication, 2006.
4.	Electrodynamics :Gupta, Kumar and Singh, Pragati Prakashan, 2014.
5.	Classical Electrodynamics: Griener, Springer Vaelag, New York, 1998.

Course Name	**PH-424: Elective 1-Electronic Communication**
Course Code	PH-424
Course Type	Elective 1
Course Outcome (CO)	(1) At the end of the course, the students will be able to understand in depth how the analog and digital electronic communication systems work. (2) Students are familiar with signal analysis (Fourier techniques) and basic understanding of probability theory and variables. (3) The objective is to introduce basic techniques used in amplitude modulation systems and to offer fundamental tools and methodologies workout in analysis and design of said systems. (4) Generalized treatment of angle modulation is provided so the students will be able to differentiate Amplitude modulation-Frequency modulation and Frequency modulation-Phase modulation. (5) Students are familiar with various aspects of digital data transmission with most of the discussion is allied to the binary case. Students would be realize how digital system is more powerful tool compared to analog system.

Course Content	
Unit 1	**<u>Fourier transform and Probability:</u>** Sampling function, Response of a linear system, Normalized power, Normalized power in a Fourier expansion, Power spectral density, Effect of transfer function on power spectral density, Fourier transform, Examples of Fourier transform, Convolution, Parseval's theorem, Correlation between waveforms, Autocorrelation, Autocorrelation of a periodic waveform, Autocorrelation of non-periodic waveform of finite energy, Concept of Probability, Random variables: Conditional Probabilities, Cumulative distribution function, and Probability density function.
Unit 2	**<u>Random Processes and Amplitude Modulation:</u>** Random processes, Classification of Random processes, Mean, correlation and covariance functions, Ergodic Processes, Central limit theorem. Amplitude modulation: Double sideband suppressed carrier AM, Modulators: Multiplier modulator, Non linear modulator, Switching modulator, Demodulation of DSB-SC Signals. Conventional amplitude modulation (AM), Sideband and carrier power, Generation of AM signals, Demodulation of AM signals, Amplitude modulation: Single side band (SSB), Time domain representation of SSB signals, Generation of SSB signal, Demodulation of SSB signals. Amplitude modulation: Vestigial side band modulation (VSB), Use of VSB in broadcast television, Comparison of various amplitude modulation systems.
Unit 3	**<u>Angle modulation and Noise:</u>** Angle modulation, Concept of instantaneous frequency, generalized concept of angle modulation, Wideband FM (WBFM), Generation of FM waves: Indirect method of Armstrong, Direct generation: Parameter variation method, Phase locked loop, Analysis of phase locked loop, Stereophonic FM broadcasting, Comparisons: Frequency and phase modulation, Frequency and Amplitude modulation, External and internal noise, Noise calculations, Noise figure, Noise temperature.

Unit 4	**Digital Communication:** Comparison of Analog and digital communication systems, Sampling theorem: low pass signals, Pulse amplitude modulation, other forms of pulse modulation, Time division multiplexing, Quantization of signals, Quantization error, Pulse code modulation, PCM system, Non uniform quantization, Compandor, Differential PCM: analysis of DPCM, Signal to noise ratio improvement, Delta modulation, Threshold of coding and overloading, Adaptive Delta modulation and output signal to noise ratio. Digital carrier schemes: Frequency shift keying (FSK): FSK bit rate and Baud, FSK transmitter and receiver, Bandwidth considerations of FSK, Phase shift keying: Binary PSK transmitter and receiver, Bandwidth considerations of BPSK, M-ary encoding, Differential Phase shift keying (DPSK).

Reference Books	
1.	Principles of communication systems: H. Taub and D. L. Schilling, (3rd Ed.), McGraw-Hill. 1986.
2.	Modern Digital and Analog communication systems: B. P. Lathi, (3rd Ed.), Oxford University Press, 1998.
3.	Electronic communication systems: G. Kennedy, (3rd Ed.), McGraw-Hill, 1998.
4.	Electronic communications: D. Roddy and J. Coolen, (2nd Ed.), PHI, 1981.
5.	Advanced Electronic Communications systems: W. Tomasi, (5th Ed.), PHI, 2003.
6.	Fundamentals of communication systems: J. G. Proakis and M. Salehi, Pearson Education, 2005.
7.	Digital and Analog communication systems: K. Samshanmugum, John Wiley & Sons, 1979.
8.	Communication Systems: S. Haykin, (4th Ed.), John Wiley & Sons,1979.
9.	Radio Engineering :G. K. Mithal, Applied Electronics Vol. II, 1987.

Course Name	**PH-424: Elective 2-Thin Film Technology and Non Destructive Testing**
Course Code	PH-424
Course Type	Elective 2
Course Outcome (CO)	(1) Fundamentals and principles of vacuum and thin film technology are understood by students. (2) The thin film preparation and characterization brief description of the devices in a cohesive manner with the impetus provided for industrial applications and recognized globally research and development work doing smoothly. (3) The emphasis knowledge of thin film technology gives a brief physical basis of technical description offers state of art in various thin film devices applications. (4) The knowledge of practical non-destructive testing is the requirement to understand the capabilities and advantages of non-destructive testing (NDT), non-destructive evaluation (NDE) and non-destructive inspection. Its knowledge benefits to developing the importance and material method systems for process control management and applications.

Course Content	
Unit 1	**Vacuum Science and Vacuum Technology:** Introduction: Vacuum characterization and unit of vacuum, Classification of vacuum range and pumps, characterization of good vacuum pumps, Production of vacuum: Rotary pump, Molecular Drag and Turbo-molecular pump, Diffusion pump, Sorption pump, Thermodynamics of adsorption, typical sorbents used in vacuum technology, construction and action of Sorption pump, Gettering and ion pumping. Pressure measurement in vacuum systems: Classification of Vacuum gauges, Mechanical gauges: Diaphragm, McLeod gauge, Thermal conductivity gauge, Hot and cold cathode ionization gauge, Bayard-Alpert Gauge, History, applications and scope of vacuum science and technology.
Unit 2	**Thin Film Technology:** Introduction: Thin and thick films processing and technology, Advantages and applications of thin films. Thin films growth process, Thin film deposition process, Physical vapour deposition (PVD): Thermal evaporations, Sputtering Yield, Sputtering systems: DC diode Sputtering, RF diode Sputtering, Magnetron Sputtering, Ion beam Sputtering, ECR plasma Sputtering, Electron beam evaporation, Pulsed Laser deposition (PLD). Chemical vapour deposition (CVD) process: Decomposition reactions, Reduction reactions, Chemical transport reactions and polymerization. Major advantages of CVD, Spray Pyrolysis and Spin Coating systems.
Unit 3	**Thin Film Characterization:** Deposition rate and thickness measurement(insitu and exsitu) methods, Quartz crystal monitor, Ellipsometry. Electrical, Optical and Mechanical properties of thin films, Sheet resistivity and temperature coefficient measurement, Antireflection and reflection coating, Interference filters and band pass filters. Applications of thin films: Optoelectronic applications, Photon detectors, Photovoltaic devices (Thin Film solar cell). Thin film passive components: Electrical behaviour of metal film, Dielectric behaviour of insulators film,

	Resistors, Capacitors and Inductors, Thin film diode, Surface Acoustic wave (SAW) devices, Charged coupled devices.
Unit 4	**<u>Non-Destructive Testing(NDT):</u>** Introduction: Comparison of destructive and non-destructive test, The basic principles, applications, advantages and limitations of important NDT methods, Visual inspection: Optical aids used for visual inspection: Microscope, Borescope, Endoscope, Flexible fiber-optic Borescope, Telescope, Liquid penetrate testing, Magnetic particle testing, Ultrasonic testing. Acoustic emission testing, Insitu metallographic examination, Statistical method for quality control.

Reference Books	
1.	Hand book of Vacuum Technology: Willey-VCH Verlag Gmbh & Co. KGaA, 1986.
2.	Hand Book of Thin Film Technology: L. I. Maissel and R. Glang , McGraw-Hill, 1983.
3.	Thin Film Phenomena: K. L. Chopra, McGraw – Hill, 1969.
4.	Preparation of Thin Films: Joy George, Marceloekker, 1992.
5.	Vacuum Science and Technology: V.V. Rao, I.B. Ghosh and K. L. Chopra Allied Publications Limited.
6.	Thin Film Device Applications: K.L. Chopra and I. Kaur, Plenum Press, 1983.
7.	Practical Non–Destructive Testing: Baldev Raj, T. Jayakumar, M. Thavasimuthu, Narosa Publishing House, 2009.

Course Name	**PH-424 Elective 3: Numerical Techniques and Fortran Programing**
Course Code	PH-424
Course Type	Elective 3
Course Outcome (CO)	(1) Students will able to use numerical techniques to solve and simulate physical problem using Fortran Language. (2) Students are able to perform curve fitting using various techniques. (3) Students are able to perform differentiation and integration using various numerical techniques. (4) Students are able to understand Fortran programing. (5) Students are able to construct the Fortran program for various numerical methods.

Course Content	
Unit 1	**<u>Least Square Fit:</u>** Introduction, Least Squares Curve Fitting Procedures, Fitting a Straight Line, Multiple Linear Least Squares, Linearization of Nonlinear Laws, Curve Fitting by Polynomials, Curve Fitting by a Sum of Exponentials, Weighted Least Squares Approximation, Linear Weighted Least Squares Approximation, Nonlinear Weighted Least Squares Approximation.
Unit 2	**<u>Numerical Differentiation and Integration:</u>** Introduction, Numerical Differentiation, Errors in Numerical Differentiation, Cubic Splines Method, Differentiation Formulae with Function Values, Maximum and Minimum Values of a Tabulated Function, Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule, Simpson's 3/8-Rule, Boole's and Weddle's Rules, Use of Cubic Splines, Romberg Integration, Newton-Cotes Integration Formulae, Euler-Maclaurin Formula, Numerical Integration with Different Step Sizes, Gaussian Integration, Generalized Quadrature, Numerical Calculation of Fourier Integrals, Numerical Double Integration.
Unit 3	**<u>FORTRAN Language:</u>** Numeric Constants and Variables, Arithmetic Expressions, List-Directed Input Statements, List-Directed Output Statements, Conditional Statements, Relational Operators, The Block IF Construct, Example Programs Using IF Structures Implementing Loops in Programs, The Block DO loop, Count Controlled DO Loop, Rules to be followed in Writing DO Loop, Logical Expressions and More Control Statements.
Unit 4	**<u>FORTRAN Programming:</u>** Functions and Subroutines: Basics, Defining and Manipulating Arrays, Elementary Format Specifications, Procedure with Array Arguments, Processing files in Fortran, creating a sequential files, Array Operation with mask, FOR ALL Statement. Least Squares Curve Fitting, integration, roots of equations, matrix diagonalization, solution of differential equations. Good programming practices.

Reference Books	
1.	COMPUTER PROGRAMMING IN FORTRAN 90 AND 95: V. Rajaraman, PHI Learning Private Limited, 2013.
2.	Introductory Methods of Numerical Analysis: S. S. Sastry, fifth edition, PHI Learning Private Limited, 2012.
3.	Computer Oriented Numerical Methods: V. Rajaraman, fourth edition, PHI Learning Private Limited,2018.
4.	Numerical Methods for Scientists and Engineers: K. S. Rao. Third edition PHI Learning Private Limited, 2006.
5.	Numerical Methods for Math., Science and Engineering: J. H. Mathews, Prentice Hall, 1992.
6.	Programming and computing with FORTAN 77-90: P.S. Grover, first edition, Allied publishers, 1990.

Course Name	**PH-424 Elective 4: Nuclear and Particle Physics**
Course Code	PH-424
Course Type	Elective 4
Course Outcome (CO)	(1) The students will learn some nuclear properties and properties of nuclear forces. (2) The students will be able to study experimental methods of determining some of the nuclear properties. (3) The students will be introduced to different nuclear models, their specifications and applications and their limitations. (4) The students will learn about the sources of elementary particles, classification of fundamental particles and study their various properties.

Course Content	
Unit 1	**Basics of Nuclear Physics:** Brief history: Developments in nuclear and particle physics, fundamental interactions, Nuclear properties: Nuclear mass and binding energy, nuclear spin and parity, magnetic dipole moment, electric quadrupole moment, isospin, Properties of the nuclear forces: The interaction between two nucleons consists to lowest order, the nucleon-nucleon interaction is strongly spin dependent, the inter-nucleon potential includes a non-central term, known as a tensor potential, the nucleon-nucleon force is charge symmetric, the nucleon-nucleon force is nearly charge independent, the nucleon-nucleon interaction becomes repulsive at short distances, the nucleon -nucleon interaction may also depend on the relative velocity or momentum of the nucleons.
Unit 2	**Determination of Some Nuclear Properties:** Measurement of nuclear spin and magnetic moment: hyperfine splitting of the atomic energy levels, hyperfine splitting, nuclear spin from Zeeman effect of hyperfine lines, isotope effect, nuclear spin and statistics from molecular spectra, atomic beam method of nuclear magnetic moment determination (non-resonance method), magnetic resonance method of Rabi, magnetic resonance absorption method of measuring nuclear magnetic moment, electron paramagnetic resonance, nuclear induction method, microwave spectroscopy method, determination of the electric quadrupole moments of nuclei.
Unit 3	**Nuclear Models:** Nuclear models, liquid drop model, Bethe-Weizsacker formula, applications of the semi-empirical binding energy formula, Fermi gas model of the nucleus, nuclear shell structure, single particle states in the nuclei, spin-orbit interaction, applications of extreme single particle shell model, nuclear spin, nuclear magnetic moments, islands of isomerism, quadrupole moments of nuclei, single particle shell model, individual particle model, collective model.
Unit 4	**Particle Physics:** Introduction, productions of elementary particles, classification of particles, quanta of forces, matter particles, antiparticles, fermions, bosons, leptons, hadrons (mesons and baryons), their productions and decays, their properties, their mean-life times, quantum numbers, conservation laws.

Reference Books	
1.	Introduction to Nuclear Physics: H. Enge.
2.	Introductory Nuclear Physics: K. Krane, Wiley India Pvt. Ltd.
3.	Introduction to Elementary Particles: Griffiths.
4.	Nuclear Physics: S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged edition, 2014.
5.	Nuclear Physics: D. C. Tayal, Himalaya Publishing House, 2017.
6.	Introduction to Nuclear and Particle Physics: Mittal, Gupta and Verma, PHI Learning Pvt. Ltd., (3rd Ed.), 2017.

Course Name	**PH-425: Practical**
Course Code	PH-425
Course Type	Core
Course Outcome (CO)	(1) After completion of the course, the students will be able to understand and evaluate various problems related to Quantum Mechanics. (2) Students are trained experimentally for theories related to solid state and condensed matter physics. (3) Students will be able to perform experiments of general physics

Course Content	
	Group A
1.	Study the hermiticity of given operator/commutator/matrix.
2.	Find the Eigen values and Eigen vectors of given matrix.
3.	Evaluate the given commutators.
4.	Solve time independent Schrödinger Equation for a given potential in one dimensional.
5.	Find the matrices representing the operators J^2, J_x, J_y and J_z for a given value of j.
	Group B
6.	Measurement of Susceptibility of Liquid by Quinck's Methods.
7.	Study of Hall Effect.
8.	Lattice Dynamics.
9.	X-Ray Diffraction.
10.	Dia , Para and Ferromagnetism.
	Group C
11.	‘e/m’ by Helical Method.
12.	Measurement of Electrical Conductivity of Graphite.
13.	Measurement of Energy Band Gap of a Semiconductor.
14.	Determination of electron’s charge ‘Q’, by using Milliken's Oil drop Method.
15.	Electrical Conductivity of a Semiconductor using Four Probe Method.
	Group D (Elective Paper 1)
16.	To design, build and test Band Pass Filter.
17.	To design, build and test Digital to Analog Converter.
18.	To design, build and test Analog to Digital Converter.
19.	Study of Delta Modulator and Adaptive Delta Modulator.
20.	Study of Time Division Multiplexing.
	Group D (Elective Paper 2)
16.	Preparation of thin film by Spin Coating unit.
17.	Speed of a vacuum pump.
18.	Liquid Penetrant testing.
19.	Curie temperature of Novel Metal.
20.	Fabrication of Aluminium thin film by thermal evaporation method.
	Group D (Elective Paper 3)
16.	Curve fitting by Least Square method.
17.	Numerical integration using Trapazodial and Simpson 1/3 rule.
18.	Writing and Testing of FORTRAN program for Least Square fit.
19.	Writing and Testing of FORTRAN program for integration using Trapazodial rule.
20.	Writing and Testing of FORTRAN program for integration using Simpson 1/3 rule.

Group D (Elective Paper 4)	
16.	To verify inverse square law for γ – rays.
17.	To study nuclear counting statistics.
18.	To study Co-60 spectrum and calculation of resolution of detector in terms of energy.
19.	To determine linear and mass absorption coefficients using Scintillation detector.
20.	To study energy calibration of gamma ray spectrometer (study of linearity).

Course Name	PH-426:Skill based course-Electronic and Biomedical Instrumentation
Course Code	PH-426
Course Type	Skill based course
Course Outcome (CO)	(1) Student learn about basic of Electronics Instrumentations. (2) Student learn to use and operate morden electronic instrumentations. (3) Students can improve their skill to find the faults in an electronic system and solve it. (4) Student is able to guide and help instrument euroners for smooth operations of Electronic Instruments.

Course Content	
Unit 1	**<u>Electronic Instrumentation:</u>** Signal Generation: Pulse and square wave generator, function generator, Oscilloscope: Oscilloscope block diagram, CRT circuits, Vertical deflection system, Delay line, Multiple trace, Horizontal deflection system, Oscilloscope probes and transducers. Digital Voltmeters: 3½-Digit DVM, Resolution and Sensitivity of Digital Meters General Specifications of DVM. Digital Instruments: Digital frequency meter, Digital multi-meter, Digital panel meter.Digital tachometer, Digital pH meter, Digital phase meter, Digital capacitance meter.
Unit 2	**<u>Biomedical Instrumentation:</u>** Introduction: Biopotential, Cardiovascular system, Electro Cardiogram (ECG), Blood pressure measuring instruments, Doppler Sonography, Computed Tomography imaging (CT scan, CAT scan), Magnetic Resonance imaging (MRI), Specialized MRI Scans, Biofeedback.

Reference Books	
1.	Electronics Instrumentation and Measurement Techniques: W. D Cooper, PHI, New Delhi.
2.	Electronic Instrumentation: H.S. Kalsi, (3rd Ed.) McGraw Hill.
3.	Electric and Electronic measurements and Instrumentation. (19th Ed.), A.K.Sawhney, Dhanpat Rai & Co., 2016.