CBCS 2019

M.Sc. Semester-I (Effective from 2021-22 to …)

Sr. No	Course code	Title of courses	Credit
1	PHY2101C01	MATHEMATICAL PHYSICS- I	3
2	PHY2102C02	CLASSICAL MECHANICS	4
3	PHY2104C03	ATOMIC & MOLECULAR SPECTROSCOPY	4
4	PHY2103C20	NUMERICAL ANALYSIS	2
5	PHY2108C05	ELECTRONICS	4
6	PHY2106C21	PHYSICS LABORATORY-I	8
		Total	**25**

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	I	**CORE:**	CREDIT	3
Semester	I	**<<PHY2101C01>> : <<MATHEMATICAL PHYSICS-I>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<<**TENSORS AND GROUP THEORY**>> <<Tensor analysis : introduction, definitions, contraction, direct product, summation convention, quotient rule, pseudotensors, Levi-Civita symbol, Irreducible tensors, Metric tensor. Group Theory:Definition of the group axioms, multiplication table, classes, subgroups, G sets, Homomorphism, Representation general and irreducible, Schur's lemma, characters, character table.>>	15 hrs.
UNIT-II	<<**THEORY OF TRANSFORM AND CONTINUOUS GROUPS** >> <<Expression of the Piecewise continuous periodic function in finite interval, properties, simple problems, applications, Fourier transform, Convolution, Parseval's theorem, Momentum representation, Dirac delta function, convolution product, solving differential equation with given boundary conditions with transform. Continuous groups: Rotation group SO(3), Lie groups and Lie algebra, special unitary (SU) groups, SU(2) group.>>	15 hrs.
UNIT-III	<< **SECOND ORDER DIFFERENTIAL EQUATION WITH VARIABLE CO-EFFICIENTS AND SPECIAL FUNCTIONS I** >> << Regular point; Simple pole, Series solution-indicial equation, Recurrence relation, Convergence of the series, Existence and evaluation of the second order solution, Hermite polynomials and their properties. Legendre polynomials and Associated Legendre polynomials, Recurrence relations, Orthogonality and Generating functions.>>	15 hrs.

REFERENCES (**Text Books)**

1.	Mathematical methods for physicists : G. B. Arfken and H. J. Weber, 5th edition Academic press/Elsevier science, India 2000.
2.	Mathematical methods for physics and engineering K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge university press 1998 (Low-price edition)
3.	Advanced Engineering Mathematics Kreyzing 8th edition, 2006, John Wiley & Sons (Asia Pvt.), Singapore .
4.	Mathematical physics P. K. Chattopadhyay: 1990, New age international publisher New Delhi.
5.	Elements of Group theory for physics A. W. Joshi, 4th edition reprint 2002 New age international publishers, New Delhi.

REFERENCES

1.	Mathematics of Classical and Quantum Physicsvol. I and II by Robert W. Fuller, Frederick W. 1992 Courier Dover Publications, NY, USA
2.	Mathematical methods for physical sciences by M. L. Boas, 3rd edition 2006, John Wiley and Sons, New York (2nd Ed. 1983)
3.	Advanced mathematical methods for scientists and engineers Carl M. Bender and Steven A. Oraszag, Springer, 1999

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	I	**CORE:**	CREDIT	4
Semester	I	**<<PHY2102C02>> : <<CLASSICAL MECHANICS >>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<Mechanics of a particles and two body central force problem >>** <<(Review**:** mechanics of a system of particles, system subjected to different constraints and various examples, generalized coordinates) D' Alembert's principle, Lagrange's equations, problems, deduction of Lagrange's equation from D' Alembert's principle, applications of Lagrange's equation, generalized momenta and energy, (Review: Cyclic or Ignorable coordinates). Calculus of variations: The Euler-Lagrange equation, First integral geodesics, Thebrachistochrone, Minimum surface of revolution, Several dependent variable.>>	15 hrs.
UNIT-II	<<**HAMILTONIAN FORMULATION** >> <<Hamilton's principle, Lagrange's equation from Hamilton's principle, Rayleigh's dissipation function, integral of motion, symmetry properties of space and time and conservation theorems.Reduction to one body problem, center of mass and relative motion, equation of motion and first integrals, equivalent one dimensional problem, Principle of least action, Hamilton's principle, derivation of Hamilton's equation of motion for holonomic system from Hamilton's principle and characteristic functions. >>	15 hrs.
UNIT-III	<< **RIGID BODY** >> <<.**:**(Review: number of degree of freedom, Euler's angles and Euler's theorem), infinitesimal rotation, rate of change of vector, (Review: Coriolis force, angular momentum and kinetic energy of a rigid body), the inertia tensor and moment of inertia, principle axes transformation, Euler's equation of motion. Precession of a charged body in a magnetic field. Small oscillations, normal modes and coordinates, transition from a discrete to a continuous system, the Lagrangian formulation for continuous system, constant of motion and symmetry properties >>	15 hrs.
UNIT-IV	<<CANONICAL TRANSFORMATION AND HAMILTONIAN - JACOBI THOERY>> <<Canonical transformation and its examples, generating functions, Poisson brackets, equation of motion, invariance of Poisson brackets under canonical transformations, angular momentum, Poisson brackets relations, infinitesimal canonical transformation, problems, Hamilton's principle and characteristic function, separation of variables in H – J method, action angle variables interpretation (for/with one degree of freedom).>>	15 hrs.

REFERENCES (**Text Books)**

1.	Introduction to classical mechanics by Golstein Poole &Safko (Pearson Education , Asia) 1st editin, 2002 (Low Price Editin)
2.	Classical Mechanics – N. C. Rana and P. S. Jog 1991, Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
3.	Introduction to Classical Mechanics R. G. Takwale and P. S. Puranik, 1979, Tata McGraw-Hill Pub. Co. Ltd., New Delhi.

	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	I	**CORE:**	CREDIT	4
Semester	I	**<<PHY2104C03>> : <<ATOMIC & MOLECULAR SPECTROSCOPY >>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<< >>** <<Intensity rules, central field approximation, interaction energy in L-S coupling and j-j coupling (two electron system). Broadening of spectral lines, natural broadening, Doppler broadening and external effects, nuclear spin and hyperfine structure. **Lasers** :- Active medium, light amplification in an inverted active medium, methods of creating population inversion, principal pumping schemes. Quality factor, different kinds of losses in a cavity, laser induced fluorescence.>>	15 hrs.
UNIT-II	<<**Astronomy and astrophysics** >> <<Basics of observational astronomy and astrophysics, Observed properties of stars (basics) Stellar evolution : Stars in formation, Virial-theorem, stellar energy generation, stellar energy cycle, evolution of stars, and end states of stars – white dwarfs, Neutron stars and black holes (qualitative), Mass radius relations, binary star (introductory). >>	15 hrs.
UNIT-III	<< >> <<**Microwave spectroscopy :–** Rigid rotator, non-rigid rotator, intensity of rotational lines, band head formation, intensity distribution in rotational structure, isotopic shift in rotational lines, techniques and instrumentation. **IR Spectroscopy :–** Vibrating diatomic molecule as a harmonic oscillator and an-harmonic oscillator, vibrational frequency and force constant for an-harmonic oscillator, vibrating rotator, isotopic shifts in vibrational bands, techniques and instrumentation>>	15 hrs.
UNIT-IV	<<**Raman Spectroscopy**>> << Raman spectra, Classical and quantum theory of Raman effect, Raman spectra and molecular spectra, infra-red spectra versus Raman spectra, principles of laser Raman spectroscopy, Frank-Condon principle, Heitler and London theory of H_2 molecule, NMR, EPR.>>	15 hrs.

REFERENCES (**Text Books)**

1.	Elements of Spectroscopy by Gupta, Kumar, Sharma, Pragati Prakashan, 2007.
2.	Laser Spectroscopy by W. Demtroder, 2nd Edition, Springer, 1998.
3.	Astrophysics : stars and Galaxies by K. D. Abhyankar Universities press (India) Limited 2001.
4.	Astrophysics – A Modern Perspective by K.S. Krishnaswamy. New. Ag International Publishers, 1996
5.	Molecules Spectroscopy - C.N. Banwell, McGraw Hill 1985

6.	Molecules Spectra and Molecular Structure, Vol.- I, II and III, by G.Herzberg, Van Nostrand Co., N.Y.1950
REFERENCES	
1.	Atomic Spectra by H.E. White.
2.	Laser Physics and Applications by Tarasov
3.	Contemporary Astronomy by J. Pasacchoff CBS college publishing, 1981
4.	Astronomy by Robert H. Baker.
5.	Atomic and Moleculer Spectra by Rajkumar, Kedas North Ram North, 2008

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	The Maharaja Sayajirao University of Baroda Faculty of Science, Department ofPhysics		ACADEMIC YEAR **2021-2022**

<<M.Sc. Physics >>

YEAR	I	**CORE:**	CREDIT	2
Semester	I	**<<PHY2103C20>> : <<NUMERICAL ANALYSIS >>**	HOURS	30
Theory/Lab		Year of Syllabus Revision:	Max marks	50

COURSE CONTENT / SYLLABUS

UNIT-I	**<<NUMERICAL METHODS >>** <<Finite difference method, eigen values of matrix, matrix diagonalisation, Monte Carlo method. Random number generator, **Application of random numbers:evaluation of π and radioactive decay,** Numerical differentiation, Numerical integration: **Trapezoidal, Simpson 1/3 & 3/8 method**s, two-dimensional integration.	15 hrs.
UNIT-II	<<**COMPUTER PROGRAMMING** >> **COMPUTER PROGRAMMING** Reviews of basic concepts of FORTRAN-90 and 95, procedure with array, Function and sub-program, subroutine, data statement, user defined operations, array values, Do while, implicit statement, program of complex numbers and variables, processing of files. <<**Basic concepts of Python: Corresponding Python programs for numerical evaluation : Relevant to computational physics laboratory need**>> Examples:1) Lagrange interpolation. 2) Millikan experiment with direct linear fit. 3) Derivatives with three point formulas. 4) To find the Madlung energy of the alkali halide types of ionic crystals. 5) To find the bond length of crystal like Nacl.>>	15 hrs.

REFERENCES (**Text Books)**

1.	Fundamentals ofPython Programming by Richard L. Halterman, Southern Adventist University.
2.	Computational physics by S.F. Koonin (Addition – Wesley , NY) 1986
3.	An introduction to computer simulation method PART – I (Addition – Wesley, NY) 1998 by Gould and J. Tebochaik.
4.	An introduction to computation physics by Tao Pang.(Cambridge Univ.-Press, 1997)

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	<< Physics Department, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara - 390 002>>, << Phone : +91-265-2795339>>, << >>	ACADEMIC YEAR **2019-2020**

<<M.Sc.>> : **<<M. Sc. Physics>>**

YEAR	I	**CORE:**	CREDIT	**4**
Semester	I	**<<PHY2108C05>> : <<ELECTRONICS>>**	HOURS	**60**

OBJECTIVES:

COURSE CONTENT / SYLLABUS

UNIT-I	<<**SEMICONDUCTOR DEVICE PHYSICS & DIGITAL CIRCUITES**>> <<**SEMICONDUCTOR DEVICE PHYSICS:** Energy distribution of electrons in a semi conductors, The Fermi-Dirac function, The density of states, Carrier concentration in an intrinsic semiconductor, Fermi level in a semiconductor having impurities, Band structure of open circuit p-n junction, Basic semiconductor equations, The p-n diode volt-ampere equation. **DIGITAL CIRCUITES:** Concept of Binary and Hexadecimal number systems, BCD codes, Introduction to RTL, DTL, TTL and CMOS logic families, Boolean algebra, De Morgan's theorem, Karnaugh mapping, Half adder, Full adder and subtractor. Flip Flop circuits, RS, J-K, Master slave, D type and T type FF circuits.>>	15 hrs.
UNIT-II	<<**COUNTERS & SHIFT RESISTORS**>> << **COUNTERS**: Asynchronous and Synchronous (up and down) Mod-N-counters, ring counters and counters as frequency dividers. SHIFT RESISTORS: Basic shift resisters, Left right shift resistor, serial in and parallel out, Parallel in and serial-out, Parallel-in and Parallel-out shift resistors, Multiplexers and De-multiplexers, Encoders, Decoders, and Buffers.>>	15 hrs.
UNIT-III	<<**APPLICATION OF OPERATIONAL AMPLIFIER & Amplifiers**>> <<**APPLICATION OF OPERATIONAL AMPLIFIER :** Review of fundamentals (Inverting and non-inverting amplifier), Analog Amplifier:- adder, Sub, Multiplication, Voltage to current, current to voltage converter, Integrator, differentiator, comparators, and Schmitt, trigger. **Amplifiers**: Two stage RC coupling (Potential), Inductive Coupling, Transformer Coupling, Class A amplifier, efficiency and push pull operation, AC load line and Q point, power output, Class B push pull amplifier, Cascaded stages, Tuned class C amplifier. >>	15 hrs.

UNIT-IV	<<**OSCILLATORS**>> <<**OSCILLATORS** Theory of oscillators, Hartley / Collpitts oscillators, phase shift oscillators, crystal oscillators, Wein Bridge oscillators. UJT Characteristics, relaxation oscillator and as a switch . FET, MOSFET (D-Type and E-Type) characteristics, FET as an amplifier. >>	15 hrs.

REFERENCES

1.	Integrated Electronics by Milman and Halkias, McGraw-Hill.
2.	Digital Technology By Virendra Kumar , New Age International
3.	Fundamental of Electronics Devices by Milman and Halkias, McGraw-Hill.
4.	Digital Principles and Application by Malvino and Leach (TMH).
5.	Hand Book of Electronics – Gupta and Kumar, Pragati Prakashan.
6.	Digital Technology by Tokheim - TMH

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	The Maharaja Sayajirao University of Baroda Faculty of Science, Department of Physics			ACADEMIC YEAR **2021-2022**
<<**M.Sc. Physics** >>				
YEAR	I	**CORE:** **<<PHY2106C21>> :<<LABORATORY >>**	CREDIT	8
Semester	**I**		HOURS	16
COURSE CONTENT / SYLLABUS				
UNIT-I	<<**LIST OF EXPERIMENTS** >> <<**(A) General laboratory:** 1. Child Langmur`s law 2. Michelson interferometer-I with Laser source 3. R-C coupled amplifier 4. Dissociation energy of I_2 –molecule 5. Talbot bands 6. Rayleigh interferometer 7. Feedback amplifier 8. e/m by Thomson method (CRT) 9. Gas filled photocell 10. Fourier Analysis 11. LogicGates-I (Basic circuits) 12. Multivibrator **(B) Computer Laboratory:** Fortran 90 /**Python3**programming on various numerical methods applied to physical problems. >>			16 hrs.

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CBCS-2019

Distribution of Credits for M. Sc. Physics Sem. – II

(Effective from 2021-22 to …)

Sr. No	Course code	Title of courses	Credit
1	PHY2201C07	MATHEMATICAL PHYSICS II	3
2	PHY2202C08	QUANTUM MECHANICS	4
3	PHY2204C09	NUCLEAR PHYSICS	4
4	PHY2208C10	CONDENSED MATTER PHYSICS	4
5	PHY2203C22	COMPUTATIONAL PHYSICS	2
6	PHY2210C12	PHYSICS LABORATORY-II	8
		Total	**25**

	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	I	**CORE:**	CREDIT	3
Semester	II	**<<PHY2201C07>> : << MATHEMATICAL PHYSICS - II >>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<COMPLEX VARIABLES I >>** <<Analytical functions and Cauchy-Riemann conditions, Poles-Taylor and Laurent series, contour integral and Cauchy's representation, Residue theorem, evaluation of residue at n^{th} order pole. Jordan's Lemma Evaluation of definite integral, Principle value of the integral, branch point, branch cut and integration around branch cut.Conformal mapping and its applications.>>	15 hrs.
UNIT-II	<<**SPECIAL FUNCTIONS II AND DIFFERENTIAL EQUATIONS** >> <<: Spherical harmonics($Y_l^m(\theta, \phi)$) and vector spherical harmonics, Laguerre polynomials, Associated Laguerre polynomials, Bessel function, spherical Bessel function, their properties, Recurrence relations, Orthogonality and Generating functions.. >>	15 hrs.
UNIT-III	<<**PARTIAL DIFFERENTIAL EQUATIONS** >> <<Review of expressions for gradient, divergence, curl and Laplacian operators in generalized co-ordinates. Boundary conditions, Laplace's equation, Heat diffusion equation and wave equation in Physics, Separation of variable technique to solve them, Green's function technique in general and especially for Poisson's equation.>>	15 hrs.

REFERENCES (**Text Books)**

1.	Mathematical methods for physicists : G. B. Arfken and H. J. Weber , 5^{th} edition Academic press/Elsevier science, India 2000.
2.	Advanced Engineering Mathematics Kreyzing 8^{th} edition, 2006, John Wiley & Sons (Asia Pvt.), Singapore .
3.	Mathematical physics P. K. Chattopadhyay: 1990, New age international publisher , New Delhi.
4.	Mathematical methods for physics and engineering K. F. Riley, M. P. Hobson
5.	Complex analysis :Churchil

	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	I	**CORE:**	CREDIT	4
Semester	II	**<<PHY2202C08>> : <<QUANTUM MECHANICS >>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<< Vectors, Matirces and Heisenberg mechanics >>** << Review of different types of matices and matirx algebra, transposition, comlex conjugation and adjoint of matrices, review of determinant and its properties, vectors and vector space, Dirac notations, linearly independent, orthigonal and orthonormal vectors, abstract representation of vectors, inner and outer product of vectors, Gram-Schmidt method of orthogonalization of vectos, Schwarz inequality, linear transformation of vectors, eigenvalues and eigenvectors of a matrix and properties of eigenvalues and eigenvectors, inversion and diagonalization of a matrix- analytical and numerical methods, special type of metrices:- orthogonal, unitary and hermitian mtrices and their properties, diagonalization of hermitian matrix, change of basis and unitary transformations, bi-linear, quardratic and hermitian forms, Cayley-Hamilton theorm, infinite dimensional Hilbert space, basis in Hilbert space, vector representation of a vector and matrix representation of an operator, Schrodinger equation in matrix form, statement of assumptions of Heisenberg quantum mechanics, general uncertainty principle for non-commuting variables. >>	15 hrs.
UNIT-II	<< >> <<.**1-D Harmonic Oscillator**: treatment of 1D harmonic oscillator problem with use of operator and matrix formalism. **Transformations, conservation laws and Symmetries:** Translation in space and conservation of linear momentum, translation in time and conservation of energy, rotation in space, quantum generalization of the rotation operator and conservation of angular momentum, conservation of charge, reflection, parity and space inversion, **Time-Reversal operator**:- Properties of anti-linear operator, time reversal for spin less particle, time reversal operator for non-zero spin particle. **MANY PARTICLES SYSTEMS:**Identical particles (fermions/bosons), symmetric and anti-symmetric wave function, multiplicity and degeneracy>>	15 hrs.

UNIT-III	<< >> << **SCHRODINGER WAVE EQUTION AND ITS EXACT SOLUTION FOR ONE DIMENSION :** (Review : admissibility condition for wave functions), observables as dynamical variables and their expressions as Hermitian operator. **SCHRODINGER EQUATION IN THREE DIMENSION:**Schrodinger equation in three dimensions, spherically symmetric different potentials, angular momentum, commutation amongst L_x, L_y and L_z , eigen value spectrum of L^2 and L_z , Legendre polynomials >>	15 hrs.
UNIT-IV	<<**APPROXIMATE METHODS**>> <<Time independent perturbation theory for non-degenerate case (1^{st} and 2^{nd} order) and for degenerate case (1^{st} order only), removal of degeneracy, application of perturbation theory, an harmonic oscillator, stack effect, variational method, upper bound to excited states, trial wave function in variational method, WKB approximation, turning point solution, validity, WKB connecting formula, Bohr – Sommerfeld quantum condition, application of variational method and WKB approximation.>>	15 hrs.

REFERENCES (**Text Books)**

1.	Quantum mechanics by L P Schiff, McGraw Hill International, 1968.
2.	Quantum mechanics by J I Powell & B Crasemann 2^{nd} edition, B. I. Publication, Delhi, 1971.
3.	Quantum mechanics by Ghatak& Loknathan
4.	Quantum mechanics G. Aruldhas; Prentice-Hall of India Pvt. Ltd. 2002

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >>		ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.** : <<**M.Sc. Physics** >>

YEAR	I	**CORE:**	CREDIT	4
Semester	II	**<<PHY2204C09>> : <<NUCLEAR PHYSICS>>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<Interaction of radiation and charged particle with matter>>** <<Energy loss of electrons and positrons, Stopping power and range of heavier charged particles, Interaction of gamma rays with matter. **Nuclear radiation detectors:** Gas filled detectors, Proportional and Geiger Muller counters, Scintillation detector, Solid state detectors.>>	15 hrs.
UNIT-II	<< >> <<**Nuclear forces and two body problems:** Saturation,Charge independence and Exchange forces, Deuteron ground and excited states, Low energy n-p scattering, Scattering length, Spin dependence of nuclear forces, Effective range theory, Meson theory of nuclear force. **Nuclear models :**Semi empirical mass formula, Single particle shell model, its validity and limitations, Collective model (Qualitative discussion on rotational and vibrational states). >>	15 hrs.
UNIT-III	<< >> << **Nuclear reactions:** Partial wave analysis of nuclear reaction (result only),Single level Briet Wigner formula, Direct reactions, Compound nucleus hypothesis, Resonances in reactions. **Reactor Physics:**Nuclear chain reaction (four factor formula), Reactor materials, Breeder reactor.>>	15 hrs.
UNIT-IV	<< >> **<< Nuclear decay:**Fermi theory of β –deacy, Kurie plot, ft- values, allowed and forbidden transition, Fermi and Gamow Teller selection rules, Multipole transition and selection rules. **Elementary particles:** Fundamental forces and fundamental particles, Symmetries and conservation laws, Space time symmetries, Space inversion, Charge conjugate and time reversal symmetries,CPT theorem and its consequences,Lepton numbers and baryon numbers, Isospin,Strangeness and Charm,Gell-Mann and Nishima relation, Hadronic spectrum and Quark model, Concept of colour and gluons.>>	15 hrs.

REFERENCES (Text Books)

1.	Atomic and Nuclear Physics – S. N. Ghoshal (Physics Vol.-II) 1st Edition, 1964, S. Chand Company Ltd, New Delhi.
2.	Nuclear Physics by Krane.
3.	Experimental Nuclear Physics by R. M. Singru.

REFERENCES

1.	Concept of Nuclear Physics by Cohen.
2.	Nuclear Physics by Blatt and Weisskopff.
3.	Physics and Nuclei and Particles by Marimier and Sheldon.
4.	Nuclear Reaction Detector by Kapoor and Ramamurthy.
5.	The Atomic Nucleus by R.D. Evans.
6.	High Energy Physics by Perkins.
7.	Nuclear Physics by D.C. Tayal, Himalaya Publication, Delhi,1982.

8.	Nuclear Physics by Roy and Nigam, Wiley-Eastern, 1st Edition 1967, first reprint 1979.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science**>>, Department of <<**Physic**s>>			**ACADEMIC YEAR** **2019-2020**
<<M.Sc.>> : <<M.Sc. Physics >>				
YEAR	I	**CORE:**	CREDIT	4
Semester	II	**<< PHY2208C10>> : <<Condensed Matter Physics>>**	HOURS	60
OBJECTIVES:				
COURSE CONTENT / SYLLABUS				
UNIT-I	**<<Title>>** <<**CRYSTAL BINDING AND COHESIVE ENERGY:** Crystals of Inert gases, Van der waals-London Interaction, Repulsive Interaction, Equilibrium lattice constant, Cohesive energy, ionic crystals, Madelung energy & Constant, covalent crystals, hydrogen-bonded crystals, and metallic crystals. Atomic & Ionic radii. **(**Refs: Kittel; Ashcroft-Mermin) **DEFECTS:** Point defects: general thermodynamic features, color centers and optical properties of ionic crystals; linear defects, planar defects, volume defects. **(**Refs: Kittel; Ashcroft-Mermin)>>			15 hrs.
UNIT-II	**<<Title>>** <<**ENERGY BAND THEORY:** Motion of an electron in a periodic potential and Bloch's theorem, Kronig-Penney model, concept of band gap, Brillouin zones, extended, reduced and repeated zone schemes, distinction between metal, insulator and semiconductor, concept of holes and effective mass, cyclotron resonance. **(**Refs: Kittel; Dekker; Ashcroft-Mermin; Quant. Mech. book by Merzbacher;). **NANOSYSTEMS:** Quantum hetero-structures, size-quantization in confined structures, density of states in quantum wells, quantum wires and quantum dots. **(**Refs: Harrison)>>			15 hrs.
UNIT-III	**<<MAGNETIC PROPERTIES>>** <<Classification of magnetic materials and their characteristics, origin of magnetism, Bohr magnetron, diamagnetism and Larmor precession, classical and quantum theories of paramagnetism, ferromagnetism, Weiss theory, ferromagnetic domains and hysteresis, anti-ferromagnetism, two sublattice model, ferrimagnetism; paramagnetic relaxation. (Refs: Kittel, Dekker, Ashcroft) >>			15 hrs.
UNIT-IV	**<<DIELECTRIC PROPERTIES>>** <<Static dielectric constant, polarization, electronic and ionic polarizabilities, orientational polarization, dielectric constant, Lorentz internal field, dielectric constant of solids, Clausius-Mosotti relation, complex dielectric constant and dielectric losses, relaxation time, electronic polarization and optical absorption; ferroelectricity: dipole theory, polarization catastrophe; introduction to piezoelectricity: **(**Refs: Kittel, Dekker, Ashcroft)>>			15 hrs.

REFERENCES	
1.	Introduction to Solid State Physics by Charles Kittel (8th Ed., Wiley Eastern, 2004).
2.	Solid State Physics by N. W. Ashcroft and N. D. Mermin (2nd Ed., Holt-Saunders, 2000).
3.	Solid State Physics by A.J. Dekker (Pan MacMillan, London, UK; Indian Edition by MacMillan India, 2000).
4.	Quant. Mech. book by Merzbacher.
5.	Quantum Wells, Wires and Dots by P. Harrison (Wiley & Sons, 2005).

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	The Maharaja Sayajirao University of Baroda Faculty of Science, Department of Physics		ACADEMIC YEAR **2021-22**	
<<**M.Sc. Physics**>>				
YEAR	I	**CORE:**	CREDIT	2
Semester	II	**<<PHY2203C22>> :<< COMPUTATIONAL PHYSICS >>**	HOURS	30
Theory/Lab		Year of Syllabus Revision:	Max marks	50

COURSE CONTENT / SYLLABUS

UNIT-I	**<<>>** << Coffee cooling problem, computer program for Coffee cooling problem.Motion of falling objects, numerical solution and computer programming in one and two dimensional trajectories.Random Number generation, Laplace equation in 2D. Kepler's problems, equation of motion of planets, equations for circular and elliptical orbits. (Its numerical solution and programming.)>>	15 hrs.
UNIT-II	<<>> <<Simple harmonic oscillators, simple/driven pendulum, damped oscillatory motion, chaotic motion. Oscillations in LCR series/parallel electric circuit: Numerical simulations in Python. Boundary value and eigen value problems: stationary solution of one dimensional Schrodinger equation using Numerov method algorithm. (TISE solution for one body in 1D).Scattering of particle by central potential (Born approximation &Partial Wave Analysis),**Python programs for numerical algorithm & evaluations.>>**	15 hrs.

REFERENCES (**Text Books)**

1.	FORTRAN-90 & 95 by V. Rajaraman, 2004 Prentice Hall Pvt. Ltd., New Delhi.
2.	Computational physics by S.F. Koonin (Addition – Wesley , NY) 1986
3.	An introduction to computer simulationmethod PART – I (Addition – Wesley , NY) , 1998 by Gould and J. Tebochaik.
4.	An introduction to computation physics by Tao Pang.(Cambridge Univ-Press, 1997)
5.	Fundamentals ofPython Programming by Richard L. Halterman, Southern Adventist University.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>		ACADEMIC YEAR **2019-2020**	
<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>				
YEAR	I	**CORE:**	CREDIT	8
Semester	II	**<<PHY2210C12>> : <<PHYSICS LABORATORY-II>>**	HOURS	
OBJECTIVES:				
COURSE CONTENT / SYLLABUS				
	<< ***LIST OF EXPERIMENTS*** >>			
	<<**(A) General laboratory:** 1. Michelson's Interferometer – II ('t' of thin glass plate) 2. Ultrasonic Interferometer 3. Vibrational spectrum of AIO molecule 4. E/m by Thomson method (CRT) 5. P-N Junction diode 6. Laser (λ and e) 7. Logic gates – II (combinational circuits) 8. Operational Amplifier (OP-AMP) 9. Fourier analysis 10. Dead time of GM counter 11. Hall effect **(B) Computer Laboratory:** FORTRAN programming on various numerical method applied to physical problems. >>			hrs.

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CBCS-2019

Distribution of Credits for M. Sc. Physics Semester - III

Sr. No	Course code	Title of core courses	Credit
1	PHY2301C13	ADVANCE QUANTUM MECHANICS	4
2	PHY2302C14	CLASSICAL ELECTRODYNAMICS & PLASMA PHYSICS-I	3
3	PHY2304E01	EXPERIMENTAL TECHNIQUES - I (Elective paper)	3
4	PHY2305E01	ASTROPHYSICS AND COSMOLOGY (Elective paper)	3
5	PHY2306E01	Advanced Theoretical Physics (Elective paper)	3
6	PHY2307S01	ELECTRONICS & COMMUNICATIONS-I (Specialization Paper)	3
7	PHY2308S02	ELECTRONICS & COMMUNICATIONS-II (Specialization Paper)	4
8	PHY2309S01	NUCLEAR PHYSICS - I (Specialization Paper)	3
9	PHY2310S02	NUCLEAR PHYSICS - II (Specialization Paper)	4
10	PHY2311S01	CONDENSED MATTER PHYSICS - I (Specialization Paper)	3
11	PHY2312S02	CONDENSED MATTER PHYSICS - II (Specialization Paper)	4
12	PHY2313S01	ATOMIC & LASER SPECTROSCOPY-I (Specialization Paper)	3
13	PHY2314S02	MOLECULAR SPECTROSCOPY-I (Specialization Paper)	4
14	PHY2303C15	PHYSICS LABORATORY-III	7
		Total	**24**

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	4
Semester	III	**<<PHY2301C13>> : <<ADVANCE QUANTUM MECHANICS >>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> <<Time dependent perturbation theory, Interaction picture, Transition amplitude, First-order perturbation, Harmonic perturbation, Transition probability, Second -order perturbation, Adiabatic and sudden approximation, Interaction of an atom with electromagnetic radiation (semi classical treatment), Absorption and emission of radiation. The dipole approximation, selection rules.>>	15 hrs.
UNIT-II	**<< >>** << **Angular Momentum**: Matrix Representation of Angular Momentum, Pauli's spin matrices and their algebra, Addition of angular moment, Simple examples. Coupling of two angular momenta and C.G. Coefficients for J_1=1/2, J_2=1/2, and J_1=1, J_2=1/2. **Many Electron Atom**: Central field approximation, Hartree method of self Consistent fields, Ground states of He atom, Hartree-Fock methods : Ortho and Para states of He.>>	15 hrs.
UNIT-III	<< >> <<Relativistic Quantum Mechanics: Klein-Gordon equations, charge & current densities, physical interpretations and short comings of K-G equation, Dirac equation and its derivation, Dirac matrices and their properties, constant of motion for Dirac equation (spin of Dirac particle), electron in electromagnetic field, Spin-orbital interaction energy , free particle solution of Dirac equation, negative energy states and the concept of hole, Dirac equation for spherically symmetric potential, deduction of K-operator and commutation relations for H, K and J; Eigenvalues of K, reduction of Dirac equation to a radial equation, solution of radial equation for hydrogen-like atom, fine structure corrections to energy.>>	15 hrs.
UNIT-IV	**<< >>** << Quantization of Fields: Classical radiation fields, Fourier decomposition and radiation oscillators, creation, annihilation and number operators, quantization of radiation oscillators, quantized radiation fields, photon states, quantization of non relativistic Schrödinger wave equations for Bosons as well as for Fermions, Matrix representation of creation, annihilation and number operators and their states for Fermions. >>	15 hrs.

REFERENCES

1.	Advance Quantum Mechanics- by J.J. Sakurai, Addison-Wesley
2.	Quantum Mechanics - by B. K. Agrawal & Hari Prakash (PHI EEE, 2004)
3.	A Text book of Quantum Mechanics: P. M. Mathews & K. Venkatesh. Tata McGraw-Hill Publ. Company Ltd. New Delhi (10th reprint) 1986
4.	Quantum Mechanics LI shift (Mc Graw Hill)
5.	Quantum Mechanics Vol.-II: A. Messiah, John Wiley & Sons, New York 1868.
6.	Quantum Physics – by S. Gasiorowicz (III Ed.) ,Wiley

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	3
Semester	III	**<<PHY2302C14>> :** **<<CLASSICAL ELECTRODYNAMICS & PLASMA PHYSICS-I>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Different system of units in electromagnetic theory, Maxwell's equation in Gaussian and MKS system of units, Conservation laws, Energy density, Poynting vector, Maxwell stress tensor, Solution of Maxwell's equations in infinite dielectric and conductin medium, plane wave and spherical wave solution, polarisations and their properties (Stoke parameters).Superposition of waves, kinematics of dispersion and classical theory of dispersion, Normal and anomalous dispersion.>>	15 hrs.
UNIT-II	**<< >>** << Dispersion in conducting medium, plasma frequency and reflection in ionosphere. Dynamical boundary conditions at the interface, Reflection and refraction at the interface, Fresnel's amplitude relations for parallel and perpendicular polarizations, Reflection and Transmission coefficients for interfaces between dielectric-dielectric and dielectric-metal, polarization by reflection, total internal reflection, skin depth and metallic plasma.>>	15 hrs.
UNIT-III	<<>> << Reflection and transmission through dielectric slab, multiple reflections and Transmissions, Wave Guide and Resonant cavities, propagation of TM, TE and TEM modes in rectangular and cylindrical wave guides and cavities, Energy flow and power losses in wave guides and cavities. Perturbation of boundary conditions.>>	15 hrs.

REFERENCES

1.	Classical Electrodynamics : Jackson J.D. 2nd Edition John Wiley & Sons New York, 1963.
2.	Classical Electricity and Magnetism : Panofsky W. K. H. and M. Phillips, 2nd Edition, ReadingMass. : Addison-Wesley (AW) 1962.
3.	Feynman Lectures, Vol.-II. AW, MIT reading 1965, Narosa Pub. 1995
4.	Introduction to Electrodynamics: D. J. Griffiths. 3rd Ed. PHI, New Delhi 2001
5.	Classical Electrodynamics: S. P. Puri, Tata McGraw-Hill Publ. Company Ltd.New Delhi 1990

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<<M.Sc.>> : <<M.Sc. Physics>>

YEAR	II	**CORE:**	CREDIT	3
Semester	III	**<<PHY2304E01>>:** **<<Elective Paper: EXPERIMENTAL TECHNIQUES-I>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<Title>>** <<Vacuum Pumps : Rotary pump, Diffusion pump, Sputter – Ion pump, Sorption pump, Turbomolecular pump. Gauges: Bourdon Gauge, Mcleod gauge, Pirani gauge, Thermocouple gauge, Hot and cold cathode ionization gauge. Vaccum Materials, Thickness measurement technique.>>	15 hrs.
UNIT-II	**<<Title>>** <<Chemical wet Processing, Solgel method, Ball-milling method, Melt and Vapour Growth methods (Zone, Bridgman, Czochralsky) Thermal Evaporation, Chemical vapour deposition (CVD); Sputtering - RF, Pulsed Laser Deposition (PLD)Beam; Molecular Beam Epitaxial Growth (MBE)>>	15 hrs.
UNIT-III	**<<Title>>** <<Review of powder X-ray, electron and Neutron diffraction Electron microscopy- Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM); Field Emission and Field Ion Microscopies (FEM & FIM), Application as Atom Probe, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM).>>	15 hrs.

REFERENCES

1.	Modern Vacuum Practice - by Nigal Harris, Tata McGraw Hill Publ., New York.
2.	Thin Film Technology and Applications - by K. L. Chopra & L. K. Malhotra, Tata McGraw Hill Publ., New Delhi.
3.	Thin film Techniques by Joy George, Marshall Dekkar Inc. 1992
4	A.V.S. Monograph on Vacuum technology by Harland G. Tompkins, A. V. Society Publ. 2nd ed. (1991).
5	Ultra high vacuum techniques Edited by D.K. Awasthi, A.Tripathi, A. C. Gupta Allied publishers Pvt. Ltd. (2002)
6	Modern Techniques of Surface Science - by D.P. Woodruff & T.A. Delchar, Cambridge University Press, Cambridge.
7	Solid State Physics - by R.L. Singhal, 7th Ed. Kedarnath Ramnath & Co.
8	Elements of X-ray diffraction,2nd edition by B.D.Cullity,Addison Wesly Publ. Comp.Inc.(1978)

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<<M.Sc.>> : **<< M.Sc. Physics>>**

YEAR	I	**Elective:**	CREDIT	3
Semester	I	**<<PHY2305E01>> :** **<< Elective Paper: Astrophysics and Cosmology>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<General Introduction and Stellar properties** >> <<Basics of electromagnetic radiation in astrophysics : Radiative flux, Radiative transfer : emission, absorption, Radiative transfer equation(brief), Eddington approximation, Brief introduction to astrophysical plasma and astrophysical fluid. Observational aspects: brightness measurement, interstellar absorption, reddening, colour magnitude diagram (inclusive two colours), Brief introduction: Sun as a star and planetary system (description of planet, their satellites origin of planetary rings atmosphere of planets(thermal structure)), stellar distances and absolute luminosities. Basic properties of stars : Spectral classification, formation of spectral lines, structure of spectral lines, photo diffusion in side Sun.>>	15 hrs.
UNIT-II	**<<Stellar dynamics, Galaxies and Interstellar medium>>** <<Stellar structure, stellar hydrostatic equilibrium, Simplified stellar models, equation of radiative transfer, radiation in solar atmosphere, Nuclear energy generation rates, energy generation cycle, Nature of galaxies(properties of normal galaxies), Hubble sequence, spirals and irregular galaxies, Spiral structure, Elliptical galaxies**,** Galactic evolution : Formation of galaxies(brief), Interstellar medium and its physical properties, Interstellar gas and electron density, , Interstellar dust grains and grains properties, grain evolution, interstellar gas dynamics, Gaseous Nebulae, H II regions. **For Unit I, II** Astrophysics : K. D. Abhyankar, Universities Press, Hydrabad. 2005 Astrophysics –I and II R. Bower and T Deeming, Jones and Barlett, 1984. Astrophysics for physicists : Arnab Rai Choudhari, Cambridge University press, 2010>>	15 hrs.
UNIT-III	**<<Cosmology and its observational support>>** <<Structure of the universe, Extragalactic distance scale, External galaxies, Clusters of galaxies, Theoretical foundation of cosmology : The metric of the Universe, Friedmann equation and scale factor of the Universe, matter and radiation content of the Universe, Universe at early epoch, the age of the Universe, brief thermal history of the Universe, formation of elements, : Cosmic Microwave background radiation (CMBR), some problems with cosmological models, different probes : COBE, WMAP, galaxy and red-shift surveys, High-red shift Supernovae Surveys, brief about dark matter and dark energy. **Ref** : Astrophysics for physicists : Arnab Rai Choudhari, Cambridge University press, 2010 Classical Theory of Fields, Vol. II, L. D. Landau and E. M. Lifshitz, Oxford : Pergamon Press. Introduction to Cosmology, 3rd Edition, J. V. Narlikar, Cambridge University Press.>>	15 hrs.

REFERENCES	
1.	Astrophysics : K. D. Abhyankar, Universities Press, Hydrabad. 2005
2.	Astrophysics –I and II R. Bower and T Deeming, Jones and Barlett, 1984.
3.	Astrophysics for physicists : Arnab Rai Choudhari, Cambridge University press, 2010
4.	Astrophysics for physicists : Arnab Rai Choudhari, Cambridge University press, 2010
5.	Classical Theory of Fields, Vol. II, L. D. Landau and E. M. Lifshitz, Oxford : Pergamon Press.
6.	Introduction to Cosmology, 3rd Edition, J. V. Narlikar, Cambridge University Press.
7.	The Physical Universe: An Introduction to Astronomy, F. Shu, Mill Valley : University Science Books.
8.	Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
9.	Theoretical Astrophysics, Vol. I:Astrophysical Processes, T. Padmanabhan, Cambridge Univ. Press (2000).
10.	Theoretical Astrophysics, Vol. II: Stars and Stellar systems, T. Padmanabhan,Cambridge Univ. Press(2001).
11.	Theoretical Astrophysics, Vol. III: Galaxies and Cosmology, T. Padmanabhan, Cambridge University Press (2002).

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<Faculty of Science>>, Department of <<Physics Department>> << Physics Department, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara - 390 002>>, << Phone : +91-265-2795339>>, << >>			ACADEMIC YEAR **2019-2020**
<<M.Sc.>> : **<<M. Sc. Physics>>**				
YEAR	II	**CORE:**	CREDIT	**3**
Semester	III	**<<PHY2306E01>> :** **<<Elective Paper: Advanced Theoretical Physics>>**	HOURS	**45**
OBJECTIVES:				
COURSE CONTENT / SYLLABUS				
UNIT-I	**<<General Theory of Relativity And Its Applications (A Few)>>** <<Introduction to totally symmetric and anti-symmetric tensors in higher dimension, principle of general covariance, parallel transport, Covariant derivative, Riemann geometry, some useful identity and locally inertial coordinates, physics in curved space-times, Riemann tensor, its properties and other identities, geodesics, geodesic deviation, symmetries of various tensors in curved space-time, principle of equivalence, energy momentum tensors, variation of metric tensor, energy tensor of matter, action principle, its conservation properties, Einstein's field equations (heuristic and action approach), Newtonian approximation, A few solutions of Einstein field equation : Schwarzschild(exterior, interior), motion of a test particle and it comparison with Newtonian approximation, cosmological solution (Friedman, de-Sitter etc.) Formal introduction to gravitational radiation: theory and experiment>>			15 hrs.

UNIT-II	**<<Density Functional Theory>>** << introduction, quantum theory and the origins of electronic structure, Born-Oppenheimer Approximation, Hartee Method, Hartee-fock (H-F) method, application of Hartee and Hartee-fock (H-F) methods to homogeneous electron gas, What is functional, functional derivatives, Hohemberg-Kohn theorems, Thomas-Fermi, Kohn-Sham equations, Exchange, Correction, Local approximations, Local density approximation, Kohn-Sham equations.>>	15 hrs.
UNIT-III	<<**Angular Momentum, many body systems of identical particles**>> <<Density Matrix, Density Matrix and statistical ensemble using Density Matrix-Spin Polarization and scattering, information and density matrix, Tensor operators and Wigner Eckart Theorem, Applications of Wigner-Eckart Theorem, Angular momentum of system of identical particles.>>	15 hrs.

Textbooks

1.	Introduction to Relativity by J. V. Narlikar, Cambridge University Press (Indian Edition), 2010
2.	Introduction to Cosmology by J. V. Narlikar Cambridge University Press (Indian 3rdEdition), 2002.

REFERENCES

1.	Principles of Physical Cosmology by P. J. E. Peebles, Princeton Series in physics, (1993)
2.	Cosmology by Steven Weinberg, Oxford university press (2008).
3.	Principles of Cosmology and Gravitation, Michael V Berry, Institute of physics publishing, (1989), Reprint (2001).
4.	Cosmology by Peter Coles, Oxford university press (2001).
5.	Fundamentals of Interferometric Gravitational Wave Detectors by Peter R Saulson World Scientific Publishing (1994).
6.	Advanced Gravitational Wave Detectors, Editors :David G. Blair, Eric J. Howell, Li Ju and Chunnong Zhao Cambridge University Press (2012).
7.	Density Foundation Theory: An approach to the Quantum Many-Body Problem by R. M. Dreizler and E.K.U. Gross.
8.	Electronic structure: Basic Theory and Practical Methods by Richard M. Martin.
9.	Understanding Molecular Simulation From Algorithm to applications by Daan Frenkal and Berend Smit.
10.	Quantum Mechanics by E Merzbacher (3rd Edition)

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<<M.Sc.>> : **<<M. Sc. Physics>>**

YEAR	II	**CORE:**	CREDIT	**3**
Semester	III	**<<PHY2307S01>> :** **<<ELECTRONICS&COMMUNICATIONS-I(Specialization Paper)>>**	HOURS	**45**

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> <<Modulation and Demodulation: Amplitude modulation, modulation index, single sideband principles, Sideband power distribution of an AM wave, AM modulators and demodulators, square law modulation, DSSB generation and reception. Data Communication system: Data representation, modes of data transmission, Signal encoding, Tansmission media, Telephone network, sampling theory, quantizing of analog signals, quantization error, Frequency and time division multiplexing, Digital modulation methods, ASK, FSK, and PSK, modems, Error detection and correction: Parity checking, Checksum error detection.>>	15 hrs.
UNIT-II	**<<>>** <<Digital Communication: Principle of digital communication system, layers of digital communication system, Bit transmission and signaling rate, error probability, digital filtering, pulse code modulation, bandwidth and noise in PCM, Quantization and Quantization noise, PCM encoding and system. Seven segment Displays. Optical Sources: LEDs and Lasers, tunnel diode, Gun diode, PIN diode **Photo detectors**-Pin detectors, detector responsivity, noise, optical receivers. Opto couplers.	15 hrs.

	Fiber Optic Communication: Principle of light transmission in a fiber, effect of index profile on propagation, modes of propagation, number of modes in a fiber, losses in fibers, dispersion in fiber, source and detectors for fiber optic, connectors and splices, fiber optic communication systems..>>	
UNIT-III	<<>> <<Transmission Lines: Wavelength and velocity of propagation, waveform distortion, distortion less lines, reflection of lines, characteristics impedance, open and short transmission lines, reflection factor and loss, standing wave and its ratio, Input impedance of distortionless lines, Power and impedance measurements. Wave Guides: Plane parallel wave guide, modes of transmission, characteristics of modes of transmission, propagation constant, phase and group velocity, skin effect, TM modes, specific wave impedance, cut off and characteristics power transmitted, Rectangular wave Guide >>	15 hrs.

REFERENCES

1.	Data Communications and Computer Networks by P.C. Gupta, PHI Publication 2006
2.	Electronics communication systems, George Kennedy & Davis, Mc.Graw., Hill.
3.	Electronic Communications, Roddey & Coolen, PHI
4.	Communication systems, R. P. Singh and S. D. Sapre, TMH
5.	Communication systems, Simon Haykin, Mc Graw Hill
6.	Modern electronic Communication by Ajay Sharma and RK Sinha , Dhanpat Rai Pub
7.	J. Keiser, Fibre Optic communication, by J. Keiser, McGraw Hill, 2nd Edition 1992
8.	Optical Fibers for Transmission, by J.E.Midwinter, John Wiley 1979
9.	Understanding Optical Communications, by H. Dutton, Printice Hall
10.	Network lines and fields, J. D. Ryder, Asia Pub. House

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<<M.Sc.>> : **<<M. Sc. Physics>>**

YEAR	II	**CORE:**	CREDIT	**4**
Semester	III	**<<PHY2308S02>> :** **<<ELECTRONICS & COMMUNICATIONS-II (Specialization Paper)>>**	HOURS	**60**

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<<>> << Applications of Op-Amp: Design and working of Op-amps as differential, Instrumentation amplifier, Signal Generator: Monoshot / Pulse Generator , , free running, triangle and sawtooth wave generators. Voltage controlled Oscillator , Sample and Hold Circuit , Precision Rectifiers. Filters**:** Active RC filter design: use of finite and infinite gain amplifiers. Two integrator loop and high order filter design. Design of Active Filter Circuits: Butter worth Filter, Low pass, high pass, band and notch filters, Bode and dB plots>>	15 hrs.
UNIT-II	**<<>>** <<VLSI Technology: An overview of VLSI, Ideal switches and Boolean operations, MOSFET as switches CMOS Logic gates, Complex logic gates in CMOS, Integrated circuit layers MOSFETS, CMOS layers, Fabricating of CMOS Integrated circuits by Lithography, Layout of Basic structures of MOSFETs, nFET current-voltage equations, DC characteristics of CMOS Inverter, Power Dissipation in CMOS, High speed CMOS network gate delays, VLSI system multiplexors, VLSI clocking, clocked flip flops, CMOS clocking.>>	15 hrs.

UNIT-III	<<>> <<Microprocessor Architecture and Programming: Encoders, Decoders, Buffers, 8085 Intel microprocessor architecture, DRAM and SRAM Memory, Memory organization, types of memory, Memory mapping, 8085 control lines, ALU, Flags, registers, data and address bus. I/O mapped I/O and memory mapped I/O, status signals, 8085 Assembly language and its instruction set, basic instructions; addressing modes, data transfer, arithmetic operations, logic operations, branch operations, 16 bit arithmetic operations, memory operation, rotate, compare operations and assembly language programs.>>	15 hrs.
UNIT-IV	<<>> <<Memory interfacing, I/O Interfacing, counters and delays Op-code Fetch operation, execution of instruction, instruction cycle, machine cycle, memory read, memory write, I/O read, I/O write, Timing diagram, stack and subroutine, 8085 interrupts, Interrupts and Interrupt service procedures, and assembly language programs based on these.>>	15 hrs.

REFERENCES

1.	Op-amp and Linear Integrated circuits: Ramakant Gayakwad, PHI
2.	Operational Amplifier and Linear IC, RF Coughlin and F. F. Driscoll, PHI
3.	S.K.Mitra, Active Inductorless Filters, IEEE Press 1971
4.	Operational Amplifier and Linear IC, RF Coughlin and F. F. Driscoll, PHI
5.	Solid State Pulse Circuits By David A. Bell , PHI
6.	Introduction to VLSI circuits and Systems: J.P. Ugemura, Wiley 2001
7.	Microprocessor and Programming, B. Ram, Dhanpatrai Pub.
8.	Microprocessor Architecture, Programming and Application, R. S. Gaonkar, Penram International
9.	Digital Principles and Application, A. P. Malvino and D. Leach, TMH

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics**>>

YEAR	II	**CORE:**	CREDIT	3
Semester	III	**<<PHY2309S01>> :** **<<NUCLEAR PHYSICS-I (Specialization Paper) >>**	HOURS	45

COURSE CONTENT / SYLLABUS

UNIT-I	<< **Nuclear radiation Detectors and Spectrometers**>> <<Scintillation detectors, Type of scintillators, Semiconductor detectors- depletion region, silicon diode detectors, Si(Li), Ge(Li), HPGedetectors, Gamma-ray spectrometer, analysis of gamma-ray-spectra, Response function, Alpha and beta spectrometers, Error Propagation, Nuclear reaction of interest in neutron detection, BF_3 detectors >>	15 hrs.
UNIT-II	**<<Nuclear Electronics>>** <<Nuclear Electronics for Pulse signal processing - Pre-amplifiers, amplifiers, pulse shaping, discriminators, single channel analyzer, analog-to-digital converters and multi-channel analyzer, time to amplitude converters (TAC), basic coincidence technique, Resolving time characteristics of a coincidence set up, Compton rejection by anti-coincidence,Charge particle identification , Applications of coincidence technique in nuclear experiments.>>	15 hrs.
UNIT-III	<<**Particle Accelerators & Nuclear Reactions**>> <<Acceleration of charged particles, Van de Graaff accelerator, Tandem accelerators, Linear accelerators, Cyclotron, Synchrocyclotron and their applications. Compound nuclear reaction cross sections, Continuum theory, Statistical model, Ghoshal experiment, Pre-equilibrium reaction mechanism. >>	15 hrs.

REFERENCES

1.	Techniques for Nuclear and Particle Physics Experiments by W. R. Leo.
2.	Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy.
3.	Experimental Nuclear Physics by R. M. Singru.
4.	Radiation Detection and Measurement by G. F. Knoll
5.	Introductory Nuclear Physics,Wiley India, by Kenneth S.Krane.

6.	Atomic and Nuclear Physics Vol-II, S. N. Ghosal.
7.	Nuclear Physics by R.D.Evans

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics**>>				
YEAR	II	**CORE:**	CREDIT	4
Semester	III	**<<PHY2310S02>> :** **<<NUCLEAR PHYSICS-II (Specialization Paper)>>**	HOURS	60
COURSE CONTENT / SYLLABUS				
UNIT-I	<<>> << Mass formula and Nuclear Models I:Semi-empirical mass formula and its applications, Mass parabola. The extreme single-particle shell model, Spin-orbit interaction and magic numbers, Ground state spin and parity, Magnetic moment-Schmidt lines, Deformed nuclei and nuclear electric quadrupole moments. Single particle model, Total spin J for various configurations; Ground state spins of odd-odd nuclei (Nordheim's rule)>>			15 hrs.
UNIT-II	**<<>>** <<Two body problem and Nuclear Models II:Phenomenological nucleon-nucleon potential, Meson theory, Derivation of Yukawa interaction, Electromagnetic properties of deuteron and tensor forces. Scattering matrix, Probing charge distribution with electrons, Form factors of nuclei and nucleons. The Nilsson model, The collective model: Vibrational levels, Rotational levels of even-even nuclei>>			15 hrs.
UNIT-III	<<>> << Nuclear Beta- Decay, Review of Fermi theory of β-decay. Electron capture, Two-component neutrino theory, Inverse β-decay and neutrino detection. Solar neutrinos; Parity violation and Wu's experiment, Helicity, Gamma decay, Spontaneous decay, Transition rates, selection rules. Nuclear isomerism, Coulomb excitation, Alpha decay.>>			15 hrs.
UNIT-IV	**<<>>** <<Nuclear Astrophysics- Cosmic abundances, Evolution of stars, Nucleo-synthesis of elements in stars, s- and r- processes, Emission and escape of neutrinos from the core of stars, Chandrashekhar limit and white dwarfs, Neutron star, Supernova, Origin of chemical elements.>>			15 hrs.

REFERENCES

1.	Fundamental of Nuclear Physics – N. A. Jelley (Cambridge Univ. Press, 1990)
2.	Introductory Nuclear Physics – K. S. Krane (Wiley India, 1988)
3.	Nuclear Physics – Roy & Nigam (Wiley Eastern Ltd. 1979)
4.	Atomic and Nuclear Physics – S. N. Ghoshal (S. Chand & Company)
5.	Nuclear and Particle Physics – Burcham&Jobes (Addison Wesley, 1995)

6.	Nuclear Physics in a Nutshell - Carlos A. Bertulani, Princeton Univ. Press
7.	Fundamentals of Nuclear Physics, Jahan Singh, Pragati Publication

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<<M.Sc.>> : <<M.Sc. Physics>>

YEAR	II	**CORE:**	CREDIT	3
Semester	III	**<< PHY2311S01>> :** **<< Condensed Matter Physics–I (Specialization Paper)>>**	HOURS	45

OBJECTIVES:

COURSE CONTENT / SYLLABUS

UNIT-I	**<<Title>>** <<**CRYSTAL LATTICES:** Primitive lattice vectors and primitive unit cell, Wigner-Seitz cell. Symmetry operations, proof for existence of rotational symmetries, Bravais and non-Bravais lattices, Two and three dimensional Bravais lattices and crystal systems. **(**Refs: Kittel, Ashcroft) **RECIPROCAL LATTICES:** Definition and properties, reciprocal lattices for simple cubic, body-centered cubic, face-centered cubic and simple hexagonal lattices. Ewald Sphere, Bragg's law in reciprocal lattice, Bragg and von Laue formulations of X-ray diffraction, equivalence of two formulations. Miller indices of lattice planes and directions. **(**Refs: Kittel, Ashcroft, Ziman) >>	15 hrs.
UNIT-II	**<<DIFFRACTION MEASUREMENTS>>** <<X-Ray crystallography, Ewald construction, X-ray diffraction methods (Laue, Single crystal & Powder), derivation of scattered wave amplitude, diffraction condition, scattering by an atom, Scattering by a unit cell, geometric structure factor and atomic form factor; Neutron diffraction –crystallography, Low Z element & Magnetic crystal structure determination; Low-energy electron diffraction – surface structure. **(**Refs: Kittel, Ashcroft)>>	15 hrs.
UNIT-III	**<<TRANSPORT PHENOMENA >>** <<Drude theory of metals – DC and AC electrical conductivity, thermal conductivity, Wiedemann-Frantz law, Boltzmann equation, Relaxation time approximation, nonequilibrium distribution function, Sommerfeld Model, general transport coefficients, electronic conduction in metals, thermoelectric effects, transport phenomena in magnetic fields, Hall effect and quantum Hall effect, Temperature dependence of resistivity. **(**Refs: Ashcroft, Ziman)>>	15 hrs.

REFERENCES

1.	Introduction to Solid State Physics by Charles Kittel (8th Ed., Wiley Eastern, 2004).
2.	Solid State Physics by N. W. Ashcroft and N. D. Mermin (2nd Ed., Holt-Saunders, 2000).
3.	Principles of the Theory of Solids by J. M. Ziman (2nd Ed., Cambridge Univ. Press 1972; Asian

	Ed., Cambridge Univ. Press – New Delhi 2011)

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science**>>, Department of <<**Physics**>> <<Address>>, <<Contact details>>, <<e-mail ID>>		**ACADEMIC YEAR** **2019-2020**
<<M.Sc.>> : <<M.Sc. Physics >>			
YEAR	II	**CORE:** **<< PHY2312S02>> :** **<<Condensed Matter Physics–II (Specialization Paper)>>**	CREDIT 4
Semester	III		HOURS 60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<PHYSICS OF SEMICONDUCRS AND DEVICES>>** <<Cyclotron resonance and effective mass, Optical absorption in semiconductors, number of carriers in thermal equilibrium – intrinsic and extrinsic cases. Population of impurity levels in thermal equilibrium, p-n junction in equilibrium, Concept of Work function, contact potential, Thermionic emission, elementary picture of rectification by a p-n junction, general physical aspects of the nonequilibrium case. Schottky barrier cell, photovoltaic effect and solar cell, Gunn effect oscillator. **(**Refs: Kittel, Ashcroft)>>	15 hrs.
UNIT-II	**<<ELECTRONIC ENERGY BANDS>>** <<Review of free-electron model, density of states, Fermi energy, Fermi surface. Two proofs of Bloch's theorem – from general quantum mechanical consideration and by explicit construction in a periodic potential, concept of Bloch wave vector and crystal momentum, Born-von Karman periodic boundary condition, number of allowed wave vectors in a Brillouin zone, Nearly free-electron model and tight-binding model, Concept of APW, OPW and LCAO methods, Psuedopotential theory. **(**Refs: Kittel, Ashcroft)>>	15 hrs.
UNIT-III	**<<LATTICE DYNAMICS >>** <<Harmonic and adiabatic approximations, lattice vibrations of three- dimensional crystals, periodic boundary conditions, normal modes, quantization of lattice waves – concepts of phonons and phonon momentum, lattice heat capacity (Einstein and Debye models), anharmonicity and thermal expansion, Grüneisen constant, lattice thermal conductivity – elementary kinetic theory, second sound, Experimental determination of phonon dispersion curve and phonon frequency. **(**Refs: Kittel, Ashcroft)>>	15 hrs.
UNIT-IV	**<<ELASTIC CONSTANTS AND ELASTIC WAVES >>** <<Geometric theory of strain, Displacement and strain components, Longitudinal and shearing strains, Finite strain, Dilational strain, Stress components, Elastic compliance constants and stiffness constants, Elastic energy density, Reduction of number of elastic constants, Elastic constants of cubic crystals, Cauchy's relation, Elastic waves along principal directions in cubic crystals, Measurement of elastic constants. **(**Refs: Kittel, Ashcroft, Theory of Elasticity by L. D. Landau and E. M. Lifshitz)>>	15 hrs.

REFERENCES

1. Introduction to Solid State Physics by Charles Kittel (8th Ed., Wiley Eastern, 2004).

2.	Solid State Physics by N. W. Ashcroft and N. D. Mermin (2nd Ed., Holt-Saunders, 2000).
3.	Theory of Elasticity by L. D. Landau and E. M. Lifshitz)

	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>		ACADEMIC YEAR **2019-2020**
<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>			
YEAR	II	**CORE:**	CREDIT 3
Semester	III	**<<PHY2313S01>> :** **<< ATOMIC & LASER SPECTROSCOPY-I (Specialization Paper)>>**	HOURS 45
OBJECTIVES:			

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Relativistic mass correction, hydrogen fine structure, Pauli's exclusion principle(with treatment), determination of spectral terms for L–S and j-j coupling (atoms with one optical electron, atoms with two or more equivalent and non-equivalent optical electrons), selection rules for multi electron atoms in L-S and j – j coupling, Energy in one and two valence electron systems.>>	15 hrs.
UNIT-II	**<<>>** <<General properties of laser, temporal coherence, spatial coherence (with analysis), mono-chromaticity of spectral lines, stimulated absorption and emission, calculation of Einstein's coefficient and condition for sustain emission population inversion, meta stable state, three level and four level system pumping processes.>>	15 hrs.
UNIT-III	<< >> <<Laser rate equation, threshold power, mode switching Shawlow - Towens condition, optical resonator, laser amplifier , laser safety, types of lasers:- CO_2 laser, dye laser, semi conductor diode laser and free electron laser, applications of laser in industry, communication, laser induced fusion>>	15 hrs.

REFERENCES (**Text Books)**

1.	Atomic Spectra by H.E.White, McGraw Hill.
2.	Atomic and Molecular Spectra by Rajkumar, Kedar Nath Ram Nath, 2008.
3.	Elements of Spectroscopy by Gupta, Kumar, Sharma, Pragati Prakasan,2007.
4.	Laser Spectroscopy by W. Demtroder, 2nd Edition,Springer, 1998.
5.	Laser Physics and Applications by L.Tarasov, Mir Publishers, Moscow,1986.
6.	Lasers and Non- Linear Optics by B B Laud, Wiley Eastern Ltd, 1985.
7.	Elements of Spectroscopy by Gupta, Kumar, Sharma, Pragati Prakasan,2007.

	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	4
Semester	III	**<<PHY2314S02>> :** **<<MOLECULAR SPECTROSCOPY- I (Specialization Paper)>>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Electronic spectra of diatomic molecules, Hund's coupling cases (a), (b), (c), symmetry properties of rotational levels, Evaluation of vibrational constants, combination relations and evaluation of rotational constants for a single headed and double headed band, isotopic effect in electronic bands.>>	15 hrs.
UNIT-II	**<< >>** << Vibrational and rotational temperatures. Determination of term manifold from the states of separated atoms, united atoms and electron configuration, Types of electronic transitions, Vibrational and Rotational perturbations, diffuse molecular spectra, pre-dissociation.>>	15 hrs.
UNIT-III	<< >> << Importance of molecular symmetry, symmetry elements and different types of symmetry operations : - identity, rotation, reflection, centre of inversion operation, rotation - reflection operation, molecular point groups, symmetry class, classification of point groups - non-axial, axial and dihedral.>>	15 hrs.
UNIT-IV	**<< >>** << IR Spectra of diatomic and poly atomic molecules, overtone and combination bands, normal mode of vibrations:- band stretching, angle deformation, rocking, wagging, twisting, out of plane and in-plane deformation, spectra of some simple molecules(H_2O, CO_2, NCS^-, OCF_2, HNF_2), Fermi resonance, skeletal and group frequency concept, coupled vibrations, interpretation of IR spectra, FTIR spectroscopy, instrumentation, sampling technique.>>	15 hrs.

REFERENCES

1.	Molecular Spectra and Molecular Structure, Vol.- I by G.Herzberg,Van Nostrand Co., N.Y.1950.
2.	2. Atomic and Molecular Spectra by Rajkumar, Kedar Nath Ram Nath, 2008
3.	3. Elements of Spectroscopy by Gupta, Kumar, Sharma, Pragati Prakasan,2007.
4.	Introduction to Infrared and Raman Spectroscopy, by N B Colthup, L H Daly & S E Wiberley, 3rd Ed , Academic Press, 1990.
5.	Vibrational Spectroscopy- Theory and Applications by D N Sathyanarayana, New age international publishers, 2000.
6.	Infrared Spectroscopy: Fundamentals and Applications by B Stuart, John Wiley & sons. Ltd , 2004.

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	7
Semester	III	**<<PHY2303C15>> : << PHYSICS LABORATTORY-III>>**	HOURS	

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

<<**List of experiments** >>

<<**List of experiments for students of Electronics & Communications Specialization:**

1. Operational Amp Applications – I
2. Logic Gate – I
3. Logic Gate – II
4. Regulated Power Supply
5. UJT Characteristics
6. Network Theorems
7. Operational Amplifier characteristics
8. Flip – Flop circuits
9. A to D converter
10. Microprocessor Programming – I
11. Integrating, Differentiating & clamping circuits

List of experiments for students of Nuclear Physics Specialization:

1. Study of characteristics of G. M. Tube and determination of its Operating voltage, Plateau, Length/Slope, Dead time (single and double source method) and to study its variation with paralysis time.
2. To determine the efficiency of a GM counter using gamma source and also verify the Inverse Square Law using gamma & β - sources.
3. Linear and Mass absorption co-efficient of gamma rays using G.M. counter - (for aluminium, lead etc.).
4. To study the pulse height spectra and the resolution of a NaI Scintillator Detector - (Cs^{137}, Co^{60}, Mn^{54}, Co^{57}, Ba^{133}).
5. Study of the energy calibration of NaI Scintillator Detector and to determine the energy of unknown source.
6. To determine the Linear Absorption co-efficient of gamma rays using NaI Scintillator Detector and establish the relation between energy and linear absorption coefficient.
7. To study the Compton scattering using NaI (TI) detector.
8. Operational Amplifier as Adder, Subtractor, Inverter, Non-invetater, Integrator, Differentiator.
9. (a) RC Pulse Shaping.
   (b) A/D & D/A Converter.

List of experiments for students of Condensed Matter Physics Specialization:

1. Stereographic Projection – I
2. Stereographic Projection – II
3. Cubic Crystal Models & Point Group Symmetry
4. Valde's Four Probe Method
5. Specific Heat of Graphite
6. Creep of Metals
7. Electrical Conductivity of Graphite
8. Crystalline & Non-crystalline Solid $\leftrightarrow$ Liquid Phase change
9. Conductivity - Pure Bi/Sb & Bi-Sb crystals
10. Hall Effect

List of experiments for students of Spectroscopy Specialization:

1. Study of intensity variation in a diffraction pattern
2. Absorption spectrum of $KMNO_4$.
3. Study of polarization of light by optical elements
4. Divergence of Laser beam
5. Vibrational Analysis of CN molecule
6. Electronic Absorption Spectrum of I_2 molecule.
7. Rotation – Vibration Spectrum of AlO molecule
8. Vibrational spectrum of MgCl molecule
9. 1^{st} & 2^{nd} order spectrum of He / Ne - atom
10. Study of FTIR spectrum.
11. Michelson Interferometer
12. Fabry-Parrot Interferometer>>

CBCS-2019

Distribution of Credits for M. Sc. Physics Sem. - IV

Sr. No	Course code	Title of core courses	Credit
1	PHY2401C16	Quantum Mechanics & Statistical Mechanics	3
2	PHY2402C17	Classical Electrodynamics & Plasma Physics-II	4
3	PHY2403C18	Physics Laboratory-IV	6
4	PHY2404C19	Project & Viva	3
5	PHY2405C20	Advanced Research Techniques (24-25-PHY)	3
6	PHY2405E02	Experimental Techniques-II (Elective Paper)	3
7	PHY2406E02	Nanosceince & Biomaterials (Elective Paper)	3
8	PHY2407E02	Advanced Material Science (Elective Paper)	3
9	PHY2408S03	Electronics & Communications-III (Specialization Paper)	4
10	PHY2409S04	Electronics & Communications-IV (Specialization Paper)	3
11	PHY2410S03	Nuclear Physics – III (Specialization Paper)	4
12	PHY2411S04	Nuclear Physics – IV (Specialization Paper)	3
13	PHY2412S03	Condensed Matter Physics - III (Specialization Paper)	4
14	PHY2413S04	Condensed Matter Physics - IV (Specialization Paper)	3
15	PHY2414S03	Atomic & Laser Spectroscopy-II (Specialization Paper)	4
16	PHY2415S04	Molecular Spectroscopy-II (Specialization Paper)	3
		Total	**26**

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2401C16>> : << QUANTUM MECHANICS & STATISTICAL MECHANICS >>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Scattering Theory: Asymptotic behaviour, Differential & total cross-section, Wave mechanical picture of scattering (scattering amplitudes), Green's function: Formal expression for scattering amplitudes, Born approximation & its validity, Partial wave Analysis of Scattering: Partial waves, Asymptotic behaviour of partial waves (phase shifts), Scattering amplitudes in terms of phase shift, Differential and total cross-section (optical theorem), Relation between phase shift and potentials of finite range and formal expression for phase shift. Scatting by a rigid sphere & square well potential.>>	15 hrs.
UNIT-II	**<< >>** << Quantum Statistics: Review of Micro-canonical and grand -canonical ensembles, Grand canonical partition function, Derivation of BE Statistics, Weak and strong degeneracy, Application of BE statistics to BE condensation and phase transition. Thermodynamical properties of an ideal BE gas. Liquid He and its properties. Two fluid model of liquid He^4.>>	15 hrs.
UNIT-III	<< >> << System of interacting bosons, elements of quantum theory of superfluidity. Electron gas in a metal. Field emission (uncorrected for image force). Screening of K electrons. Application of FD statistics to Pauli-paramagnetism and white dwarf, Ising model in 1-D, liquid He^3 >>	15 hrs.

REFERENCES

1.	Quantum Mechanics- by E. Merzbacher John Wiley & Sons, New York 1868.
2.	Quantum Mechanics - by B. K. Agrawal & Hari Prakash (PHI EEE, 2004)
3.	A Text book of Quantum Mechanics: P. M. Mathews & K. Venkatesh. Tata McGraw-Hill Publ. Company Ltd. New Delhi (10^{th} reprint) 1986
4.	Quantum Mechanics Vol.-II by Ghatak & Loknathan
5.	Statistical Mechanics - by K. Huang 2^{nd} Editions(John Wiley & Sons, 1987).
6.	Statistical Mechanics - by F.Reif (International student ed. McGraw Hill 1988).
7.	Statistical Mechanics - by R. K. Pathria, Elsevier publication

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	4
Semester	IV	**<<PHY2402C17>> : <<CLASSICAL ELECTRODYNAMICS & PLASMA PHYSICS-II >>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> <<Solution of Maxwell's equations with nonzero ρ and j, scalar and vector potentials, Gauge transformations, Lorentz and Coulomb gauges, solution of inhomogeneous wave equation, retarded and advance Green function , retarded potentials. Non-relativistic multipole radiations: Electric dipole and quadruple radiations, Magnetic dipole radiation's, simple antenna problems, radiation resistance.>>	15 hrs.
UNIT-II	**<< >>** << Radiations by moving charges: LienardWeinchert potentials and field for a point charge, total power radiated by an accelerated charge (Larmor's Formula and its relativistic generalization). Angular distribution and frequency spectrum of the radiation power. Covariant formulation of electromagnetic theory: Mathematical properties of space time of special relativity, Matrix representation of Lorentz transformation, Invariance of electric charge, covariance of electrodynamics, Transformation of electromagnetic field (Lorentz force)>>	15 hrs.
UNIT-III	<< >> << Magnetohydrodynamics(MHD) and Plasma Physics: Introduction and definitions, MHD equations, Magnetic diffusion, viscosity and pressure, Magnetohydrodynamic flow between boundaries with crossed electric and magnetic fields, Magnetohydrodynamical waves, pinch effects. Instability in a pinched plasma column, High frequency plasma oscillations, short wave length limit of plasma oscillations and Debye-screening distance, >>	15 hrs.
UNIT-III	**<< >>** << Particle drift in non-uniform static magnetic fields, Magnetic mirrors, adiabatic invariance of flux through orbit of a particle, Two stream instability, Kinetic treatment of plasma oscillations and Landau damping physical explanation, Potentials and problems of controlled thermonuclear fusion, Ignition temperature and Lawson criteria, Magnetic confinement, Simple discussion of Tokomak and Z-pinch, Ideas about inertial confinement and Laser fusion, Methods of plasma heating and problems of fusion. >>	15 hrs.

REFERENCES

1.	Classical Electrodynamics : Jackson J.D. 2nd Edition John Wiley & Sons, New York, 1963.
2.	Classical Electricity and Magnetism : Panofsky W. K. H. and M. Phillips, 2nd Edition,

	ReadingMass. : Addison-Wesley (AW) 1962.
3.	Feynman Lectures, Vol.-II. AW, MIT reading 1965, Narosa Pub. 1995
4.	Introduction to Electrodynamics: D. J. Griffiths. 3rd Ed. PHI, New Delhi 2001
5.	Classical Electrodynamics: S. P. Puri, Tata McGraw-Hill Publ. Company Ltd.New Delhi 1990
6.	Introduction to Plasma Physics and Controlled fusion :F. F. Chen. 2nd Edition Plenum Press, New YorkLondon 1984

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2405E02>> : <<EXPERIMENTAL TECHNIQUES-II>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Spectroscopy - X -ray Photoelectron spectroscopy (XPS); Ultra violet photo electron spectroscopy (UPS); X-ray emission (XES) and Absorption spectroscopy (XAS- XANES & EXAFS), Mossbouer Spectroscopy >>	15 hrs.
UNIT-II	<< >> << Rutherford Back Scattering (RBS), Positron Annihilation, PIXE, Auger electron spectroscopy (AES) ; X-ray Fluorescence Spectroscopy (XRF). >>	15 hrs.
UNIT-III	<< >> < A.C. & D.C. Conductivity Measurements; Hall-effect measurements; Thermopower measurement; A.C. & D.C. Magnetic Susceptibility measurements; dielectric constant and dielectric loss tangent measurement; Introduction to Photoluminescence Techniques and Thermal Analysis technique.>>	15 hrs.

REFERENCES

1.	Modern Techniques of Surface Science - by D.P. Woodruff & T.A. Delchar, Cambridge University Press, Cambridge.
2.	Solid State Physics - by J.P.Srivastava.
3.	Method of surface Analysis Ed. By J.M. Walls and V.G. Ionex UK, CAMBRIDGE UNIVERSITY PRESS (1989)
4.	Modern Methods of Trace Element Analysis by MAURICE PINTA, ANN ARBOR SCIENCE Publ. Inc. Michiyon USA (1978)

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science**>>, Department of <<**Physic**s>> <<Address>>, <<Contact details>>, <<e-mail ID>>	**ACADEMIC YEAR** **2019-2020**

<<M.Sc.>> : <<M.Sc. Physics>>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2406E02>> : <<Elective Paper: Nanoscience & Biomaterials>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<Title>>** <<Introduction and applications of nanostructures and Nanomaterials, Confinement of electrons, quantization of energy bands and density states of quantum well, quantum wire, quantum dot, Carbon nanotubes, HOMO-LUMO gap, size-dependence of gap and dielectric constants and consequences size-dependence on various properties>>	15 hrs.
UNIT-II	**<<Title>>** <<Nnaocomposite materials, Natural nanocomposite systems such as spider silk, cellulose, bones, man-made Nanocomposites through self-assembly. Bioelectronics, Conducting polymers, Synthesis of nanomaterials (Chemical, Physical, Biological methods), Nucleation kinetics and growth of Nanoparticles>>	15 hrs.
UNIT-III	**<<Title>>** << Statistical description of living systems, transformation of energy, Osmosis, electrical potentials – action potential, redox potential and pH, Diffusion, Molecular machines and mechanisms, Thermal and mechanical properties of DNA and RNA – the genetic materials of life.>>	15 hrs.

REFERENCES

1.	Introduction to Nanotechnology – Charles P. Poole Jr. and Franks J. Qwens
2.	Handbook of Nanostructured Biomaterials and their Applications in nanobiotechnology -Hari Singh Nalwa
3.	Nano composite Science & Technology Ajayan, Schadler & Braun
4.	Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology) - Massimilliano Di Ventra
5.	Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S., S. R. Kumar, J. H. Carola
6.	Biological Physics – Energy, Information and Life by Phil Nelson. -W. H. Freeman & Co. Publishers

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2407E02>> :** **<<Elective Paper: Advanced Materials Science>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Phase Diagrams: Phase rule, complete solid solution, Eutectic diagram with no solid solution, Eutectic diagram with limited solid solution, eutectoid diagram, peritectic General binary diagrams, Intermediate phases or intermetallic compounds, ceramic and ternary phase diagrams, phase transformations, Lever rule, Microstructural development, metals for nuclear energy Ceramics and glasses: Ceramics – crystalline materials, Glasses – noncrystalline materials, Glass-Ceramics, processing of ceramics and glasses>>	15 hrs.
UNIT-II	**<< >>** << Polymers and composites: Polymerization, Structure of polymers, copolymers, polymer crystallinity, thermoplastic polymers, thermosetting polymers, additives and polymer processing, Fibre reinforced composites, conventional fiberglass, advanced composites, wood - a natural fibre reinforced composite, aggregate composites, property averaging in composites, electrical, thermal and mechanical properties and processing of composites, Quasicrystals, golden ratio, Fractals and aerogels>>	15 hrs.
UNIT-III	<< >> << Ferromagnetism, ferrimagnetism, metallic magnets, soft and hard magnets, superconducting magnets, ceramic magnets, low conductivity and superconducting ceramic magnets, Giant Magnetoresistance and Colossal Megnetoresistance materials, Spintronic Materials Amorphous metals for electrical power distribution, thermoplastics versus thermosetting polymers, metal alloys for Flip-Chip technology, Light emitting diodes, conducting polymers, metallic glasses, shape memory alloys, non-linear materials, nanostructured materials>>	15 hrs.

REFERENCES

1.	Materials Science for Engineers *by Shackelford J. F.* and *Muralidhara M. K.,* Dorling Kindersley (Ind) Pvt. Ltd., Noida, 6th ed., 2007
2.	Materials Science *by Kakani S. L. and Kakani Amit,* New Age International Publishers, N. Delhi, 2nd ed., 2010
3.	Elements of Solid State Physics *by J. P. Srivastava, Prentice-Hall of India Private Limited, Delhi 2007, 2nd Ed.*

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	The Maharaja Sayajirao University of Baroda Faculty/College of **Faculty of Science**, Department of **Physics**	ACADEMIC YEAR **2024-2025**

Name of the Programme: M.Sc.-Physics

YEAR	II	**PHY2405C20 : Advanced Research Techniques**	CREDIT	3
Semester	IV		HOURS	90
OBJECTIVES:				

COURSE CONTENT / SYLLABUS

UNIT-I	**Experiments:** **List of experiments:** 1. FTIR spectrum analysis. 2. Raman spectrum analysis. 3. Vacuum sealing of various tubes. 4. Glass blowing of various tubes. 5. Meteorological observations and measurement. 6. Astronomical planets observation using astronomical Telescope. 7. Advanced Electronic circuit design and measurements. 8. Making of Pellets of different type of samples using Pelletiser. 9. Radiation detectors and measurements. 10. Development of computer program for least square fitting and error analysis . 11. HPGE Detector	90 hrs.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>		ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	4
Semester	IV	**<<PHY2408S03>> : << Specialization Paper: ELECTRONICS & COMMUNICATIONS-III >>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Frequency Modulation: Angle modulation, directly and indirectly modulated FM transmitters, angle modulation detectors, Foster Seeley discriminator, Phase locked loop discriminator. Pulse Modulation: Pulse amplitude modulation, pulse sampling theory, pulse width modulation, pulse position modulation, digital multiplexing. Radio**:** Radio receivers, Regenerative superheterodyne for AM and FM Receivers & Receiver Characteristics.>>	15 hrs.
UNIT-II	**<< >>** <<Satellite Transmission: Satellite uplink and Down Link, Satellite orbits, Station Keeping, Satellite Altitude, Transmission Path and its losses, Noise, Frequency and Propagation considerations, Communication link design Modulation, coding, Base band design, Multiple Access techniques, Communication satellites, Earth stations. **Microwave Communication**: ***Microwave Generators****:* Klystrons, velocity modulation process, bunching process, an apple gate diagram output power and efficiency of klystron and reflex klystron, dynatron operation of magnetron, ***Line of Sight (LOS) propagation****:* LOS propagation on flat earth, path clearance, Effect of ground, effect of nature of earth's surface, effect of atmosphere, ground based LOS, LOS microwave systems LOS propagation on flat earth, path clearance.>>	15 hrs.
UNIT-III	<< >> <<Radio wave Propagation: Character of Ionosphere, effect of frequency on transmission, effect of ground on transmission, skip distance, Ionospheric refraction, maximum usable frequency, Virtual height and its determination. Antenna: Isotropic radiator, Antenna Action, Power gain, effective length of antenna, The Hertzian dipole, radiation resistance of an antenna, impedance matching, half wave dipole and quarterwave antenna, Brief description of- vertical antenna loop , ferrite rode, yagi-uda array, **Microwave antenna**: parabolic reflector and dielectric lens antenna.>>	15 hrs.
UNIT-IV	**<< >>** <<Digital Modulation Techniques: Network hardware and Software-LAN, protocol hierarchies, design issues for the layers, Different Layers and their functions : OSI reference model, Physical Layer, Data Link Layer: Services provided to Network	15 hrs.

	layer, Elementary ideas of framing, Ethernet, protocols, Token Bus, Token ring, Packet Switching, Integrating Services Digital Network (ISDN) system, its functioning and applications, Repeaters, Bridges and Gateways. Internetworking and Email Terminology: ISP, www, Web Page, Web Browser, Search Engines, IP address, Domain name, URL, TCP/IP, FTP.>>	

REFERENCES

1.	Communication systems, R. P. Singh and S. D. Sapre, TMH
2.	Electronics communication systems, George Kennedy & Davis, Mc.Graw., Hill.
3.	Electronic Communications, Roddey & Coolen, PHI
4.	Active Inductor less Filters, by S. K. Mitra, IEEE Press 1971
5.	Satellite Communication systems by M. Richharia, McGraw Hill, 1998
6.	Communication Systems, R. P. Singh and S. D. Sapre, TMH
7.	Principle of Communication Engineering By Anoke Singh , (S. Chand & Co. 1994)
8.	Network lines and fields, J. D. Ryder, Asia Pub. House.
9.	Hand Book of Electronics – Gupta and Kumar, Pragati Prakashan, Meerut
10.	R.C.Johnson and H.Jasik, Antenna Engineering Handbook, McGraw Hill, 1984
11.	R.E. Collin, Antennas and Radiowave propagation,McGraw Hill, 1985
12.	Hand Book of Electronics – Gupta and Kumar
13.	B.P. Lathi, Modern digital and analog communication systems
14.	Proakis J.J. , Digital Communications, McGraw Hill
15.	S. Tannenbaum, “Computer Networks”, PHI
16.	Data Communication by P. Gupta, Tata McGraw Hill

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2409S04>> : << Specialization Paper: ELECTRONICS & COMMUNICATIONS-IV >>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Digital to analog Converter:Basic Summing Amplifier technique, Weighted D to A , BCD D/A Converter, Ladder R-2R network, 8 bit digital to analog converter, A to D Converter: Flash ADC and successive approximation ADC, Integrating ADC/Dual Slope A/D Converter Integrated Circuit 555 Timers: Operating modes and functioning of 555 timer, Astable, monostable operation, counters, Frequency divider, Ramp Generator, Timers circuits and applications, Linear IC regulators: 3-pin voltage regulators with unregulated power supply, Adjustable three terminal positive and negative voltage regulators with Circuit analysis.>>	15 hrs.
UNIT-II	**<< >>** << Interfacing: Interfacing Peripherals and Applications : Parallel I/O and Interfacing applications, General purpose Programmable Peripheral Devices: 8255A, 8253,8259A, DMA Controller, its architecture, control word, different modes of programming, Interfacing programs in assembly language, interfacing with memory and other peripheral devices.>>	15 hrs.
UNIT-III	<< >> << Microprocessor Controlled Devices: Interfacing transducer to electronic controller and measuring systems. Microprocessor compatibility of ADC and DAC circuits, Interfacing of LEDs, Strain Gauge Transducer with 8085 μP, Interface of Traffic Light signal, Interfacing of Stepper Motor, Interfacing of ADC 0800 series and analog multiplexer ADC, Interfacing of Digital to Analog devices - 0800 series.>>	15 hrs.

REFERENCES

1.	Digital Technology *by* Virendra Kumar , New Age International
2.	Fundamental of Electronics Devices *by* Milman and Halkias.
3.	Fundamentalof electronics Devices by Milman and Halkias
4.	Digital Technology by Tokheim – TMH
5.	Electronic Devices –Floyd , Pearson Education
6.	Solid State Pulse Circuits By David A. Bell , PHI
7.	Microprocessor Architecture, Programming and Applications with 8085/8080A: R.S. Gaonkar, Penram Pub.
8.	Mircoprocessor Interfacing : Douglas Hall,McGraw Hill
9.	Microprocessor Architecture, Programming and Applications with 8085/8080A: Gaonkar, Penram Pub.

10.	Mircoprocessor Interfacing : Douglas Hall,McGraw Hill
11.	Microprocessor and Programming, B. Ram, Dhanpatrai Pub.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science**>>, Department of <<**Physics**>> << Physics Department, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara - 390 002>>, << Phone : +91-265-2795339>>, << >>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics**>>

YEAR	II	**CORE:**	CREDIT	4
Semester	IV	**<<PHY2410S03>> : <<Specialization Paper: NUCLEAR PHYSICS–III>>**	HOURS	60

COURSE CONTENT / SYLLABUS

UNIT-I	<<**Nuclear Moments and Measurements**>> <<Nuclear size and radii, Methods for nuclear charge radius measurements, Nuclear potential radius, Nuclear magnetic moment, Gyromagnetic ratio, Larmor precession, Measurement of nuclear magnetic moment, Magnetic moment of proton and neutron, Nuclear statistics, Nuclear electric moment (electric dipole, quadrupole moments), Measurement of nuclear electric quadrupole moment.>>	15 hrs.
UNIT-II	**<<Mossbauer Effect, Angular Correlation and High Spin State>>** <<Nuclear resonance fluorescence and absorption of gamma rays, Mossbauer Effect. Angular correlation of gamma rays, Gamma-gamma angular correlations. Perturbed angular correlation, Production and measurements of high spin states in heavy ion reactions, Kinematics, Back bending phenomena in high spin state.>>	15 hrs.
UNIT-III	<<**Neutron Physics**>> <<Production and detection of neutrons, Time of flight method, Stability limit against spontaneous fission, Thermalization of neutrons, Dynamics of elastic scattering of neutrons, Angular distribution of neutrons, Average logarithmic decrement in energy of neutrons, Slowing down power and moderating ratio, slowing down density and time.>>	15 hrs.
UNIT-III	**<< Reactor Physics>>** <<Thermal neutron diffusion and diffusion equation, Fast neutron diffusion and Fermi age equation, Critical size of reactor, critical size of reactors of different shapes, Nuclear reactor, Classification of reactors, Physical process in reactors, Nuclear fuel conversion, Nuclear materials employed in reactors, Nuclear power>>	15 hrs.

REFERENCES

1.	Atomic and Nuclear Physics Vol-II, S. N. Ghosal.
2.	Introduction to Nuclear Physics-Kenneth S. Krane
3.	The Atomic Nucleus by R. D. Evans.
4.	Introduction to Nuclear Physics by H. Enge.
5.	Basic Nuclear Physics and Cosmic Rays by B. N. Srivastava.
6.	Neutron Physics by Curtis
7.	The Elements of Nuclear Reactor Theory- Glasstone and Edlund
8.	Nuclear Reactor Engineering (4^{th} edn.,V-1),by S.Glasstone&A.Sesonske.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science**>>, Department of <<**Physics**>> << Physics Department, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara - 390 002>>, << Phone : +91-265-2795339>>, << >>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics**>>

YEAR	II	**CORE: <<PHY2411S04>> :**	CREDIT	3
Semester	IV	**<< Specialization Paper: NUCLEAR PHYSICS- IV>>**	HOURS	45

COURSE CONTENT / SYLLABUS

UNIT-I	<<**Nuclear Reactions I**>> <<Rutherford scattering, Optical model for elastic scattering, Coulomb excitations; Stripping and pick-up reactions using Born approximation, Thermonuclear fusion reaction. Qualitative ideas on deep inelastic electron-proton scattering, Bjorken scaling and the parton model.>>	15 hrs.
UNIT-II	**<< Nuclear Reactions II>>** <<Physical description of heavy ion interaction, elementary ideas of classical and quantum mechanical theories, Classical and semi-classical analysis of heavy ion reaction data, Complete and incomplete fusion reactions, Idea of sub-barrier fusion, Stability of heavy nuclei, Super heavy elements>>	15 hrs.
UNIT-III	<< **Particle Physics**>> <<Invariance in relation to particle reactions and decays, Ideas of C, P and T symmetries, Lie groups generators, representation and products of representation, SU(2) and SU(3) groups, Light mesons and baryons in quark model. Charm, bottom and top quarks, CP violation, Spontaneous symmetry breaking and Higgs mechanism.Standard model for electroweak unification (in brief)>>	15 hrs.

REFERENCES

1.	Fundamental of Nuclear Physics – N. A. Jelley (Cambridge Univ. Press, 1990)
2.	Introductory Nuclear Physics – K. S. Krane (Wiley India, 1988)
3.	Nuclear Physics – Roy & Nigam (Wiley Eastern Ltd. 1979)
4.	Atomic and Nuclear Physics – S. N. Ghoshal (S. Chand & Company)
5.	Introduction to High Energy Physics – D.H. Perkins (Cambridge Univ. Press, 4th Ed.)
6.	Quarks and leptons – Halzen& Martin (John Wiley & Sons, 1984)
7.	Nuclear and Particle Physics – Burcham&Jobes (Addison Wesley, 1995)
8.	Nuclear Physics in a Nutshell - Carlos A. Bertulani, Princeton Univ. Press
9.	Nuclear Physics by V.Devanathan

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science**>>, Department of <<**Physic**s>> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<M.Sc.>> : **<<M.Sc. Physics >>**

YEAR	II	**CORE:**	CREDIT	4
Semester	IV	**<<PHY2412S03>> :** **<<Condensed Matter Physics – III (Specialization Paper)>>**	HOURS	60

OBJECTIVES:

COURSE CONTENT / SYLLABUS

UNIT-I	**<<Title>>** << **NONCYSTALLINE SOLIDS:** Diffraction pattern, Mono and Di atomic amorphous matrials, Radial distribution function, Glasses, Amorphous Ferromagnets and Semiconductors, Low energy excitations in amorphous solids, Fiber optics. **(**Refs: Kittel) **ALLOYS:** General concept of alloys, Substitutional solid solutions- HUME-ROTHERY rules, order-disorder transformations, phase diagrams, transition metal alloys, Kondo effect. **(**Refs: Kittel)>>	15 hrs.
UNIT-II	**<<Title>>** << **MAGNETIC PROPERTIES:** Magnetic properties of insulators, Langevin diamagnetism and Van Vleck paramagnetism, Curie paramagnets and Curie-Weiss ferromagnets, Neel antiferromagnets, Heisenberg model, spin waves, Ising model, elements of magnetic properties of metals, Landau diamagnetism, Stoner ferromagnetism, magnetic resonance. **(**Refs: Kittel, Ashcroft, Kantorovich) **MAGNETIC FIELD EFFECTS IN METALS:** Motion of a charged particles in a uniform magnetic field, Landau levels of Bloch electrons and origin of the oscillatory phenomena, de Haas-van Alphen effect and	15 hrs.

	Fermi surface measurement, effect of electron spin **(**Refs: Kittel, Ashcroft, Ziman, Quantum Mechanics – Nonrelativistic by L. D. Landau & E. M. Lifshitz)>>	
UNIT-III	**<<Title>>** << **OPTICAL PROCESSES AND EXCITONS** **Optical Reflectance:** Kramers-Kroning relations, Example: Conductivity of collisionless Electron Gas, Electronic Interband Transitions. **Excitons:** Frenkel Excitons, Alkali Halides, Molecular Crystals, Weakly Bound (Mott-Wannier) Excitons, **PLASMONS, POLARITONS AND POLARONS** **Dielectric Function of the Electron Gas:** Definitions of the Dielectric Function, Dispersion Relation for Electromagnetic Waves, Transverse Optical Modes in a Plasma, Transparency of Metals in the Ultraviolet, Longitudinal Plasma Oscillations; **Plasmons**: Electrostatic Screening, Screened Coulomb Potential, Mott Metal-Insulator Transition; **Polaritons:** LST Relation, Electron-Electron Interaction, Fermi-Liquid, Electron-Phonon interaction-Polaron. **(**Refs: Kittel, Ashcroft)>>	15 hrs.
UNIT-IV	**<<MANY-ELECTRON PROBLEMS IN SOLIDS >>** <<Hartee equations, Hartree-Fock equations, Hartree-Fock theory of free electrons, screening effects, Thomas-Fermi and Landau theory of screening, Landau Fermi-Liquid theory (elementary aspects) and Quasiparticles**.** **(**Refs: Ashcroft)>>	15 hrs.

REFERENCES

1.	Introduction to Solid State Physics by Charles Kittel (8th Ed., Wiley Eastern, 2004).
2.	Solid State Physics by N. W. Ashcroft and N. D. Mermin (2nd Ed., Holt-Saunders, 2000).
3.	Quantum Theory of the Solid State: An Introduction by Lev Kantorovich (Kluwer Academic, 2004).
4.	Principles of the Theory of Solids by J. M. Ziman (2nd Ed., Cambridge Univ. Press 1972; Asian Ed., Cambridge Univ. Press – New Delhi 2011)
5.	Quantum Mechanics – Nonrelativistic by L. D. Landau & E. M. Lifshitz

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<<M.Sc.>> : <<M.Sc. Physics >>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2413S04>> :** **<<Condensed Matter Physics – IV (Specialization Paper)>>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	**<<SURFACE, INTERFACE AND NANOSTRUCTURE PHYSICS>>** <<**Surface Electronic Structure:** Work Function, Thermionic Emission, Surface States, **Magnetoresistance in a Two-Dimensional Channel:** Introduction to Integral Quantized Hall Effect (IQHE), IQHE in real systems. **Electronic Structure of 1D system**s: One-Dimensional Subbands, Spectroscopy of Van Hove Singularities, 1D Metals-Coulomb interactions and Lattice couplings. **Electrical Transport in 1D:** Conduction Quantization and the Landauer Formula, Two barriers in Series-resonant tunneling, Incoherent addition and Ohm's Law, Localization, **Electronic structure of 0D systems:** Quantized Energy Levels, Semiconductor Nanocrystals, Metallic Dots. **Electrical Transport in 0D:** Coulomb Oscillations, Spin, Mott Insulators and the Kondo Effect. **Vibrational and Thermal Properties of Nanostructures:** Quantized Vibrational Modes, Transverse Vibrations. **(**Refs: Ashcroft: Chap. 18; Harrison,; Physical Properties of Carbon Nanotubes by R. Saito, G. Dresselhaus and M. S. Dresselhaus, World Scientific; Graphene- Carbon in two-dimensions by M. I. Katsnelson, Cambridge Univ. Press.)>>	15 hrs.
UNIT-II	**<<SUPERCONDUCTIVITY >>** <<Electron-phonon interaction, Electron-electron interaction via exchange of bosons, binding energy of a cooper pair, ground state of superconducting electron gas, gap-equation, transition temperature and isotope effect, Josephson tunneling, elements of high Tc- Superconductivity. **(**Refs: Tilley & Tilley, Chap. 11 for High-T_C ; Ashcroft, Kittel)>>	15 hrs.

UNIT-III	<<**CRYSTAL GROWTH AND THIN FILM GROWTH** >> <<Crystal Growth and its Techniques: Nucleation kinetics, Homogeneous and Heterogeneous Nucleation, Interface controlled growth, Surface nucleation and layer growth mechanisms, Real crystals and role of screw dislocations. Solution, Melt (Zone melting method, Bridgman method, Czochralsky method) and vapour growth methods. Thin Films and Properties: Stages of thin film growth, Thickness measurement by interference techniques, Tolansky technique, Thickness monitoring by crystal Oscillator, Film adhesion to the substrate and its measurement, Sheet resistant. (Ref.: Crystal Growth Process - J.C.Baxi., Art and Science of Growing crystals - J.J. Gilman, Handbook of Thin Film Technology.-Meissel and Glang, Thin Film Phenomena - K. L Chopra)>>	15 hrs.

REFERENCES

1.	Solid State Physics by N. W. Ashcroft and N. D. Mermin (2nd Ed., Holt-Saunders, 2000).
2.	Quantum Wells, Wires and Dots by P. Harrison (Wiley & Sons, 2005).
3.	Physical Properties of Carbon Nanotubes by R. Saito, G. Dresselhaus and M. S. Dresselhaus, World Scientific; Graphene- Carbon in two-dimensions by M. I. Katsnelson, Cambridge Univ. Press.
4.	Superfluidity and Superconductivity by D. R. tilley and John Tilley (3rd Ed, Overseas Press – Indian Edition, 2005).
5.	Solid State Physics by N. W. Ashcroft and N. D. Mermin (2nd Ed., Holt-Saunders, 2000)
6.	Introduction to Solid State Physics by Charles Kittel (8th Ed., Wiley Eastern, 2004).
7.	Crystal Growth Process - J.C.Baxi., Art and Science of Growing crystals - J.J. Gilman Handbook of Thin Film Technology.-Meissel and Glang, Thin Film Phenomena - K. L Chopra

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<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	4
Semester	IV	**<<PHY2414S03>> :** **<<Specialization Paper: ATOMIC & LASER SPECTROSCOPY-II>>**	HOURS	60

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Explanation of normal and anomalous Zeeman effect, examples of Zeeman splitting in some transitions (^{1}F----^{1}D ,^{2}D----^{2}P and ^{3}P ---- ^{3}S), Paschen-Back effect, Stark effect in hydrogen (weak and strong field), Zeeman effect in hyperfine structure (inclusive quantum mechanical treatment), Back-Goudsmit effect in hyperfine structure, 21cm line due to nuclear spin transition line and its detection (natural population inversion). Fine structure in X-ray emission spectra, screening doublets, spin – relativity doublets, regular and irregular doublets law, satellites, structure of absorption edges.>>	15 hrs.
UNIT-II	**<< >>** <<**Raman Spectra:** selection rules, depolarization ratio, Raman band intensities, rotation and vibration-rotation Raman spectra, resonance Raman effect, non- linear Raman effects - stimulated Raman effect, hyper Raman effect, Coherent Anti-Stokes Raman Scattering(CARS), instrumentation, sample handling techniques, interpretation of Raman spectra.>>	15 hrs.
UNIT-III	<< >> <<Intra cavity control of spectral characteristics, Single mode operation, Multi mode operation, Methods of Q-Switching – Acousto-optic and passive, Pulsed lasing, methods of mode locking, optical mixing, frequency tuning by parametric oscillation , wave front correction of laser output, Light beam manipulation, Mode pulling, Hole burning.>>	15 hrs.
UNIT-IV	**<< >>** <<Harmonic generation, phase matching, second harmonic generation, third harmonic generation, fourth harmonic generation, intra-cavity absorption, photo-acoustic spectroscopy, photo-thermal deflection spectroscopy, opto-galvanic spectroscopy, two photon and multi photon absorption.>>	15 hrs.

REFERENCES (**TEXT BOOKS)**

1.	Atomic Spectra by H.E.White, McGraw Hill.
2.	Atomic and Molecular Spectra by Rajkumar, Kedar Nath Ram Nath, 2008.
3.	Elements of Spectroscopy by Gupta, Kumar, Sharma, Pragati Prakasan,2007.
4.	Modern Raman Spectroscopy - A Practical Approach by W E Smith & G Dent, John Wiley & sons. Ltd , 2005.

5.	Introduction to Infrared and Raman Spectroscopy, by N B Colthup, L H Daly & S E Wiberley, 3rd Ed , Academic Press, 1990.
6.	Lasers & Non- Linear Optics by B B Laud, Wiley Eastern Limited, 1985
7.	Laser Spectroscopy by W. Demtroder, 2nd Edition,Springer, 1998.
8.	Lasers and Non- Linear Optics by B B Laud, Wiley Eastern Ltd, 1985
9.	Laser Physics and Applications by L.Tarasov, Mir Publishers, Moscow,1986.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	3
Semester	IV	**<<PHY2415S04>> :** **<< Specialization Paper: MOLECULAR SPECTROSCOPY-II >>**	HOURS	45

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I	<< >> << Electronic spectra of polyatomic molecules, change of shape on excitation, chemical analysis by electronic spectroscopy, rotational fine structure of vibronic transitions, determination of LCAO Coefficients, overlap and resonance integrals, Intensity and oscillator strength of vibronic spectra, vibronic interaction (Renner-Teller effect), Jahn-Teller effect.>>	15 hrs.
UNIT-II	**<< Radio astronomy>>** <<Introduction, Basic definitions, Radio telescopes, Interferometry and aperture synthesis telescope, Determination of the structure of radio source, Radiation processes, Radio emission in our galaxy, Brief of the milky way, radio galaxies, Quasars and Blazars, Pulsars, Radio spectra and structure>>	15 hrs.
UNIT-III	<< >> <<Radio astronomy and Cosmology, introduction to cosmological models (Friedmann-Robertson Walker), Hubble's law, red-shift, cosmic microwave background radiation (CMBR), WMAP (Wilkinson Microwave Anisotropy probe), Implications of CMBR and WMAP for modern cosmology>>	15 hrs.

REFERENCES

1.	Astrophysics - A Modern Perspective by K.S. Krishnaswamy, New Age International Publishers, 1996. (Reprint 2008/2009)
2.	Introduction to cosmology by J V Narlikar 3rd Cambridge Indian Edition, 2003.
3.	Astrophysics: Stars and galaxies by K D Abhyankar, Univ. press, H'bad, 2001.

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	The Maharaja Sayajirao University of Baroda Faculty/College of <<**Faculty of Science** >>, Department of <<**Physics** >> <<Address>>, <<Contact details>>, <<e-mail ID>>	ACADEMIC YEAR **2019-2020**

<<Name of the Programme: **M.Sc.**>> : <<**M.Sc. Physics** >>

YEAR	II	**CORE:**	CREDIT	6
Semester	IV	**<<PHY2403C18>> : << Physics Laboratory-IV>>**	HOURS	75

OBJECTIVES:	

COURSE CONTENT / SYLLABUS

UNIT-I

<< **List of experiments** >>

<< **List of experiments for students of Electronics & Communications Specialization:**

1) SCR Characteristics
2) FET Amplifier
3) Adder & Subtractor
4) Up & Down counter
5) 555 Timer
6) Multiplexing and demultiplexing, SRAM
7) Operational Amplifier - II
8) AM & FM Demodulation
9) μ Processor Programming - II
10) LVDT, Strain gauge, load Cell
11) Interfacing Peripherals with μ processor.
12) Active Filters

List of experiments for students of Nuclear Physics Specialization:

1) Study of Back Scattering of β-particle using G. M. counter with different materials.
2) Study the random nature of radioactive decay by G. M. counter.
3) Study of Feather analysis by G. M. counter.
4) Range of α-particles (Am-241) in air and polymer using alpha detector.
5) Determination of absolute efficiency of NaI (Tl) Scintillation detector using standard sources.
6) Determination of the activity of a gamma source using NaI (Tl) detector.
7) Analysis of efficiency spectrum of Ge detector using ^{152}Eu standard source.
8) To study the working of an active low and high pass filter circuits
9) To study the transistor co-incidence circuit.

List of experiments for students of Condensed Matter Physics Specialization:

1) Optical Band Gap
2) Single Crystal Rotation – X-ray diffraction
3) Laue Method
4) X-Ray Powder Method

	5) Intensity of X-Ray Diffraction (Powder Pattern) 6) Powder Diffraction Pattern – Graphical Analysis 7) Electron Diffraction 8) Ionic Conductivity of Alkali Halide Crystal 9) Dielectric Constant 10) Use of RL: Non-cubic crystal projection **List of experiments for students of Spectroscopy Specialization:** 1) Salt analysis by spectroscopic method. 2) Isotopic shift in AgCl molecule. 3) Rotational analysis of CN molecule. 4) Doppler broadening. 5) Waist of laser. 6) Rotational temperature of PbO molecule. 7) Rotational analysis of CO molecule. 8) Raman Spectrum of CCl_4. 9) UV – Vis Spectrum analysis. 10) Solar Spectrum analysis. 11) Brightness of night sky. 12) Study of (a) Lunar craters (b) Sun spots.>>	

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