Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Physics)

Programme Specific Outcome (PSO)

PSO1 Learn basics of Physics and develop methodology to understand and solve various problems
PSO2 Basic understanding and their applications in various fields
PSO3 Learn theoretical and experimental techniques used in physical sciences including simulations
PSO4 Advanced understanding and application of physical techniques used in industries at various levels including nondestructive evaluation and device fabrication
PSO5 Hands-on practice of basics and advanced techniques for industrial and research applications
PSO6 Training and exposure to research problems through practical.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**I**	**Core** **PHY2101C01: Mathematical Physics**	**Credits / Hours per week**	**03**
Semester	**I**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2101C01

CO1 Understanding the basic concepts and general formalism of mathematical physical
CO2 Learn about the physical interpretation of Complex Variable, Special Function and Differential Equation
CO3 Solving the Complex Variable, Special Function and Differential Equation
CO4 Applications of Mathematical Physics to various other branches of Physics

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/	Relevance to Local (L)/ National	Relation to Gender (G), Environ

							Entrepreneurship (Ent)/ Skill Development (SD)	(N)/ Regional (R)/Global (G) developmental needs	ment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**TENSORS AND GROUP THEORY** Tensor analysis: introduction, definitions, contraction, direct product, summation convention, quotient rule, pseudo tensors, 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	33.33%	1,2,3	CO1 to CO3	PSO1 to PSO4	Employability Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)
2	**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	33.33%	1,2,3	CO1 to CO3	PSO1 to PSO4			
3	**SECOND ORDER DIFFERENTIAL EQUATION WITH VARIABLE CO-EFFICIENTS AND SPECIAL FUNCTIONS** 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	15	33.33%	2,3,4	CO1 to CO4	PSO5 PSO6			

	Legendre polynomials, Recurrence relations, Orthogonality and Generating functions								

Reference Books

	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

Syllabus of Courses

The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**		**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**I**	**Core** **PHY2102C10: Classical Mechanics**	**Credits / Hours per week**	**04**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2102C10

CO1 Understanding the basic concepts of classical mechanics
CO2 Learn about the physical interpretation of wave function and Schrodinger equation
CO3 Solving the Schrodinger equation for arbitrary potentials

CO4	Understand the General formalism of quantum mechanics
CO5	Applications of Quantum mechanics to other systems

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**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, The brachistochrone, Minimum surface of revolution, Several dependent variable	15	25%	1,2,4	CO1, CO2	PSO1, PSO3, PSO5, PSO6	Employability Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)
2	**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	15	25%	1,2,3,4	CO1, CO2	PSO1, PSO3, PSO5			

	motion for holonomic system from Hamilton's principle and characteristic functions								
3	**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	25%	2,3,4,5	CO1 to CO4	PSO1 to PSO4			
4	**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	25%	2,3,4,5	CO1, CO2, CO4, CO5	PSO3 to PSO6			

Reference 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 Mc Graw-Hill Pub. Co. Ltd., New Delhi.

Syllabus of Courses

The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**		**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**I**	**Core** **PHY2104C03: Atomic & Molecular Spectroscopy**	**Credits / Hours per week**	**04**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2104C03

CO1 Understanding the basic concepts of spectroscopy, Astronomy and Astrophysics
CO2 Learn about the physical interpretation of the Laser spectroscopy
CO3 Applications of Astronomy and Astrophysics
CO4 Understand the General formalism of Different types of spectroscopy and its applications
CO5 Applications of Laser Spectroscopy to other systems

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Intensity rules, central field approximation, interaction energy in L-S coupling and j-j coupling (two electron system).	15	25%	1,2,4	CO1, CO2,	PSO1, PSO2,	Employability	Global (G)	Environment and

	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.				CO4, CO5	PSO4, PSO5	Skill Develop ment,	develop mental needs	Sustaina bility (ES)
2	**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	25%	1,2,3,4	CO1, CO3	PSO1, PSO2, PSO3			
3	**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	25%	2,3,4,5	CO1, CO3	PSO1, PSO3, PSO4, PSO5			
4	**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	25%	2,3,4,5	CO1, CO4	PSO1, PSO3, PSO4, PSO5			

Reference 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
7	Atomic Spectra by H.E. White.
8	Laser Physics and Applications by Tarasov
9	Contemporary Astronomy by J. Pasacchoff CBS college publishing, 1981
10	Astronomy by Robert H. Baker.
11	Atomic and Moleculer Spectra by Rajkumar, Kedas North Ram North, 2008

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**
	M.Sc. (Physics): Regular Programme		
Year	**I**	**Core** **PHY2105C04: Numerical Analysis**	**Credits / Hours per week**	**04**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2105C04

CO1 Understanding the basic concepts of Numerical Analysis
CO2 Learn about the physical interpretation of the Numerical Methods
CO3 Understand the General computer programme and its applications
CO4 Applications of numerical analysis to other systems

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Develop	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values

							ment (SD)	develop mental needs	(HV)and Professio nal Ethics (PE)
1	**NUMERICAL METHODS** Finite difference method, stability test, eigen values of matrix, matrix diagonalization, Monte Carlo method. Random number generator, multi-dimensional integrals. Numerical differentiation, Numerical integration	15	50%	1,2,4	CO1, CO2, CO4	PSO1, PSO2, PSO3, PSO4	Employa bility Skill Develop ment,	Global (G) develop mental needs	Environ ment and Sustaina bility (ES)
2	**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. Examples:1) Lagrange interpolation 2) Millikan experiment with direct linear fit. 3) Derivatives with three points 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	50%	2,3,5,6	CO1, CO3, CO4	PSO1, PSO4, PSO5			

Reference 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 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)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2109C06: Laboratory**	**Credits / Hours per week**	**02**
Semester	**I**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures, Practical, Problem solving and programming sessions		

Course Outcome (CO) PHY2109C06

CO1 Understanding the basic concepts of Experimental and Computational Physics
CO2 Learn about the physical interpretation of physical problems and solutions
CO3 Solving the Computational problems and writing programmes
CO4 Applications of Experimental/Computational Physics to other branches of Physics

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**(A) General laboratory:** Child langmur`s law Michelson interferometer I with Laser source	15	70%	1,2,3,4	CO1, CO4	PSO1, PSO3	Employability	Global (G)	Environment and Sustaina

	R-C coupled amplifier Dissociation energy of I_2 –molecule Talbot bands Rayleigh interferometer Feed back amplifier R. F. Oscillator Gas filled photocell Power factor of a coil Regulated power supply Logic Gates Multivibrator β – Ray Absorption						Skill Develop ment,	develop mental needs	bility (ES)
2	**(B) Computer Laboratory:** FORTRAN programming on various numerical method applied to physical problems	15	30%	3,4,5,6	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3			

Reference 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 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)
5.	A physicist's guide to Mathematica by P.T. Tam (Academic Press, II Edition)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**I**	**Core** **PHY2108C05: Electronics**	**Credits / Hours per week**	**04**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2108C05

CO1 Understanding the basic concepts of semiconductor devices, digital circuits
CO2 Learn about basics of shift resistors, Op-AMP, Oscillators
CO3 Understand the electronics devices and circuits
CO4 Applications of electronics to other systems

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**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	25%	1,2,3,4	CO1, CO3, CO4	PSO1, PSO3, PSO4	Employability Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)

2	**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	25%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	**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	25%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			
4	**<u>OSCILLATORS</u>** 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 & E-Type) characteristics, FET as an amplifier.	15	25%	3,4,6	CO1, CO2, CO4, CO5	PSO1, PSO2, PSO4			

Reference Books

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

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Physics)

Programme Specific Outcome (PSO)

PSO1 Learn basics of Physics and develop methodology to understand and solve various problems
PSO2 Basic understanding and their applications in various fields
PSO3 Learn theoretical and experimental techniques used in physical sciences including simulations
PSO4 Advanced understanding and application of physical techniques used in industries at various levels including nondestructive evaluation and device fabrication
PSO5 Hands-on practice of basics and advanced techniques for industrial and research applications
PSO6 Training and exposure to research problems through practical.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2201C07 : Mathematical Physics**	**Credits / Hours per week**	**03**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2201C07

CO1 Understanding the basic concepts and general formalism of mathematical physical
CO2 Learn about the physical interpretation of Complex Variable, Special Function and Differential Equation
CO3 Solving the Complex Variable, Special Function and Differential Equation
CO4 Applications of Mathematical Physics to various other branches of Physics

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**COMPLEX VARIABLES I** Analytical functions and Cauchy-Riemann conditions, Poles-Taylor and Laurent series, contour integral and Cauchy's	15	33.33%	1,2,3	CO1 to CO3	PSO1 to PSO4	Employability	Global (G)	Environment and Sustaina

	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						Skill Develop ment,	develop mental needs	bility (ES)
2	**SPECIAL FUNCTIONS II AND DIFFERENTIAL EQUATIONS** Spherical harmonics(Y_l^m (θ, ϕ)) and vector spherical harmonics, Laguerre polynomials, Associated Laguerre polynomials, Bessel function, spherical Bessel function, their properties, Recurrence relations, Orthogonality and Generating functions.	15	33.33%	1,2,3	CO1 to CO3	PSO1 to PSO4			
3	**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	33.33%	2,3,4	CO1 to CO4	PSO5 PSO6			

Reference Books

1.	Mathematical methods for physicists: G. B. Arfken and H. J. Weber , 5th edition Academic press/Elsevier science, India 2000.
2.	Advanced Engineering Mathematics Kreyzing 8th 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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2202C08: Quantum Mechanics**	**Credits / Hours per week**	**04**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2202C08

CO1 Understanding the basic concepts of quantum mechanics
CO2 Learn about the physical interpretation of wave function and Schrodinger equation
CO3 Solving the Schrodinger equation for arbitrary potentials
CO4 Understand the General formalism of quantum mechanics
CO5 Applications of Quantum mechanics to other systems

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Vectors, Matrices and Heisenberg mechanics Review of different types of matrices and matrix algebra, transposition, complex conjugation and adjoint of matrices,	15	25%	1,2,4	CO1, CO2	PSO1, PSO3,	Employability	Global (G)	Environment and Sustaina

	review of determinant and its properties, vectors and vector space, Dirac notations, linearly independent, orthogonal and orthonormal vectors, abstract representation of vectors, inner and outer product of vectors, Gram-Schmidt method of orthogonalization of vectors, 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 matrices:- orthogonal, unitary and Hermitian matrices and their properties, diagonalization of Hermitian matrix, change of basis and unitary transformations, bi-linear, quadratic and Hermitian forms, Cayley-Hamilton theorem, 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.					PSO5, PSO6	Skill Develop ment,	develop mental needs	bility (ES)
2	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	15	25%	1,2,3,4	CO1, CO2	PSO1, PSO3, PSO5			
3	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.	15	25%	2,3,4,5	CO1 to CO4	PSO1 to PSO4			

	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.								
4	APPROXIMATE METHODS Time independent perturbation theory for non-degenerate case (1st and 2nd order) and for degenerate case (1st 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	25%	2,3,4,5	CO1, CO2, CO4, CO5	PSO3 to PSO6			

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2204C09 : Nuclear Physics**	**Credits / Hours per week**	**04**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving seasons		

Course Outcome (CO) PHY2204C09

CO1 Understanding the limitation of Newtonian Mechanics and introduction to basic concepts of Nuclear Physics
CO2 Learn about the physical interpretation of wave function and Schrodinger equation
CO3 Solving the Schrodinger equation for arbitrary potentials
CO4 Understand the General formalism of quantum mechanics
CO5 Understand basics of Statistical mechanics and thermodynamics
CO6 Applications of statistical mechanics to gases and other systems

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**Interaction of radiation and charged particle with matter:**	15	25%	1,2,3	CO1	PSO1 PSO5	Employability	Global (G)	Environment and

	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.>>					PSO7	Skill Develop ment,	develop mental needs	Sustaina bility (ES)
2	**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	25%	2,3,4	CO1	PSO1 PSO4			
3	**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	25%	2,3,5	CO1	PSO1 PSO2 PSO5 PSO8			

Reference Books

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).

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2210C12 : Laboratory**	**Credits / Hours per week**	**02**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures, Practical, Problem solving and programming sessions		

Course Outcome (CO) PHY2210C12

CO1 Understanding the basic concepts of Experimental and Computational Physics
CO2 Learn about the physical interpretation of physical problems and solutions
CO3 Solving the Computational problems and writing programmes
CO4 Applications of Experimental/Computational Physics to other branches of Physics

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**(A) General laboratory:** Michelson's Interferometer – II ('t' of thin glass plate) Ultrasonic Interferometer	15	70%	1,2,3,4	CO1, CO4	PSO1, PSO3	Employability	Global (G)	Environment and Sustaina

	Vibrational spectrum of AIO molecule E/m by Thomson method (CRT) P-N Junction diode Laser (λ and e) Logic gates – II (combinational circuits) Operational Amplifier (OP-AMP) Fourier analysis Dead time of GM counter Hall effect						Skill Develop ment,	develop mental needs	bility (ES)
2	**(B) Computer Laboratory:** FORTRAN programming on various numerical method applied to physical problems	15	30%	3,4,5,6	CO1, CO2, CO3, CO4	PSO1, PSO2, PSO3			

Reference 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 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)
5.	A physicist's guide to Mathematica by P.T. Tam (Academic Press, II Edition)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty Technology and Engineering** **Department of Applied Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2208C10 : Condensed Matter Physics**	**Credits / Hours per week**	**04**
Semester	**I**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving seasons		

Course Outcome (CO) PHY2208C10

- CO1 Understanding the limitation of Newtonian Mechanics and introduction to basic concepts of quantum and statistical mechanics
- CO2 Learn about the physical interpretation of wave function and Schrodinger equation
- CO3 Solving the Schrodinger equation for arbitrary potentials
- CO4 Understand the General formalism of quantum mechanics
- CO5 Understand basics of Statistical mechanics and thermodynamics
- CO6 Applications of statistical mechanics to gases and other systems

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	**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	25%	2,3,4	CO1	PSO1	Employability Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)
2	. **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	25%	2,3,4	CO1	PSO1 PSO4			
3	**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	25%	2,3,4	CO1	PSO1 PSO2 PSO5			
4	**DIELECTRIC PROPERTIES**	15	25%	2,3,4	CO1	PSO1 PSO2			

	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)					PSO5			

Reference Books

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).

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2209C11 : Computational Physics**	**Credits / Hours per week**	**02**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures, Problem solving and programming sessions		

Course Outcome (CO) PHY2209C11

CO1 Understanding the basic concepts and general formalism of Computational Physics
CO2 Learn about the physical interpretation of physical problems and solutions
CO3 Solving the Computational problems and writing programmes
CO4 Applications of Computational Physics to various other branches of Physics

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Coffee cooling problem, computer program for Coffee cooling problem.	15	50%	1,2,3,4	CO1, CO2	PSO1, PSO2	Employability	Global (G)	Environment and

	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.)						Skill Develop ment,	develop mental needs	Sustaina bility (ES)
2	Simple harmonic oscillators, numerical simulation, simple pendulum, damped oscillatory motion, electric circuit oscillations. Boundary value and eigen value problems: stationary solution of one dimensional Schrodinger equation. , Numerov method, algorithm TISE solution (for one body in 1D) Scattering of particle by central potential (Rutherford formula & Born approximation scattering angles section and impact parameter), Application of numerical quadrature.>>	15	50%	3,4,5,6	CO2, CO3, CO4	PSO3, PSO4			

Reference 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 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)
5.	A physicist's guide to Mathematica by P.T. Tam (Academic Press, II Edition)

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Physics)

Programme Specific Outcome (PSO)

PSO1 Remember basics of Physics and develop methodology to understand and solve various problems
PSO2 Basic understanding of the basic applications in other fields
PSO3 Hands-on practice of basics and advanced Physics for research applications
PSO4 Training and exposure to research problems through project dissertation
PSO5 Hands-on practice of basics and advanced experiments intended for industrial and research applications
PSO6 Training and exposure to research problems through project dissertation

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core** **PHY2301C13: Advanced Quantum Mechanics**	**Credits / Hours per week**	**04**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2301C13

CO1 Understanding the basic concepts of Quantum Mechanics
CO2 Learn about basics Quantum Applications
CO3 Understand Quantum Mechanics theory
CO4 Applications of Quantum Mechanics in various fields

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Time dependent perturbation theory, Interaction picture, Transition amplitude, First- order perturbation, Harmonic perturbation, Transition probability, Second -order	15	25%	1,2,3,4	CO1, CO3, CO4	PSO1, PSO3, PSO4	Employability	Global (G)	Environment and Sustaina

	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						Skill Develop ment,	develop mental needs	bility (ES)
2	**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	25%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	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	25%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			
4	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	25%	3,4,6	CO1, CO2, CO4, CO5	PSO1, PSO2, PSO4			

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core** **PHY2302C14: CLASSICAL ELECTRODYNAMICS & PLASMA PHYSICS-I**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2302C14

CO1 Understanding the basic concepts of Electrodynamics & Plasma Physics
CO2 Learn about basics Electrodynamics & Plasma Physics
CO3 Understand Plasma theory
CO4 Applications of Maxwell equations in various fields

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	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 conducting medium, plane wave and spherical wave solution, polarisations and their properties (Stoke's parameters).Superposition of waves, kinematics of dispersion and classical theory of dispersion, Normal and anomalous dispersion.	15	33%	1,2,3,4	CO1, CO3, CO4	PSO1, PSO3, PSO4	Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)
2	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	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	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	33%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core** **PHY2304E01: Elective Paper:** **EXPERIMENTAL TECHNIQUES – I**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2304E01

CO1 Understanding the basic concepts of Experimental Techniques
CO2 Learn about functions and operation of experimental devices
CO3 Understand Plasma theory
CO4 Applications of various techniques in various fields

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	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	33%	1,2,3	CO1, CO3, CO4	PSO1, PSO3, PSO4	Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)
2	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	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	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 Tunnelin Microscopy (STM).	15	33%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**PHY2306E01: Elective Paper: Advanced Physics**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2306E01

CO1 Understanding the basic concepts of Theoretical Techniques
CO2 Learn about functions and operation of theoretical models
CO3 Understand Advanced theory
CO4 Applications of various techniques in various fields

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**General Theory And Its Applications (A Few)** Introduction to totally symmetric and anti-symmetric tensors in higher dimension, principle of general covariance, parallel	15	33%	1,2,3	CO1, CO3, CO4	PSO1, PSO3, PSO4		Global (G)	Environment and Sustaina

	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.						Skill Develop ment,	develop mental needs	bility (ES)
2	**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-Shamequations.	15	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	**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	33%	3,4	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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 physicspublishing, (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).

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**PHY2305E01: Elective Paper: Astrophysics and Cosmology**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2305E01

CO1 Understanding the basic concepts of Astrophysics & Cosmology
CO2 Learn about fundamentals of Astrophysics
CO3 Understand Advanced Cosmology theory
CO4 Applications of in explanation of star formation

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	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	33%	1,2,3	CO1, CO3, CO4	PSO1, PSO3, PSO4			
2	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	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3	Skill Develop ment,	Global (G) develop mental needs	Environ ment and Sustaina bility (ES)
3	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	15	33%	3,4	CO2, CO3, CO4	PSO1, PSO2, PSO4			

	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.								

Reference Books

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).

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**PHY2307S01: Specialization Paper: ELECTRONICS & COMMUNICATIONS-I**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2307S01

CO1 Understanding the basic concepts of Electronics & Communications
CO2 Learn about fundamentals of Electronics
CO3 Understand the methodology of communication
CO4 Applications of in Electronics and Communications

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	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.	15	33%	1,2,3	CO1, CO3	PSO2, PSO3	Skill Development,	Global (G)	Environment and Sustaina

	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.							develop mental needs	bility (ES)
2	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. 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.	15	33%	1,2,3,4	CO1, CO2, CO3	PSO2, PSO3, PSO4			
3	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	33%	3,4	CO2, CO3	PSO2, PSO6			
Reference Books									
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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**PHY2308S02: Specialization Paper: ELECTRONICS & COMMUNICATIONS-II**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2308S02

CO1 Understanding the basic concepts of Electronics & Communications
CO2 Learn about fundamentals of Electronics
CO3 Understand the methodology of communication
CO4 Applications of in Electronics and Communications

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Applications of Op-Amp: Design and working of Op-amps as differential, Instrumentation amplifier, Signal Generator:	15	25%	1,2,3	CO1, CO3	PSO2, PSO3		Global (G)	Environment and

	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						Skill Develop ment,	develop mental needs	Sustaina bility (ES)
2	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	25%	1,2,3,4	CO1, CO2, CO3	PSO2, PSO3, PSO4			
3	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	25%	3,4	CO2, CO3	PSO2, PSO6			
4	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	25%						
Reference Books									
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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core / ~~Elective / Foundation~~** **PHY2309S01: Nuclear Physics I**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2309S01

CO1 Understanding and introduction to basic concepts of Nuclear Physics
CO2 Learn about the physical interpretation of Nuclear phenomena
CO3 Understanding of Electronics related to Nuclear experiment
CO4 Understand the General methods of nuclear radiation detection
CO5 Applications of nuclear detection, electronics and accelerator

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**Nuclear radiation Detectors and Spectrometers** Scintillation detectors, Type of scintillators, Semiconductor detectors- depletion region, silicon diode detectors, Si(Li),	15	33.33	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO6	Emp, SD	L,N, R, G	ES

	Ge(Li), HPGe detectors, 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								
2	**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	33.33	1	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO5, PSO6	Emp, SD	L,N,R,G	ES
3	**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	33.33	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core / ~~Elective / Foundation~~** **PHY2310S02-Nuclear Physics-II**	**Credits / Hours per week**	**04**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY 2310S02-Nuclear Physics II

CO1 Understanding and introduction to basic concepts of Nuclear Physics
CO2 Learn about the physical interpretation of Nuclear phenomena
CO3 Understanding of Electronics related to Nuclear theory
CO4 Understand the General methods of nuclear analysis
CO5 Applications of nuclear theory and interpretation

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	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	15	25	1, 2, 3	CO1		Emp,		ES

	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).				CO2 CO5	PSO1 to PSO6	SD	L,N, R, G	
2	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	25	1,2,3,4	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO5, PSO6	Emp, SD	L,N,R,G	ES
3	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	25	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES
4	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	25	2, 3, 5	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**II**	**Core / ~~Elective / Foundation~~** **PHY2311S01: (Specialization Paper)** **Condensed Matter Physics–I**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision:	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2311S01

CO1 Understanding and introduction to basic concepts of Solid State Physics
CO2 Learn about the physical interpretation of Solid State phenomena
CO3 Understanding of related to Solid State Physics
CO4 Understand the General methods of Solid StatePhysics
CO5 Applications of Solid State Physics

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
	CRYSTAL LATTICES:								

1	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	33.33	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO6	Emp, SD Emp, SD	L,N, R, G L,N,R,G	ES ES
2	**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	33.33	1	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO5, PSO6	Emp, SD	L,N,R,G	ES
3	**TRANSPORT PHENOMENA** Drude theory of metals – DC and AC electrical conductivity, thermal conductivity, Weidman-Frantz law, Boltzmann equation, Relaxation time approximation, non-equilibrium distribution function, Somerfield 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	33.33	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO4			

Reference Books

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)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**II**	**Core / ~~Elective / Foundation~~** **PHY2312S02: (Specialization Paper)** **Condensed Matter Physics–II**	**Credits / Hours per week**	**04**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision:	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2312S02

CO1 Understanding and introduction to basic concepts of Solid-State Physics
CO2 Learn about the physical interpretation of Solid-State phenomena
CO3 Understanding of related to Solid State Physics
CO4 Understand the General methods of Solid-State Physics
CO5 Applications of Solid-State Physics

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
	PHYSICS OF SEMICONDUCRS AND DEVICES								

1	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	25	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO6	Emp, SD	L,N, R, G	ES
2	**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	25	1,2,3,4	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO5, PSO6	Emp, SD	L,N,R,G	ES
3	**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	25	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES
4	**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,	15	25	2, 3, 5	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES

	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)>>								

Reference Books

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)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core / ~~Elective / Foundation~~** **PHY2313S01: ATOMIC & LASER SPECTROSCOPY-I**	**Credits / Hours per week**	**03**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2313S01

CO1 Understanding and introduction to basic concepts of Atomic & Laser Spectroscopy
CO2 Learn about the physical interpretation of Atomic & Laser Spectroscopy
CO3 Understanding of related to Atomic & Laser Spectroscopy
CO4 Understand the General methods of Atomic & Laser Spectroscopy
CO5 Applications of Atomic & Laser Spectroscopy

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
	Relativistic mass correction, hydrogen fine structure, Pauli's exclusion principle(with treatment), determination of								

1	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	33.33	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO3	Emp, SD	L,N, R, G	ES
2	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	33.33	1	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO3	Emp, SD	L,N,R,G	ES
3	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	33.33	2, 3, 4	CO1, CO2	PSO1 PSO2	Emp, SD	L,N,R,G	ES

Reference 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.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**II**	**Core / ~~Elective / Foundation~~** **PHY2314S02: MOLECULAR SPECTROSCOPY- I**	**Credits / Hours per week**	**04**
Semester	**III**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2314S02

CO1 Understanding and introduction to basic concepts of Molecular Spectroscopy
CO2 Learn about the physical interpretation of Molecular Spectroscopy
CO3 Understanding of related to Molecular Spectroscopy
CO4 Understand the General methods of Molecular Spectroscopy
CO5 Applications of Molecular Spectroscopy

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
	<< Electronic spectra of diatomic molecules, Hund's coupling cases (a), (b), (c), symmetry properties of rotational								

1	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	25	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO3	Emp, SD	L,N, R, G	ES
2	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	25	1,2,3,4	CO1, CO2, CO3, CO5	PSO1, PSO2			
3	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	25	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO3	Emp, SD	L,N,R,G	ES
							Emp, SD	L,N,R,G	ES
4	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	25	2, 3, 5	CO1, CO2	PSO1 PSO2 PSO3	Emp, SD	L,N,R,G	ES

Reference Books

1.	Molecular Spectra and Molecular Structure, Vol.- I by G.Herzberg,Van Nostrand Co., N.Y.1950.
2.	Atomic and Molecular Spectra by Rajkumar, Kedar Nath Ram Nath, 2008
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.
7.	Molecular Spectra and Molecular Structure, Vol.- I by G.Herzberg,Van Nostrand Co., N.Y.1950.
8.	Atomic and Molecular Spectra by Rajkumar, Kedar Nath Ram Nath, 2008

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Physics)

Programme Specific Outcome (PSO)

PSO1 Remember basics of Physics and develop methodology to understand and solve various problems
PSO2 Basic understanding of the basic applications in other fields
PSO3 Hands-on practice of basics and advanced Physics for research applications
PSO4 Training and exposure to research problems through project dissertation
PSO5 Hands-on practice of basics and advanced experiments intended for industrial and research applications
PSO6 Training and exposure to research problems through project dissertation

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2401C16: QUANTUM MECHANICS & STATISTICAL MECHANICS**	**Credits / Hours per week**	**04**
Semester	**IV**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2401C16

CO1 Understanding the basic concepts of Quantum Mechanics
CO2 Learn about basics Quantum Applications
CO3 Understand Quantum Mechanics theory
CO4 Applications of Quantum Mechanics in various fields

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	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	33.33%	1,2,3,4	CO1, CO3, CO4	PSO1, PSO3, PSO4	Employability Skill Development,	Global (G) developmental needs	Environment and Sustainability (ES)
2	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	33.33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	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	33.33%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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 (10th reprint) 1986
4.	Quantum Mechanics Vol.-II by Ghatak & Loknathan
5.	Statistical Mechanics - by K. Huang 2nd Editions(John Wiley & Sons, 1987).
6.	Statistical Mechanics - by F.Reif (International student ed. McGraw Hill 1988).

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2402C17: CLASSICAL ELECTRODYNAMICS & PLASMA PHYSICS-I**	**Credits / Hours per week**	**03**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2402C17

CO1 Understanding the basic concepts of Electrodynamics & Plasma Physics
CO2 Learn about basics Electrodynamics & Plasma Physics
CO3 Understand Plasma theory
CO4 Applications of Maxwell equations in various fields

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Different system of units in electromagnetic theory, Maxwell's equation in Gaussian and MKS system of units, Conservation	15	33%	1,2,3,4	CO1, CO3, CO4	PSO1, PSO3, PSO4		Global (G)	Environment and Sustaina

	laws, Energy density, Poynting vector, Maxwell stress tensor, Solution of Maxwell's equations in infinite dielectric and conducting medium, plane wave and spherical wave solution, polarisations and their properties (Stoke's parameters).Superposition of waves, kinematics of dispersion and classical theory of dispersion, Normal and anomalous dispersion.						Skill Develop ment,	develop mental needs	bility (ES)
2	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	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	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	33%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core** **PHY2405E02: Elective Paper:** **EXPERIMENTAL TECHNIQUES – I**	**Credits / Hours per week**	**03**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2405E02

CO1 Understanding the basic concepts of Experimental Techniques
CO2 Learn about functions and operation of experimental devices
CO3 Understand Plasma theory
CO4 Applications of various techniques in various fields

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Vacuum Pumps : Rotary pump, Diffusion pump, Sputter – Ion pump, Sorption pump, Turbomolecular pump.	15	33%	1,2,3	CO1, CO3, CO4	PSO1, PSO3, PSO4		Global (G)	Environment and Sustaina

	Gauges: Bourdon Gauge, McLeod gauge, Pirani gauge, Thermocouple gauge, Hot and cold cathode ionization gauge. Vaccum Materials, Thickness measurement technique.						Skill Develop ment,	develop mental needs	bility (ES)
2	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	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	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 Tunnelin Microscopy (STM).	15	33%	3,4,5,6	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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)

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**PHY2407E02: Elective Paper: Advanced Physics**	**Credits / Hours per week**	**03**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2407E02

CO1 Understanding the basic concepts of Theoretical Techniques
CO2 Learn about functions and operation of theoretical models
CO3 Understand Advanced theory
CO4 Applications of various techniques in various fields

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**General Theory And Its Applications (A Few)** Introduction to totally symmetric and anti-symmetric tensors in higher dimension, principle of general covariance, parallel	15	33%	1,2,3	CO1, CO3, CO4	PSO1, PSO3, PSO4		Global (G)	Environment and Sustaina

	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.						Skill Develop ment,	develop mental needs	bility (ES)
2	**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-Shamequations.	15	33%	1,2,3,4	CO1, CO2, CO3	PSO1, PSO2, PSO3			
3	**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	33%	3,4	CO2, CO3, CO4	PSO1, PSO2, PSO4			

Reference Books

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 physicspublishing, (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).

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**PHY2408S03: Specialization Paper: ELECTRONICS & COMMUNICATIONS-III**	**Credits / Hours per week**	**03**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2408S03

CO1 Understanding the basic concepts of Electronics & Communications
CO2 Learn about fundamentals of Electronics
CO3 Understand the methodology of communication
CO4 Applications of in Electronics and Communications

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	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	33%	1,2,3	CO1, CO3	PSO2, PSO3	Skill Develop ment,	Global (G) develop mental needs	Environ ment and Sustaina bility (ES)
2	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. 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.	15	33%	1,2,3,4	CO1, CO2, CO3	PSO2, PSO3, PSO4			
3	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 distortion less 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	33%	3,4	CO2, CO3	PSO2, PSO6			

4	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.								

Reference Books	
1.	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.
2.	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 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.
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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**PHY2409S04: Specialization Paper: ELECTRONICS & COMMUNICATIONS-IV**	**Credits / Hours per week**	**03**
Semester	**II**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Problem solving sessions		

Course Outcome (CO) PHY2409S04

CO1 Understanding the basic concepts of Electronics & Communications
CO2 Learn about fundamentals of Electronics
CO3 Understand the methodology of communication
CO4 Applications of in Electronics and Communications

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	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:	15	33%	1,2,3	CO1, CO3	PSO2, PSO3		Global (G)	Environment and Sustaina

	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.						Skill Develop ment,	develop mental needs	bility (ES)
2	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	33%	1,2,3,4	CO1, CO2, CO3	PSO2, PSO3, PSO4			
3	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	33%	3,4	CO2, CO3	PSO2, PSO6			

Reference Books	
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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core / ~~Elective / Foundation~~** **PHY2410S03: Nuclear Physics III**	**Credits / Hours per week**	**03**
Semester	**I**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2410S03

CO1 Understanding and introduction to basic concepts of Nuclear Physics
CO2 Learn about the physical interpretation of Nuclear phenomena
CO3 Understanding of Electronics related to Nuclear experiment
CO4 Understand the General methods of nuclear radiation detection
CO5 Applications of nuclear detection, electronics and accelerator

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	**Nuclear radiation Detectors and Spectrometers** Scintillation detectors, Type of scintillators, Semiconductor detectors- depletion region, silicon diode detectors, Si(Li), Ge(Li), HPGe detectors, Gamma-ray spectrometer, analysis of gamma-ray-spectra, Response function, Alpha and beta	15	33.33	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO6	Emp, SD	L,N, R, G	ES

	spectrometers, Error Propagation, Nuclear reaction of interest in neutron detection, BF_3 detectors								
2	**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	33.33	1	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO5, PSO6	Emp, SD	L,N,R,G	ES
3	**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	33.33	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core / ~~Elective / Foundation~~** **PHY2411S04-Nuclear Physics-IV**	**Credits / Hours per week**	**04**
Semester	**I**	Year of Introduction: 2016-17 Year of Syllabus Revision: 2016	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2411S04-Nuclear Physics II

CO1 Understanding and introduction to basic concepts of Nuclear Physics
CO2 Learn about the physical interpretation of Nuclear phenomena
CO3 Understanding of Electronics related to Nuclear theory
CO4 Understand the General methods of nuclear analysis
CO5 Applications of nuclear theory and interpretation

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	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-	15	25	1, 2, 3	CO1 CO2 CO5	PSO1 to PSO6	Emp, SD	L,N, R, G	ES

	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).								
2	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	25	1,2,3,4	CO1, CO2, CO3, CO5	PSO1, PSO2, PSO5, PSO6	Emp, SD	L,N,R,G	ES
3	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	25	2, 3, 4	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES
4	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	25	2, 3, 5	CO1, CO2	PSO1 PSO2 PSO4	Emp, SD	L,N,R,G	ES

Reference Books

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

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**

M.Sc. (Physics): Regular Programme

Year	**I**	**Core / ~~Elective / Foundation~~** **PHY2414S03: ATOMIC & LASER SPECTROSCOPY-II**	**Credits / Hours per week**	**04**
Semester	**I**	Year of Introduction: 2015-16 Year of Syllabus Revision: 2014	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY 2414S03

CO1 Understanding and introduction to basic of Atomic spectroscopy
CO2 Learn about the physical interpretation of Atomic spectroscopy
CO3 Understanding of Raman spectroscopy
CO4 Understand the General principles of Laser
CO5 Applications of Laser

Unit No.	**Topic/Unit**	**Contact Hours**	**Weightage (%)**	**BT Level**	**CO**	**PSO**	**Elements of** Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	**Relevance to** Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	**Relation to** Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Explanation of normal and anomalous Zeeman effect, examples of Zeeman splitting in some transitions (^1F—^1D , D----^2P and ^3P ---- ^3S), Paschen-Back effect, Stark effect in	15	25	1, 2, 3	CO1 CO2	PSO1 PSO2	Emp, SD	L,N, R	ES

	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.				CO5	PSO3 PSO6			
2	**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	25	1,2,3,4	CO3 CO4 CO6	PSO3 PSO4 PSO6	Emp, SD	L,N,R,G	ES
3	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	25	1,2, 3	CO3 CO4	PSO3 PSO4 PSO6	Emp, SD	L,N,R,G	ES
4	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	25	3, 5	CO3 CO4 CO5	PSO3 PSO4 PSO5	Emp, SD	L,N,R,G	ES

Reference 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.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda **Faculty of Science** **Department of Physics**	**Academic Year**	**2019-20**
M.Sc. (Physics): Regular Programme			
Year	**I**	**Core / ~~Elective / Foundation~~** **PHY2415S04>>: MOLECULAR SPECTROSCOPY-II >>**	**Credits / Hours per week**	**03**
Semester	**I**	Year of Introduction: 2015-16 Year of Syllabus Revision: 2014	**Maximum Marks / Grade**	**100**
Mode of Transaction		Lectures and Tutorials		

Course Outcome (CO) PHY2415S04

CO1 Understanding and introduction to basic of electronic spectroscopy of poly atomic molecules
CO2 Learn about the chemical analysis of electronic spectroscopy of poly atomic molecules
CO3 Understanding of electronic vibration interaction in poly atomic molecules
CO4 Understand the basic principles of Radio Astronomy
CO5 Understanding of general principles of cosmology

Unit No.	Topic/Unit	Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G) developmental needs	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	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	33.33	2, 3,4	CO1 CO2 CO3	PSO1 PSO2 PSO3	Emp, SD	L,N, R, G	ES
2	**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	33.33	1,2,3	CO3 CO4 CO5	PSO4 PSO5 PSO6			
3	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	33.33	1,2, 3	CO1, CO2	PSO4 PSO5 PSO6	Emp, SD	L,N,R,G	ES
							Emp, SD	L,N,R,G	ES

Reference Books

1.	Molecular Spectra and Molecular Structure. Vol. I, II and III by G. Herzberg, Van Nostrand Co. NY 1950
2	Fundamentals of Molecular spectroscopy by C N Banwell, McGrow Hill, 1985
3	Vibrational Spectroscopy-Theory and Applications by D N Sathyanarayana. New Age International publishers, 2000.
4	Introduction to Infrared and Raman Spectroscopy, by N B Colthup, L H Daly & S E Wiberley, 3rd Ed, Academic Press, 1990.
5	Infrared spectroscopy: Fundamentals and applications by B Stuart. John Wiely& Sons Ltd 2004
6	Astrophysics – A Modern Perspective by K S Krishnaswamy, New Age International publishers, 2009.
7	Introduction to cosmology by J V Narlikar 3rd Cambridge Indian Edition, 2003.
8	Astrophysics: Stars and Galaxies by K D Abhyankar, Univ. Press, H'bad, 2001