(Implemented from AY 2025-26)

Four Year B. Sc. (Hons.) Physics Programme under NEP2020

COURSE OUTLINE (B.Sc. Physics)

FSBSC-III

Semester-V (NEP2020)

Course Code	Course Details	Credit
Semester-V: Major		
PHM3005C	Experimental Physics- V	04
PHM3015C	Nuclear and Particle Physics	04
PHM3025C	Quantum Mechanics-II	04
Semester-V: Minor		
PHE3005C	Solid State Physics	04
PHE3015C	Electronics and Basics of Optoelectronics	04
Semester-V: Skills Enhancement Courses (SEC)		
SEC3715C	Experimental Physics-VI	02

SSBSC-III

Semester-VI (NEP2020)

Course Code	Course Details	Credit
Semester-VI: Major		
PHM3006C	Experimental Physics-VII	04
PHM3016C	Classical Mechanics & Statistical Mechanics-I	04
PHM3026C	Computational Physics and Introduction to Special Theory of Relativity	04
Semester-VI: Minor		
PHE3006C	Experimental Physics-VIII	04
Semester-VI: AEC		
AEC3466C	Machine Learning for Physicists using Python Language	02
Semester-VI: SEC: Internship		
SEC3506C	**Internship** in Physics: Skills for Laboratory	04

	The Maharaja Sayajirao University of Baroda Faculty/College of **Faculty of Science**, Department of **Physics**	ACADEMIC YEAR **2025-2026**

Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR	III	**Major Physics** **PHM3005C: Experimental Physics-V**	CREDIT	4
Semester	V		HOURS	120 hrs.

OBJECTIVES:	1. Introduction to the basic concepts of Optics, Lasers and Electronic circuits 2. Learn about the physical interpretation and applications of Interference, diffraction and resolving power 3. Solving the problems related to Interference, diffraction, resolving power 4. Understand the handling of various sophisticated equipment

COURSE CONTENT / SYLLABUS

UNIT-I, II, III & IV	List of Experiments: 1. Quarter Wave Plate. 2. Fabry Perot Etalon 3. Lloyd's Mirror 4. Hartman's Formula 5. Resolving Power of a Prism 6. Double Slit Source Method 7. Mutual Inductance 8. Capacity of Condenser 9. Thermistor 10. Photocell 11. High Resistance By Leakage 12. Goniometer

Reference Books

1.	Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House.
2.	A Manual on Experiments in Physics; R Srinivasan, K R Priolkar and T G Ramesh, e-book of the Indian Academy of Science
3.	C.L. Arora , B.Sc. Practical Physics, S. Chand Publication, Delhi
4.	A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011,Kitab Mahal
5.	Students can refer to the standard text books used in theory to get an insight of the practical listed.

	The Maharaja Sayajirao University of Baroda Faculty/College of **Faculty of Science**, Department of **Physics**	ACADEMIC YEAR **2025-2026**

Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR	III	**Major Physics** **PHM3015C: NUCLEAR AND PARTICLE PHYSICS**	CREDIT	4
Semester	V		HOURS	60

OBJECTIVES:	1. Introduction to THE basic concepts of Nuclear Physics and Radioactive decay 2. Learn about the various types of nuclear reaction 3. Learn of radiation detection and diriment type of detectors 4. Introduction of the particle physics and classification of particles

COURSE CONTENT / SYLLABUS

UNIT-I	**Radioactivity**: **Properties of nucleus:** Radius of the nucleus, nuclear density, atomic mass, binding energy, Neutron and proton separation energies, Segre chart, Angular momentum, Parity, Magnetic moment, Electric quadrupole moment, Quantum states and Nuclear excited states. **Radioactive Decay:** (a)Alpha decay: α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b)β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. Kurie Plot. allowed and forbidden transition (c)Gamma decay: Gamma ray emission & kinematics, internal conversion. **Illustrative Examples**	15 hrs.
UNIT-II	**Nuclear Radiation:** **Interaction of Radiation:** Radiation and classification of radiation, interaction of charge radiation with matter, range and energy straggling, Bethe-Bloch formula (Quantitative discussion), Cherenkov radiation, bremsstrahlung Interaction of gamma radiation with matter, photoelectric effect, Compton's scattering, Derivation of scattered photon energy in Compton's scattering, Pair production, Neutron interaction with matter – elastic and inelastic scattering. **Nuclear Reactions:** Types of Reactions, Conservation Laws, Kinematics of reactions, Q-value, Reaction rate, Reaction cross section, Concept of compound and direct Reaction, Resonance reaction, Coulomb scattering (Rutherford scattering). **Illustrative Examples**	
UNIT-III	**Radiation Detectors:**	

	Radiation Detectors: Gas filled detectors: Pulse height characteristics of gas filled detectors, proportional counter, Giger-Muller counter. Scintillation detector: Scintillation process, Scintillation materials and classification, NaI(Tl) detector, photomultiplier tube (PMT). Particle Accelerators: Requirements of accelerator in nuclear physics, Van-de Graff generator, Cyclotron. Nuclear Reactor: Fission reaction, Distribution of fission fragments, Fission reactor, Fusion reactor, Nuclear reaction for energy production in stars. **Illustrative problems**	15 hrs.
UNIT-IV	**Elementary Particle Physics:**	
	Fundamental forces and fundamental particles, Symmetries and conservation laws, energy and momentum, angular momentum, parity, Leptons, hadrons, Elementary particle quantum numbers: baryon number, Lepton number, Isospin, Strangeness and charm. Space time symmetries, Space inversion, Charge conjugate and time reversal symmetries, CPT theorem and its consequences, Gell-Mann and Nishijima relation, Hadronic spectrum and Quark model, Concept of colour and gluons. **Illustrative problems**.	15 hrs.

	Reference Books (Text Books)
1.	Nuclear Physics - An Introduction by S. B. Patel (New Age International Publishers)
2.	Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
3.	Concepts of Modern Physics, A. Beiser (TATA Mc Graw Hill Indian Edition)
4.	Nuclear Physics by S. N. Goshal (S. Chand & Co Ltd Publisher, 2019)
5.	Modern Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
	Reference Books
1.	Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2.	Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3.	Introduction to High Energy Physics,D.H.Perkins,Cambridge Univ. Press
4.	Nuclear Physics: Problem based approach by H.M. Agrawal (PHI Learning Eastern Economy Edition)
5.	The Basics of Nuclear and Particle Physics by Alexander Belyaev, Douglas Ross (Springer, 2022)
6.	Nuclear Physics D.C. Tayal. Himalaya Publishing House.2019
7.	Nuclear Physics: Problem based approach by H.M. Agrawal.PHI Learning (Eastern Economy Edition)

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Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics				
YEAR	III	**Major Physics**	CREDIT	4
Semester	V	**PHM3025C: QUANTUM MECHANICS - II**	HOURS	60

OBJECTIVES:	
	1. Introduction to the basic concepts of quantum mechanics and its application 2. Learn about the physical interpretation of wave function and Schrodinger equation 3. Solving the Schrodinger equation for arbitrary potentials and discuss applications 4. Vibrational and rotational spectra of diatomic molecules and their applications

COURSE CONTENT / SYLLABUS

UNIT-I	**Vectors, Matrices and Heisenberg mechanics:** (Review of different types of matrices and matrix algebra, transposition, complex conjugate and adjoint of matrices, 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.	15 hrs.
UNIT-II	**Quantum theory of hydrogen atom:** Quantum theory of H_2 atom: Time independent Schrodinger wave equation in spherical polar coordinates; separation of variables for second order partial differential equation and its solution; angular momentum operator and physical interpretation of quantum numbers; calculation of zero point energy; Radial wave functions ; calculation of the probability densities ; Problems and applications related to the topics covered in this unit.	
UNIT-III	**Atomic Spectra:**	

	Orbital angular momentum; orbital magnetic dipole moment; Larmor precession; Space quantization; Stern-Gerlach Experiment; vector atom Model; spin–orbit interaction; Fine structure of spectral lines; L-S and j-j couplings schemes; interaction energy in L-S coupling; Pauli's Exclusion Principle; symmetric & antisymmetric Wave Functions; spectroscopic notations; Spectra of alkali atom (Na); spectra of He atom, **Atoms in External Magnetic Field**: Normal and Anomalous Zeeman Effect Paschen Back and Stark Effect (Qualitative Discussion only).	15 hrs.
UNIT-IV	**Molecular Spectra:**	
	Molecular formation; ionic bonding; covalent bonding; electron sharing; theories of bonding- the valence-bond and molecular orbital approaches; the H_2^+ molecular ion; the H_2 molecule; rotational energy levels of diatomic molecules; rotational spectra of diatomic molecules; vibrational energy levels of diatomic molecules; vibrational spectra of diatomic molecules; vibration-rotation spectra; electronic spectra; **Raman spectra**: Raman effect, experimental arrangement for Raman effect; molecular polarizability, quantum theory of Raman effect	15 hrs.

Reference Books

1.	A Textbook of Quantum Mechanics,P.M.MathewsandK.Venkatesan,2ndEd.,2010, McGraw Hill
2.	Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley
3.	Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4.	Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5.	Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6.	Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
7.	Quantum Mechanics for Scientists & Engineers, D.A.B.Miller,2008,CambridgeUniversity Press
8.	Atomic and Molecular Spectra: Laser, Raj Kumar, 5th Edn. 2017, Kedar Nath Ram Nath

Additional Books for Reference

1.	Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
2.	Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
3.	Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

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Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR		III	**Minor Physics** **PHE3005C: SOLID STATE PHYSICS**	CREDIT	4
Semester		V		HOURS	60

OBJECTIVES:	1. Introduction to the basic concepts of Solid State Physics 2. Learn about reciprocal lattice and crystal structure 3. Understand the Bending in crystals and its effect on Crystal properties 4. Introduction to the band theory of solids 5. To understand the lattice dynamics and role of Phonons in thermal and electric properties 6. To understand the semiconductor and its properties for semiconductor applications

COURSE CONTENT / SYLLABUS

UNIT-I		**Crystalline State, Reciprocal Lattice and X-ray diffraction:**	15 hrs.
		The Crystalline State: Lattice, basis and Crystal Structures (2D and 3D), Unit Cell, Primitive Cell, Crystal Types, Wigner-Sitz cell, Introduction to Crystal Point Groups and Space groups, Symmetry Operations, Indices of a Lattice Direction and a Lattice Plane, family of places, interplanar spacing, Atomic packing fraction: *sc*, *bcc*, *fcc*, *hcp*; Quasicrystals **Reciprocal Lattice:** Concept of Reciprocal lattice, Construction of Reciprocal Lattice, Relationships between a, b, c and a*,b*,c*, Volume of the reciprocal lattice primitive cell; First Brillouin zone: for *sc*, *bcc* and fcc structures. **X-ray diffraction:** Bragg's law, Laue's interpretation of X-ray diffraction, single crystal and powder diffraction method	
UNIT-II		**Bonding and defects in the crystal:**	
		Crystal bonding: Forces between the atoms, Cohesive energy, Bonding in solids, ionic bonding: Madelung constant, properties of ionic solid; Covalent bonding: properties of covalent solids; Metallic bonding; hydrogen bonding. **Defects:** Point defects: Vacancies-Schottky defects; interstitial defects-Frenkel defect; compositional defects: substitutional and interstitial; Line defects: Edge and screw dislocation; Surface defects: Grain boundary, tilt boundary; Volume defects	
UNIT-III		**Free electron Fermi gas; Energy levels; Elementary Lattice Dynamics:**	

		Free Electron gas model; ground state properties of free electron gas; Fermi wave vector; Fermi momentum, Fermi velocity; Fermi energy. Ground state energy, energy density and Fermi temperature. Electron level in periodic potential; Periodic potential; Bloch's theorem and its proof; origin of band gap; Korring Penny model **Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law .	
UNIT-IV		**Semiconductor Crystal:**	
		Bang gap; Equation of Motion: Holes, effective mass, physical basic of effective mass, energy band diagram and effective mass of few semiconductors like Si, Ge; Mechanism of current conduction in semiconductor; Hall effect; Intrinsic semiconductor: carrier concentration; Thermal ionization of Donors and Acceptors; Mobility in presence of impurity; Thermoelectric effect in semiconductors, Semimetals; Amorphous semiconductor.	15 hrs.

Reference Books

1.	IntroductiontoSolidStatePhysics,CharlesKittel,8th Edition,2004,Wiley India Pvt. Ltd.
2.	Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
3.	Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
4.	Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
5.	Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India.
6.	Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

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Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR	III	**Minor Physics** **PHE3015C: Electronics and Basics of Optoelectronics**	CREDIT	4
Semester	V		HOURS	60

OBJECTIVES:	1. Introduction to the basic concepts of Electronics &Applications, 2. Detail understanding of the amplifier and its applications 3. Introduction of different types of oscillator and multivibrator 4. Theory of number system 5. Principles of display devices 6. SIntroduction to Fiber optics

COURSE CONTENT / SYLLABUS

UNIT-I	**Oscillators and Wave shaping:** Transistor Oscillators: Principle of feedback in oscillators, Tuned Collector oscillator, Tuned emitter oscillator and its operation and circuit analysis. Hartley, Colpitt's and Wein's bridge Oscillator & their limitations. Multivibrators (Using transistor), Classification and applications. Monostable, Bi-stable, Astable multivibrators. Wave shaping circuits, its classifications, Types of wave shaping circuits, RC differentiator, RC integrator, input and output waveforms, Series clipper circuits, shunt clipper circuits. Clamping circuits.	15 hrs.
UNIT-II	**Operational Amplifier & Number Systems:** Operational Amplifier: Characteristics:- Concept of Differential mode, Input off set voltage, Common mode rejection ratio, Bias Current, Input off set current, slew rate, input-output impedance, negative feedback in Op-Amp, Inverting, non-inverting, Summing, voltage follower, zero level detector & Comparator circuit analysis. Number Systems:- Binary number System its Conversion to decimal hexadecimal and octal system and vice versa, BCD code, Excess-3code, Gray code. Digital gates, Buffers and other gate formation by universal gates, Boolean algebraic laws and De-Morganization, Simplification of Boolean algebraic expressions, Parity generator and parity checker.	
UNIT-III	**Modulation of Light and Display devices:** Modulation of Light: Elliptical polarization; Birefringence, Optical activity; Opto-electric effect, Kerr modulator: Keer effect; Scanning and switching; Magnto-optical devices: Faraday effect; Acousto-optic effect; Introduction to non-linear optics. Display Device: Luminescence; Photo-Luminescence; Cathodoluminescence (Review of CRT); Electroluminescence; Injection Luminescence and light-emitting diode: Radiative recombination, LED materials, commercial LED, construction, Response time; Plasma display, LCD.	15 hrs.

UNIT-IV	**Lasers and Fiber optics:** Laser: (review of Emission and adsorption of radiation, Einstein relation, population inversion, threshold condition, laser losses, pumping threshold) Laser modes: Axial and Transverse; Classes of laser: Doped insulator laser, semiconductor laser, Gas laser,; Mode locking; Q-switching. Application of Laser; Holography. Fiber Optics: Total internal reflection, Planar dielectric waveguide, Types of optical fiber waveguide, Losses in fiber, optical fiber connections; Measurement of fiber characteristics; Types of fiber material.	15 hrs.

Reference Books

1.	Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2.	Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3.	Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6thEdn,2009, PHI Learning.
4.	Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3rd Ed. 2012, Tata Mc-Graw Hill.
5.	OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th Edition, 2000, Prentice Hall.
6.	Opto-electronics: An Introduction, J. Wilson and J. Hawkes; Prantic Hall Europe
7.	Principles of lasers by O Svelto, Springer New York, NY
8.	Laser and electro-optics- C C Davis
9.	Quantum Electronics- A Yariv

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Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR	III	**SEC:** **SEC3715C: Experimental Physics-VI**	CREDIT	2
Semester	V		HOURS	60 hrs

OBJECTIVES:	1. Introduction to basic concepts of Optics, Lasers and Electronic circuits 2. Learn about the physical interpretation of resonance 3. Solving the problems related to material's properties

COURSE CONTENT / SYLLABUS

UNIT-I & II	List of Experiments: 1. Cathode Ray Oscilloscope 2. Bridge Rectifier (For self Inductance) 3. Susceptibility of a Solution 4. Series and Parallel Resonance 5. Stefan's Constant 6. Band Gap of Semiconductor	.

Reference Books

1.	Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House.
2.	A Manual on Experiments in Physics; R Srinivasan, K R Priolkar and T G Ramesh, e-book of the Indian Academy of Science
3.	C.L. Arora , B.Sc. Practical Physics, S. Chand Publication, Delhi
4.	A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11thEd., 2011,Kitab Mahal
5.	Students can refer to the standard text books used in theory, to get insight of the practical listed.

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Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics				
YEAR	III	**Major Physics** **PHM3006C: Experimental Physics-VII**	CREDIT	4
Semester	VI		HOURS	120 hrs.

OBJECTIVES:	1. Introduction to basic concepts of Optics, Lasers and Electronic circuits 2. Learn about the physical interpretation of Interference, diffraction and resolving power 3. Solving the problems related to Interference, diffraction, resolving power 4. Understand the handling of various sophisticated equipment

COURSE CONTENT / SYLLABUS

UNIT-I, II, III & IV	List of Experiments: 1. BABINET COMPENSATOR 2. TEMPERATURE OF A FLAME 3. CYLINDRICAL OBSTACLE 4. R.P. OF GRATING 5. EDSER BUTLER FRINGES 6. R.P. OF A TELESCOPE 7. LASER 8. SELF INDUCTANCE (RAYLEIGH'S METHOD) 9. 'h' BY PHOTOCELL 10. ANCHOR RING 11. MULTIVIBRATOR 12. PLANK'S CONSTANT BY PHOTOELECTRIC EFFECT

Reference Books

1.	Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House.
2.	A Manual on Experiments in Physics; R Srinivasan, K R Priolkar and T G Ramesh, e-book of the Indian Academy of Science
3.	C.L. Arora , B.Sc. Practical Physics, S. Chand Publication, Delhi
4.	A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011,Kitab Mahal
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Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR	III	**Major Physics** **PHM3016C: Classical Mechanics & Statistical Mechanics**	CREDIT	4
Semester	VI		HOURS	60

OBJECTIVES:	1. Introduction to basic concepts of Classical Mechanics and concept of generalized coordinates 2. Learn about the central force field and its applications 3. Understanding the rigid body dynamics and its examples Introduction of statistical mechanics and its basic concepts

COURSE CONTENT / SYLLABUS

UNIT-I	**Mechanics of a particles and two body central force problem:** 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, Cyclic or Ignorable coordinates. Calculus of variations: The Euler-Lagrange equation, First integral geodesics, The Brachistochrone, Minimum surface of revolution, Several dependent variables.	15 hrs.
UNIT-II	**Rigid Body:** Number of degree of freedom, Euler's angles and Euler's theorem, infinitesimal rotation, rate of change of vector, (Review: Coriolis force, angular momentum and kinetic energy of a rigid body), the inertia tensor and moment of inertia, principle axes transformation, Euler's equation of motion. Precession of a charged body in a magnetic field. Small oscillations, normal modes and coordinates, transition from a discrete to a continuous system, the Lagrangian formulation for continuous system, constant of motion and symmetry properties.	15 hrs.
UNIT-III	**Classical Statistics:** Probability and Probability distribution; Random number, Phase Space; Ensemble: types of Ensembles; Density of Distribution in Phase space; Liouville's theorem (statements only); Statistical Equilibrium, Entropy and Thermodynamic Probability; Microstate and Macrostates; Maxwell-Boltzmann Distribution Law (Energy and momenta) , Equipartition Theorem (with proof); Applications of MB statistics to Specific Heat capacity of gases, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature	15 hrs.

UNIT-IV	**Partition Function:**	
	Partition Function; Partition function and thermodynamical quantities; Partition Function for Microcanonical, Canonical, Grand Canonical Ensembles; Partition function for Magnetic substance. Thermodynamic Functions of an Ideal monoatomic gas by Partition function, Gibbs Paradox, Sackur Tetrode equation.	15 hrs.
Reference Books		
1.	Introduction to classical mechanics by Golstein Poole & Safko (Pearson Education , Asia) 1st edition, 2002 (Low Price Edition)	
2.	Classical Mechanics by 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.	
4.	StatisticalMechanics,R.K.Pathria,ButterworthHeinemann:2nd Ed.,1996, Oxford University Press.	
5.	Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill	
6.	Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall	
7.	Thermodynamics, KineticTheory and Statistical Thermodynamics, Francis W.Sears and Gerhard L. Salinger, 1986, Narosa.	
8.	Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer	
9.	An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press	
7.	An Introductory course of statistical mechanics by Palash B. Pal Narosa Pub.House 2008	

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YEAR	III	**Major Physics**	CREDIT	4
Semester	VI	**PHE3026C: Computational Physics and introduction to Special theory of Relativity**	HOURS	60

OBJECTIVES:	1. Introduction to basic concepts of Numerical analysis and computer programming 2. Learn about the skill of solving partial DIFFERENTIAL equations and its applications 3. Basic COMPUTER PROGRAMMING: FORTRAN 90 & 95 based real world Problems 4. Applications of numerical methods to solve problems in physics 5. Introduction to the basic concepts of Special Theory of Relativity 6. Understand the concept ofLorentz transformation, Minkowski space 7. Understand the concept of time dilation

COURSE CONTENT / SYLLABUS

UNIT-I	**Numerical Methods – I** Experimental errors and their analysis, Roots of polynomial equation using Newton –Raphson's and Laggurre's methods. Least square approximation: (a) Linear regression (b) Polynomial regression (c) Fitting of exponential and trigonometric functions (d) Curve fitting by interpolation and extrapolation, related Physics problems. **Numerical Methods – II** Lagrange's interpolation formula, forward and backward differences, derivatives of function, Detection of error in data table, maxima and minima of a tabulated function, Gaussian integration, Double integration, related problems.	15 hrs.
UNIT-II	**Numerical Methods** Finite difference method, stability test, eigen values of matrix, matrix diagonalisation, Monte Carlo method. Random number generator, multi-dimensional integrals. Numerical differentiation, Numerical integration. Problem related to computational Physics such as: Lagrange interpolation, Millikan experiment with direct linear fit, Derivatives with three points formulas, To find the Madlung energy of the alkali halide types of ionic crystals, To find the bond length of crystal like Nacl.	15 hrs
UNIT-III	**Frame of References:** Inertial and accelerated frames of reference, the earth as a reference frame, fixed stars and inertial reference frame, forces in inertial reference system, absolute and relative acceleration, fictitious forces, accelerometer, centrifugal (also pseudo force : Coriolis force) and centripetal forces, acceleration in uniformly rotating frame, Foucault pendulum, mechanics of N-particle system.	15 hrs
UNIT-IV	**Theory of Relativity:** Doppler Effect, Space-time diagram, world-line, the Twin Paradox, relativity in electromagnetism, variation of mass with velocity. relativistic formula for kinetic energy, Experimental verification of Time dilation, Lorentz transformation, Minkowski space, time like and space like intervals.	15 hrs

Reference Books	
1.	Computer Oriented Numerical Methods by V. Rajaraman 2004, Prentice Hall Pvt. Ltd., New Delhi.
2.	Numerical Method by Kalavathi 2006, Thomson Pub. : Learning Vijay Nicole Imprint Pvt. Ltd. (2004)
3	Numerical Methods by E. Balaguruswami 2006, Tata McGraw-Hill, New Delhi.
4.	Advance Engineering Mathematics by Kreyszig 8th edition, 2006, John Wiley & Sons, (Asia Pvt.) Singapore
5.	Concepts of Modern Physics – Arthur Beiser, 6th Edition, 2005, Tata McGraw-Hill, New Delhi.
6.	The special theory of Relativity : S. Banerji and A. Banerji, 2002, Prentice Hall Pvt. Ltd., New Delhi
7.	Berkeley Physics Course – Vol. I (Mechanics), Kittle, Knight, Ruderman, Helmholtz, Mayer 2nd Edition, 1981, McGraw Hill International (Asia Student edition).
8.	Feynman Lecture Series (Vols. I and II) Feynman, Leighton and Sands MIT reading, Addission Wesley 1964, (Narosa pub. India 1995).
9.	Introduction to Special Relativity R. Resnick (1989) Wiley Eastern Ltd., New Delhi.
10.	Classical Mechanics by Goldestein, Poole and Safko, Pearson education Asia, 2002
11.	Analytical Mechanics by L. H. Hand and J. D. Finch Cambridge University press, reprint 2001
12.	Introduction to Special Relativity – By Gupta (2015)Pragati Prakashan, Meerut

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YEAR	III		CREDIT	2
Semester	VI	**Minor:** **PHE3006C: Experimental Physics-VIII**	HOURS	60 hrs

OBJECTIVES:	1. Introduction to basic concepts of Electronic circuits 2. Learn about the physical interpretation of various concepts of electronic circuits 3. Understand the handling of various sophisticated equipment

COURSE CONTENT / SYLLABUS

UNIT-I&II	List of Experiments: 1. e/m BY HELICAL METHOD 2. OWEN'S BRIDGE 3. ABERRATION METER 4. FILTER CIRCUIT 5. REGULATED POWER SUPPLY 6. LOGIC GATES	.

Reference Books

1.	Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House.
2.	A Manual on Experiments in Physics; R Srinivasan, K R Priolkar and T G Ramesh, e-book of the Indian Academy of Science
3.	C.L. Arora , B.Sc. Practical Physics, S. Chand Publication, Delhi
4.	A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011,Kitab Mahal
5.	Students can refer to the standard text books used in theory, to get and insight of the listed practicals.

	The Maharaja Sayajirao University of Baroda Faculty/College of **Faculty of Science**, Department of **Physics**	ACADEMIC YEAR **2025-2026**

Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics				
YEAR	III	**AEC:** **AEC3466C: Machine Learning for Physicists using Python Language**	CREDIT	2
Semester	VI		HOURS	30

OBJECTIVES:	1. Introduction to the concept of Machine Learning 2. Methods of various Machine learning models 3. Concept of data handling and different methods. 4. Basic programming for Machine learning using Python language and use for real world Problem

COURSE CONTENT / SYLLABUS

UNIT-I	**Introduction to Machine Learning (Theory)** Introduction to Machine Learning (ML), Types of ML, Unsupervised learning, Supervised learning & Reinforcement learning, Classification, Clustering and Regression, Introduction to Python libraries Data collection and handling, Fingerprint & feature engineering, ML algorithms: Linear regression, kernel-based algorithms, Tree based algorithms, Basics of artificial neural networks, Model evaluation and cross-validation, Overview of ML applications in physics	15 hrs.
UNIT-II	**Machine Learning using Python Language (lab)** ● Setting up Python environment (Jupyter Notebook, Anaconda) ● Python libraries: NumPy, Pandas, Matplotlib, Scikit-learn ● Exploration of physics-based datasets ● Data visualization and preprocessing ● Implementing linear regression in Python ● SVR implementation for fitting non-linear physics datasets ● Real-world physics classification problem using scikit-learn ● Building and training Tree based algorithms ● Implementing a simple neural network for a physics problem ● Evaluation and visualization of model performances	15 hrs.

Reference Books

1.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2.	Introduction to Machine Learning Edition2, by EthemAlpaydin

	The Maharaja Sayajirao University of Baroda Faculty/College of **Faculty of Science**, Department of **Physics**	ACADEMIC YEAR **2025-2026**

Name of the Programme: 4 year B.Sc. (Hons.) Programme under NEP2020-Physics

YEAR	III	**SEC3506C:Internship in Physics: Skills for Laboratory ***	CREDIT	4
Semester	VI		HOURS	120

OBJECTIVES:	1. Gain hands on experience in a professional setting, applying theoretical knowledge to real-world problem. 2. Develop skills such as communication team work, problem solving and time managing. 3. Understand the inner working of an organization, industry trends and best practice. 4. Explore different career path and establish connections. 5. Conduct original research develop critical thinking and analysis and prepare students for advanced research.

COURSE CONTENT / SYLLABUS

1.Laboratory Work

***Rules and Regulations:**

Those students who could not get internship outside the university will be allotted project. Further, students can couple internship for 60 hrs. after 4^{th} and 5^{th} semester examinations and during vacation. However, internship will be evaluated only in 6^{th} semester with others papers.