SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with ‘A++’ Grade

NATIONAL EDUCATION POLICY (NEP-2020)
Syllabus For

M.Sc. Part-I

Physics

Syllabus to be implemented from AUGEST, 2022 onwards

Department of Physics,
Shivaji University, Kolhapur
M. Sc. –Part-I (Physics) Course Structure

NOTE:
The following in a nutshell gives the scope and extent of each course offered. Each core theory course has two levels of teaching: Lectures and Internal exam. The elective courses are offered during the second year.

M.Sc. (Physics) NEP-2020				
Part-I (Semester-I)				
	Sr. No	**Course code**	**Course Title**	**Credits**
CGPA	**1**	CC-101	Mathematical Physics	4
	2	CC-102	Classical Mechanics	4
	3	CC-103	Quantum Mechanics-I	4
	3	CC-104	Condensed Matter Physics	4
	3	CCPR-105	i. Physics Lab–I ii. Physics Lab–II	4 4
Non-CGPA	**6**	AEC-106	Communicative English	
M.Sc. (Physics) NEP-2020				
Part-I (Semester-II)				
	Sr. No	**Course code**	**Course Title**	**Credits**
CGPA	**1**	CC-201	Quantum Mechanics-II	4
	2	CC-202	Statistical Mechanics	4
	3	CC-203	Electrodynamics	4
	4	CC-204	Atomic & Molecular Physics	4
	5	CCPR-205	i. Physics Lab–III ii. Physics Lab–IV	4 4
Non-CGPA	**6**	SEC-206	Skill Enhancement Course	

M.Sc. (Physics) (Semester-I)
Course Code: CC-101
Paper title: Mathematical Physics
Total Credits: 4-credits

Mathematical Physics

Unit - I: Vector Spaces and matrices (15)

Linear vector space (Rajput 123 – 126), Matrix multiplication – inner product, direct product, diagonal matrices, trace, matrix inversion, example of Gauss-Jordon inversion, problems (Rajput 735 – 45). eigen values and eigen vectors, properties of eigen values and eigen vectors, Cayley-Hamilton theorem and applications, similar matrices and diagonalizable matrices, eigen values of some Special complex matrices, quadratics forms, problems.

Unit - II: Differential equations and Special functions (15)

Solution for first order differential equation, Bernulli equation, exact equation, second order linear differential equation with constant and variable coefficient, special functions (Hermite, Bessel, Laguerre and Legendre functions) generating functions, recurrence relation (Rajput 510 –667)

Unit - III: Fourier- Series, Integral, and Transform (15)

Definition, evaluation of coefficients of Fourier series (Cosine and Sine Series), graphical representation of a square wave function, complex form of Fourier series, Fourier integral exponential form, applications of Fourier series analysis in physics (square wave, full wave rectifier, expansion of Raman Zeta function) (Rajput 527 – 561). Fourier transform, inversion theorem, exponential transform Example: full wave train, uncertainty principle [Arfken 931-946]. Dirac delta function, derivative of δ- function and Laplace Transform of δ- function (Rajput1467 – 1475).

Unit – IV: Complex Analysis (15)

Analytical functions, Cauchy-Riemann conditions, Cauchy's theorem, Cauchy integral formula, derivatives of analytical functions, Taylor's theorem, Laurent's theorem, residues, evaluation of definite integrals.(Rajput 404-499)

Reference book:

1) Rajput B. S., Mathematical Physics, Pragati Prakashan (Meerat) 1999
2) Iyengar S. R. K., Jain R. K. , Mathematical Methods, Narosa, 2006
3) Arfken and Weber, Mathematical Methods For Physicists 6th Edition, Academic Press, 2005
4) Mathematical Physics, Binoy Bhattacharyya, New Central Book Agency (P) Limited, 2010
5) Complex Variables and Applications – J. W. Brown, R. V. Churchill – (7th Edition) - Mc-Graw Hill – Ch. 2 to 7.
6) Complex Variables –Seymour Lipschutz, John J. Schiller, Dennis Spellman, (2nd Edition) Mc-Graw Hill – 2009.

M.Sc. (Physics) (Semester-I)
Course Code: CC-102
Paper title: Classical Mechanics
Total Credits: 4-credits

Classical Mechanics

Unit - I:Central Force Problem and Small oscillations: (15)

Two body problem, The equation of motion and firs tintegrals, Equation of orbit, Kepler'slaws, Kepler's problem, General analysis of orbits, Stability of orbits, Rutherford Scattering: Differential scattering cross–section, Rutherford Formulae for scattering, Virial theorem. Small oscillations: Potential energy and equilibrium-one dimensional oscillator, general theory of small oscillations.

Unit - II:Variational principle and Hamiltonian Dynamics: (15)

Variational principle, Deduction of canonical equations from Variational principle, Principle of least action with proof, Hamilton's principle, Hamiltonian, **Generalized momentum & Conservation Theorems using cyclic coordinates,** Hamilton's canonical equations of motion, Applications of Hamilton's equations of motion-**1) Simple Pendulum 2) Compound Pendulum 3)Linear Harmonic Oscillator.**

Unit - III:Canonical Transformations and Poisson's Brackets: (15)

Legendre transformations, Generating Functions, Illustrations of Canonical transformations, Condition for Canonical Transformation, Examples. Poisson's Brackets, Poisson's theorem, Properties of Poisson's Brackets, **Lagrange Bracket, Relation between Lagrange and Poisson's Brackets**, Hamilton's Canonical equations interms of Poisson's Brackets, Hamilton–Jacobi Theory, Solution of harmonic oscillator problem by HJ Method, Problems.

Unit - IV:Special Theory of Relativity and Relativistic Mechanics: (15)

Special theory of relativity and its postulates, Galilean transformations, Lorentz transformations **relativistic kinematics** (Relativity of Mass, Length, Time), Minkowski Space, 4-Vectors, 4-Momentum, Lorentz Tensor, Addition of velocities, Mass-Energy relation, Force in relitivstic mechanics, Lagrangian formulation of relativistic mechanics, Particle accelerating under constant force, Hamiltonian formulation of relativistic mechanics, Relativistic Doppler's Effect.

Reference Books:

1. Classical Mechanics, by H Goldstein (Addison Wesley 1980).
2. Classical Mechanics, by J. C. Upadhyaya (Himalaya Publishing House 2015).
3. Classical Mechanics, by N. C. Rana and P. S. Joag (Tata McGraw Hill 1991).
4. Introduction to Classical Mechanics, by R. G. Takwale and P. S. Puranik (Tata McGraw Hill 1999).
5. Classical Mechanics, by Gupta, Kumar and Sharma (Pragati Prakashan 2000).

M.Sc. (Physics) (Semester-I)
Course Code: CC-103
Paper title: Quantum Mechanics-I
Total Credits: 4-credits

Quantum Mechanics-I

Unit - I: Wave Mechanical Concepts and General formalism (15)
Why Q.M? Revision; Inadequacy of classical mechanics; sequential Stern Gerlach experiment, analogy with polarization of light, Ehrenfest's theorem, Linear vector space, linear operator, postulates of quantum mechanics, simultaneous measurability of observables, general uncertainty relations, Dirac's notation, equation of motion, momentum representation, Heisenberg method, matrix representation of wave function and operators, unitary transformation

Unit - II: Quantum Dynamics (15)
Unitary time evolution and Schrödinger equation, the Schrödinger verses the Heisenberg picture, Interaction picture, simple harmonic oscillator, Bloch wave in a periodic potential, Kronig-Penney Square periodic potential (use of wave mechanics), linear harmonic oscillator: Schrodinger method and operator method, free particle, particle moving in a spherical symmetric potential, system of two interacting particles, rigid rotator, hydrogen atom, hydrogenic orbital's

Unit - III: Angular Momentum (15)
Orbital angular momentum, general formalism of angular momentum, eigen values of J^2 and Jz, Paulli theory of spins (Paulli's Matrices), Matrix representation of angular momentum, Computation of Clebsch-Gordon coefficients in simple cases.

Unit - IV: Time independent perturbation theory (15)
Basic concept, non-degenerate energy levels, Eigen value of energy and Eigen function in the first order approximation, first order correction to ground state of helium, effect of electric field on the ground state of hydrogen, degenerate energy levels, effect of electric field on the n = 2 state of hydrogen, spin-orbit interaction.

Reference Books:
1. Quantum Mechanics Concepts and Applications, NouredineZettili, 2nd edition (2009)
2. Quantum Mechanics, Aruldhas G, Prentice Hall India Learning Private Limited, 2ndedition (2008)
3. Quantum Mechanics: Theory and Applications, AjoyGhatak and S. Lokanathan, Macmillan publishers India, 5th edition (2004)
4. Introductory Quantum Mechanics (4th Edition), Richard Liboff, Pearson Education,4thedition (2004)
5. Introduction to Quantum Mechanics, J. Griffiths David ,Pearson Education, 2nd edition (2015)
6. Quantum Mechanics, L I Schiff, McGraw-Hill,4th edition (2014)
7. Modern Quantum Mechanics, J J Sakurai, Pearson Education India; 2nd edition, (2013)

M.Sc. (Physics) (Semester-I)
Course Code: CC-104
Paper title: Condensed Matter Physics
Total Credits: 4-credits

Condensed Matter Physics

Unit – I : Crystal Physics **(15)**

Crystalline state of solid, unit cell and Bravias lattice (2D and 3D), bonding of common crystal structure, direction, position and orientation of planes in crystal, concept of reciprocal lattice, concept of Brillouin zones, closed packed structure, Fourier analysis of the basis (structure factor), Bragg's law, comparison of X-ray, electron and neutron diffraction method.

Unit - II : Crystal Defects **(15)**

Types of defects, Point defects-Vacancies, Interstitisials, impurities, electronic, , Line defects-Edge and screw dislocation, Schottky and Frenkel defect Expression for Schottky and Frenkel defects, equilibrium concentration of vacancies, color center, line defect, crew and edge dislocation, Berger's vector and circuit, role of dislocation in plastic deformation and crystal growth, observation of imperfection in the crystals. Frank-Read mechanism. Planer defects, Surface defects- Grain boundaries, Tilt boundaries, Twin boundaries, Effect of Imperfections

Unit – III : Semiconducting and superconducting properties **(15)**

Semiconductor: Determination of Band gap energy, direct and indirect band gap, effective mass, intrinsic and extrinsic semiconductors, carrier concentration, Fermi level and conductivity for intrinsic and extrinsic semiconductor, impurity level in doped semiconductor, Hall Effect. Superconductor : Critical temperature, effect of magnetic field, Meissner effect, type-I and type-II superconductor, London equation, coherence length, Josephson effect (flux quantization), BCStheory, introduction of high Tc superconductor. SQUID

Unit – IV: Dielectric and Magnetic properties **(15)**

Dielectric: Polarization mechanism, dielectric constant, Lorenz cavity field, Clausius-Mossotti equation, theory of diamagnetism, ferroelectricity and piezoelectricity, type of ferroelectric and piezoelectric. Magnetic: Classification of magnetic material, Langevin theory of diamagnetism, paramagnetism and ferromagnetism, theory of diamagnetism- Heisenberg exchange interaction theory (ferro- antiferro- and ferrimagnetism), Weiss theory of ferromagnetism. Comparison between dia, para, and ferromagnetism

Reference Books:

1. Introduction to solid state physics - C. Kittel, 8th edn, John Wiley & Sons. Inc., New York (1976).
2. Solid state physics by A. J. Dekker, MacMillan India Ltd. (1986).
3. Solid state physics - N. W. Ashcroft and N. D. Mermin, HRW International edn. (1976).
4. Solid state physics – S. O. Pillai. New Age International Publication.-2002
5. Solid State Physics - H. C. Gupta- Vikas Publishing House, New Delhi-2002
6. Electronic Properties of Materials- R. E. Humel, 2nd edn. Springer International(1994)
7. Solid State Physics – J. S. Blakemore, 2nd edn. Cambridge University Press(1985)

M.Sc. (Physics) (Semester-II)
Course Code: CC-201
Paper title: Quantum Mechanics-II
Total Credits: 4-credits

Quantum Mechanics-II

Unit - I: Variational Method and WKB approximation (15)

The variational principle, Rayleigh-Ritz method, variational method for excited states, the Hellmann-Feynman theorem, ground state of harmonic oscillator, infinite square well, hydrogen atom, helium atom and deuteron, the WKB method, the connection formulas, validity of WKB method, barrier penetration, Alpha emission

Unit - II: Time-Dependent perturbation theory (15)

Dyson series, First-order perturbation, transition probability, constant perturbation, harmonic perturbation, transition to continuum states (Fermi-Golden rule), semi-classical theory of radiation: absorption and emission of radiation, electric dipole approximation Einstein's A and B coefficients, selection rules, the adiabatic approximation, the sudden approximation

Unit - III: Scattering theory (15)

Scattering cross-section, scattering amplitude, partial wave, scattering by central potential: partial wave analysis, optical theorem, scattering by hard sphere, scattering by square well, Breit-Wigner formula, scattering length, expression for phase shifts, integral equation, the Born approximation, scattering by screened Coulomb potential, scattering by Yukawa potential, validity of Born approximation

Unit - IV: Identical particles and Relativistic wave equations (15)

Identical particles: Indistinguishable particles, Pauli principle, inclusion of spin, spin functions for two electrons, spin functions for three electrons, spin-statistics connection, scattering of identical particles

Relativistic wave equations: Klein-Gordon Equation and its interpretation, Dirac equation for a free particle, covariant form of Dirac equation

Reference Books:

1. Quantum Mechanics, Aruldhas G, Prentice Hall India Learning Private Limited, 2nd Edition (2009).
2. Quantum Mechanics: Theory and Applications, Ajoy Ghatak and S. Lokanathan, Macmillan publishers India, Fifth Edition (2004).
3. Introductory Quantum Mechanics, Richard Liboff, Pearson Education, Fourth Edition (2004).
4. Introduction to Quantum Mechanics, David J. Griffiths, Pearson Education, Second Edition (2015).
5. Quantum Mechanics, L. I. Schiff, McGraw-Hill, Fourth Edition (2014).
6. Modern Quantum Mechanics, J. J. Sakurai and Jim J. Napolitano, Pearson Education India, Second Edition, (2013).
7. Quantum Mechanics: Concepts and Applications, Zettili Nouredine, John Wiley & Sons Ltd., Second Edition (2009).

M.Sc. (Physics) (Semester-II)
Course Code: CC-202
Paper title: Statistical Mechanics
Total Credits: 4-credits

Statistical Mechanics

Unit - I: Contact between Statistics and Thermodynamics: 15

Fundamental postulate of equilibrium statistical mechanics, basic concepts - phase space, ensemble, a priori probability, Liouville's theorem (Revision). fluctuations of physical quantities, statistical equilibrium, Thermodynamic Laws and their consequences (in brief) , Thermodynamic functions – entropy, free energy, internal energy, enthalpy (definitions), Maxwell's equations (only equations), contact between statistics and thermodynamics – entropy in terms of microstates, Gibb's paradox, Sackkur-Tetrode formula.

Unit - II: Classical Statistical Mechanics: 15

Micro canonical ensemble– Micro canonical distribution, entropy and specific heat of a perfect gas, entropy and probability distribution, canonical ensemble– canonical distribution, partition function, calculation of free energyof an ideal gas, thermodynamic functions, energy fluctuations. grand canonical ensemble– Grand Canonical distribution, thermodynamic functions,number and energy fluctuations.

Unit - III: Quantum Statistics of ideal quantum gases: 15

Quantum Statistics: Distinction between MB, BE and FD distributions, Quantum distribution functions –Bosons and Fermions and their distribution functions, Boltzmann limit of quantum gases,Partition function, Ideal Bose gas, Bose -Einstein condensation, specific heat of solids (Einstein and Debye models) phonon gas, liquid He4: second Sound.

Ideal Fermi gas: weakly and strongly degenerate, Fermi temperature, Fermi velocity of a particle of a degenerate gas, electron gas: free electron theory of metals, Pauli paramagnetism, white dwarfs

Brownian motion: Einstein-Smoluchowski theory, Langevin theory, Approach to equilibrium: Fokker-Planck equation, the fluctuation-dissipation theorem.

Unit - IV: Phase Transitions, and Critical Phenomenon 15

Phase Transitions, Conditions for phase equilibrium, First order Phase Transition: Clausius - Clayperon equation, Second order phase transition, The critical indices, Weakly Interacting Gases, Weiss Molecular theory of paramagnetism, The Ising Model of a Ferromagnetism

Reference books:

1. Statistical Mechanics Theory and Applications, S K Sinha, Tata McGraw-Hill, (1990).
2. Introduction to Statistical mechanics, B B Laud, Macmillan, N Delhi, (1981).
3. Statistical Mechanics by R K Pathria, Pergamon press (1972).
4. Statistical and thermal Physics F Reif, McGraw-Hill (1965).
5. Statistical Physics, L D Landau and E M Lifshitz, Pergamon press (1958).

M.Sc. (Physics) (Semester-II)
Course Code: CC-203
Paper title: Electrodynamics
Total Credits: 4-credits

Electrodynamics

Unit - I: Maxwell's Equations and E.M. Waves: (15)
Maxwell's Equations: microscopic and macroscopic forms (revision), Maxwell's equations in free space, dielectrics and conductors, conservation of the bound charge and current densities (Equation of Continuity and Displacement Current), E.M. wave equations in waveguide of the arbitrary cross section: TE and TM modes; Transmission lines and wave guides, rectangular and circular waveguides , dielectric waveguide, resonant cavity. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction.

Unit - II: Time –Dependent Potentials and Fields: (15)
Scalar and vector potentials: coupled differential equations, Gauge transformations: Lorentz and Coulomb Gauges, Retarded Potentials, Lienard – Wiechert Potentials, Fields due to a charge in the arbitrary motion.

Unit - III: Radiation from Accelerated Charges and Radiation Reaction: (15)
Fields of charge in uniform motion, applications to linear and circular motions: cyclotron and Synchrotron radiations, Power radiated by point charge – Larmor's formula, Angular distribution of radiated power, Cerenkov radiation and Bremsstrahlung (qualitative treatments). Radiation Reaction: criteria for validity, Abraham –Lorentz formula, Physical basis of radiation reaction –self force.

Unit - IV: Electrodynamics and Relativity: (15)
The Special Theory of Relativity, Einstein's Postulates, the Geometry of Relativity, the Lorentz Transformations , The Structure of Space time, Relativistic Mechanics, Proper Time and Proper Velocity, Relativistic Energy and Momentum, Relativistic Kinematics, Relativistic Dynamics, Relativistic Electrodynamics, Magnetism as a Relativistic Phenomenon, How the Fields Transform, The Field Tensor, Electrodynamics in Tensor Notation Relativistic Potentials.

Reference books:

1. **Introduction to Electrodyanamics** – D. J. Griffiths (Prentices- Hall 2002 (3rd edn)
2. **Foundation of E.M. Theory**- J. R. Reitz, F.J. Milford & R.W. Christy (Narosa Publication House 3rd edition 1993)
3. **Classical Electrodynamics** – J. D. Jackson (Wiley Eastern 2nd edition)
4. **Classical Electrodynamics** –S. P. Puri (Tata McGraw Hill 1990)
5. **Electromagnetics -** Laud B. B. - New Age International Private Limited; 3rd edition

M.Sc. (Physics) (Semester-II)
Course Code: CC-204
Total Credits: 4-credits
Paper title: Atomic & Molecular Physics

Atomic & Molecular Physics

Unit - I: Atomic Spectra (15)

Quantum states of an electron in an atom, electron spin, spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, ll-coupling, ss-coupling, LS or Russell - Saunder's coupling; the Pauli exclusion principle, Coupling schemes for two electrons, Γ- factors for LS coupling, Lande interval rule, jj coupling, branching rules, selection rules, Intensity relations.

Unit - II: Effect of magnetic and electric field on atomic spectra (15)

The magnetic moment of the atom, Zeeman effect for two-electrons, Intensity rules for Zeeman effect, Paschen-Back effect for two electrons, Stark effect of hydrogen, weak field Stark effect in hydrogen, strong field Stark effect in hydrogen, origin of hyperfine structure, Inner shell vacancy, X- ray and Auger transitions, Compton effect.

Unit - III: Molecular spectra (15)

Molecular physics – covalent, ionic and Vander Waal's interaction, Classification of molecules: linear, symmetric tops, spherical tops, asymmetric tops; rotational spectra: the rigid diatomic molecule, the non rigid rotator, spectrum of a non-rigid rotator, techniques and instrumentation of microwave spectroscopy, chemical analysis by microwave spectroscopy, the vibrating diatomic molecule: the energy of a diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating-rotator, vibrational rotational spectra, techniques and instrumentation of infra-red spectroscopy, chemical analysis by infra-red spectroscopy.

Unit - IV: Electronic, Nuclear and Raman spectra (15)

Revision on electronic spectra of diatomic molecules, electron spins resonance, nuclear magnetic resonance, chemical shift. Frank-Condon principle, dissociation energy and dissociation products, rotational fine structure of electronic-vibration, transitions. Born-Oppenheimer approximation, separation of electronic and nuclear motions in molecules, band structures of molecular spectra. Raman spectra: Pure rotational Raman spectra, vibrational Raman spectra, polarization of light and Raman effect, techniques and instrumentation of Raman spectroscopy.

Reference books

1) Introduction to Atomic Spectra – H.E. White, Mac-Graw Hill (1934).

2) Fundamentals of Molecular Spectroscopy, 4th Edition. – C.N. Banwell, Tata MacGraw Hill (2008).
3) Molecular Structure and Spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd. Spectra of diatomic Molecules, Vol. I – G. Herzberg, N.J.D. van Nostrand (1950).
4) Spectroscopy, Vol. I, II and III – B.P. Straughan and S. Walker, Chapman and Hall (1976).
5) Introduction to Molecular Spectroscopy – G.M. Barrow, MacGraw Hill (1962).
6) Molecular Spectroscopy – J.M. Brown, Oxford University Press (1998).

M. Sc. I (Physics) Semester I
Course Code: CCPR-105(i)
Paper title: Physics LAB-I
Total Credits: 4-credits

Laboratory/ Practical Course-I (two experiments and certified journal-4-credits)

1. Hall effect (Hall coefficient & carrier concentration of semiconductor).
2. Linear Variable Differential Transducer.
3. Crystal structure identification by Neutron diffraction pattern.
4. Wavelength of given source by using Fabry-Parrot etalon.
5. Crystal structure identification by X- ray diffraction pattern.
6. Structure identification of given samples (F.C.C.& B.C.C.)
7. Monatomic/ diatomic lattice vibrations using lattice dynamics kit.
8. Characteristic of Temperature Transducers (Thermocouple, Thermister and IC sensor)
9. Specific heat capacity of given metals.
10. Staircase Ramp Generator using UJT
11. Negative feedback amplifier (with and without feedback)
12. Astable multivibrator
13. Monostabel multivibrator.
14. Stefan’s constant.
15. Magnetic parameters of given sample using B-H curve kit
16. Thermal & electrical conductivity of copper.
17. Numerical, algebraic and trigonometric problems using Mathematica.
18. Analysis of statistical data.

19. Numerical differentiation using Python.
20. Numerical integration using Python.
21. Physical density of material by using Archimedes's Principle.

M.Sc. (Physics) (Semester-I) **Course Code:** CCPR-105(ii) **Paper title:** **Physics LAB-II Total Credits:** 4-credits

Laboratory/ Practical Course-II (Seminar & certified seminar report 2-credits +Tutorials on practical 2-credits)

M.Sc. (Physics) (Semester-II)
Course Code: CCPR-205(i)
Total Credits: 4-credits
Paper title: Physics LAB-III

Laboratory/ Practical Course-III (two experiments and certified journal-4-credits)

1. Fourier analysis.
2. Transmission characteristics of passive filters.
3. I-V characteristics of solar cell.

4. A. C. bridges (Maxwell, Anderson and De-Sauty bridge)
5. Thermal diffusivity of brass.
6. Mutual inductance of given coil.
7. Series & parallel resonant LCR circuits.
8. Young’s modulus of a beam by flexural vibration created by frequency generator.
9. 2D and 3D plots using Mathematica.
10. Band gap energy of semiconductor.
11. Resistivity of given semiconductor sample using four probe method.
12. Thermoelectric Power
13. Magnetic field variation as a function of resonance frequency using ESR.
14. Crystal structure of thin film by using given XRD data.
15. Rydberg constant.
16. Dissociation energy of iodine molecule.
17. Magnetic susceptibility of ferric chloride solution.
18. Plank’s constant using photocell.
19. Numerical solutions of simple first order differential equation using Python (Euler and Runge - Kutta 4^{th} order method)
20. Plotting simple functions using Python.
21. Plotting of simple graphs using origin software .
22. Crystallite size by Debye- Scherrer Formula (**$D=0.9\lambda/\beta \cos\theta$).**

M.Sc. (Physics) (Semester-I)
Course Code: CCPR-105(ii)
Paper title: Physics LAB-IV
Total Credits: 4-credits
Laboratory/ Practical Course-IV (Seminar & certified seminar report 2-credits +Tutorials on practical 2-credits)

Nature of Question Paper

Theory: Time -3 hours, Marks-80

Instructions: **1) Question No.1 is compulsory.**

2) Attempt any four questions from Q.2 to Q.7

Question 1: Answer in Short (8 short questions –each having -2 Marks) - 16 marks

Question 2 a) Long Answer question for - 12 marks

b) Short answer questions for - 4 marks

Question 3 a) Long Answer question for - 12 marks

b) Short answer questions for - 4 marks

Question 4 a) Long Answer question for - 12 marks

b) Short answer questions for - 4 marks

Question 5 a) Long Answer question for - 12 marks

b) Short answer questions for - 4 marks

Question 6 a) Long Answer question for - 12 marks

b) Short answer questions for - 4 marks

Question 7 a) Long Answer question for - 12 marks

b) Short answer questions for - 4 marks

Note: Equal weightage should be given to each unit.