"Education for Knowledge, Science, and Culture"
- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

KOLHAPUR (AUTONOMOUS)

Department of Physics (2018-19)

M.Sc. (Physics) (Part-I)

CORE PAPER (COMPULSORY)-(CP)

M.Sc. (Physics) Part -I Semester-I (Total Credits = 24)		
Paper Code	**Paper Title**	**Credits**
CP-1100A	Mathematical methods of Physics	4
CP-1101A	Classical Mechanics	4
CP-1102A	Quantum Mechanics I	4
CP-1103A	Condensed Matter Physics	4
CPPR-1104A(Practical Lab-I)	Laboratory/ Practical Course-I	4
CPPR-1105A (Practical Lab-II)	Seminar +Tutorials on practical Course-I	4
M.Sc. (Physics) Part -I Semester-II (Total Credits = 24)		
Paper Code	**Paper Title**	**Credits**
CP-1106B	Quantum Mechanics-II	4
CP-1107B	Statistical Mechanics	4
CP-1108B	Electrodynamics	4
CP-1109B	Atomic & Molecular Physics	4
CPPR-1110B(Practical Lab-III)	Laboratory/ Practical Course-II	4
CPPR-1111B(Practical Lab-IV)	Seminar +Tutorials on practical Course-II	4

Paper title: Mathematical methods of Physics

Course Outcomes:

After the completion of course, the student could able to:

CO-1) Well-versed with the Matrices.

CO-2) Understand the elementary ideas and have acquired facility with numerical tools for solving mathematical problems in Complex Variables.

CO-3) can understand the complications associated with the Fourier Series and Transform

CO-4) Learn about the concept of some special functions, Frobenius power series and polynomials

Paper title: Classical Mechanics

Course outcomes:

After the completion of course, students will attain

CO-1). Understanding of Mechanics and Lagrange's and Hamilton's theory.

CO-2). Gain basic knowledge of Canonical Transformation and Special Relativity and the evolutionary significance of it.

CO-3). Students develop important basic understanding about overall Mechanics.

CO-4) Learn about the concept of Lagrange's and Hamilton's theory.

Paper title: Quantum Mechanics-I

Course outcomes:

After the completion of course, students will attain

CO-1) Students would understand basic concepts in the Origin and general formalism and representation of states and quantum dynamics.

CO-2) Students develop theoretical knowledge of Angular Momentum operator

CO-3) Students develop important basic understanding about time independent perturbation theory, and its applications.

CO-4) Learn about the concept of various aspects of quantum theory

Paper title: Condensed Matter Physics

Course outcomes:

Upon completion of the course, students will be able to:

CO-1) Understand and describe various crystal structures in crystallography.

CO-2) Describe and understand fundamental concepts of crystal defects.

CO-3) Discuss different aspects of Dielectric, Magnetism & Superconductivity.

CO-4) Assess and critique Semiconductor theory, semiconductor materials, which will eventually lead to a general framework of concepts applicable across a variety of semiconductordevices.

Paper title: Quantum Mechanics-II

Course outcomes:

At the end of the course, students will be able to:

CO-1) The fundamental understanding of the time dependent perturbation and scattering theory.

CO-2) A thorough understanding of the fundamentals of the quantum theory of radiation.

CO-3) Student will learn about quantum computation, Paradoxes of entanglement.

CO-4) Learn about the concept of various aspects of quantum theory

Paper title: Statistical Mechanics

Course outcomes:

After the completion of course, students will be able to,

CO-1) Students learn the classical statistical tools as required for analyzing research data.

CO-2) Students gained an understanding about classical statistics.

CO-3) Students gained an understanding about Quantum statistics.

CO-4) Students gained an understanding about problem solutions regarding classical Quantum statistics.

Paper title: Electrodynamics

Course outcomes:

At the end of the course, students will be able to:

CO-1) The fundamental understanding of the Maxwell's equations and propagation of plane electromagnetic wave

CO-2) Better understanding of the Time dependent potentials and fields

CO-3) The student shall gain a sound understanding of Electromagnetic fields and Radiations

CO-4) The student shall gain a sound understanding of the Relativistic mechanics and covariance

Paper title: Atomic and Molecular Physics

Course outcomes:

At the end of the course, students will be able to:

CO-1) The fundamental understanding of the atom Model for two valance electron.

CO-2) Better understanding of the Zeeman and Paschen-Back Effect

CO-3) The student shall gain a sound understanding of the basics of Microwave

CO-4) The student shall gain a sound understanding of the basics Infra-RedSpectroscopy

M.Sc. (Physics) (Semester-I)Paper Code: CP-1100A
Paper title: Mathematical PhysicsTotal Credits: 4-credits

Unit 1. Matrices [15]

Mathematical Physics

Matrix multiplication – Inner product, direct product, Diagonal matrices, trace, matrix Inversion, Gauss-Jordon Inversion, Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors, Cayley-Hamilton Theorem and applications, similar matrices and diagonalizable Matrices, functions of matrices, Quadratics forms.

Unit 2. Complex Variables [15]

Limits and continuity of complex functions, Derivatives and analytic functions, Cauchy-Riemann conditions, Line integrals in the complex plane, Cauchy Integral theorem and Cauchy integral formulas, Singularities- Poles, Branch Points, Calculus of Residues-Residues Theorem, Cauchy Principle value, Pole Expansion of Meromorphic Functions, Product expansion of entire functions.

Unit 3. Fourier Series and Transform [15]

Definition, Evaluation of Coefficients of Fourier Series (Cosine and Sine Series), Dirichelet's Theorem, Graphical representation of a square wave function, Extension of interval, Complex form of Fourier Series, Properties of Fourier Series (Conversions, Integration, Differentiation, Parseval's Theorem), Fourier Integral- exponential form, Applications of Fourier Series analysis in Physics (Square wave, Full wave rectifier, Expansion of Raman Zeta function).

Unite 4. Special Functions [15]

Frobenius power series method, Legendre differential equation (Rodrigues' formula for Legendre polynomials, generating function, Orthogonality of Legendre polynomials), Hermite differential equation (Rodrigues' formula for Hermite polynomials, generating function, Orthogonality of Hermite polynomials), Laguerre differential equation ((Rodrigues' formula for Laguerre polynomials, generating function, Orthogonality of Laguerre polynomials))

Text Books and References:

1. Mathematical Methods, H.K. Das
2. Mathematical Methods, Rajput
3. Mathematical Methods for Physicists, Arfken and Weber
4. Mathematical Methods for Physicists, Tai Chow

M.Sc. (Physics) (Semester-I)
Paper Code: CP-1101A
Paper title: Classical Mechanics
Total Credits: 4-credits

Classical Mechanics

Unit-I- Mechanics (15)

Mechanics of a system of particles in vector form. Conservation of linear momentum, energy and angular momentum. Degrees of freedom, generalised coordinates and velocities. Lagrangian, action principle, external action, Euler-Lagrange equations. Constraints. Applications of the Lagrangian formalism. Generalised momenta, . Legendre transform, relation to Lagrangian formalism. Phase space, Phase trajectories. Applications to systems with one and two degrees of freedom

Unit-II-Lagrange's and Hamilton's theory: (15)

Configuration space, techniques of calculus of variation, Applications of the variational principle. Hamiltonian principle, Equivalence of Lagrange's and Newton's Equations, Lagrange's Equation for non-Holonomic systems, Hamilton's equations of motion, Hamilton's applications-Simple pendulum, Charged particle in an electromagnetic field.

Unit-III-Canonical Transformation ; (15)

Guge transformation, Canonical transformation- it's conditions and illustration. Poisson Bracket-canonical equations in terms of Poisson bracket notation, Hamiltonian Jacobi Equations, Separation of Variables-Kepler's problem: solution by Hamilton-Jacobi method. Examples.

Unit-IV- Special Relativity :

Review of Frame of reference, and Newtonian relativity, Gallelian transformation equation, Principal and postulates of special theory of relativity, Lorentz transformation equations, Length contraction, Time dilation, Relativity of simultaneity, Addition of velocities, Variation of mass with velocity, Mass energy equivalence, Minkowskis four dimensional space time continuum, Energy-momentum four-vector for a particle. Relativistic invariance of physical laws. Gravitational Red shift,

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

M.Sc. (Physics) (Semester-I)
Paper Code: CP-1102A
Paper title: Quantum Mechanics
Total Credits: 4-credits

Quantum Mechanics – I

Unit 1: **(15)**

Origin and general formalism

Inadequacy of classical physics (origin of quantum mechanics), sequential Stern-Gerlach experiment, analogy with polarization of light, linear vector space, linear operator, eigenfunction and eigen values, Hermitian operator

Unit 2: **(15)**

Representation of states and quantum dynamics

Postulates of quantum mechanics , Diracs bra and ket notation, equation of motion, schrodinger representation, Heisenberg representation, momentum representation.

Unit 3: **(15)**

Angular Momentum

Angular momentum operator, angular momentum commutation relations, Eigen values of J^2 J_Z , angular momentum matrices, spin angular momentum , addition of angular momenta, computation of clebsch- Gorden coefficients in simple cases(J_1=1/2, J_2=1/2)

Unit 4: **(15)**

Approximation methods I

Time independent perturbation theory, non degenerate and degenerate case, first and second perturbations, applications- anharmonic oscillator ,stark effect, hydrogen like atoms: fine structure and Zeeman effect

Reference Books:

1)Quantum mechanics by G.Aruldhas
2)Modern Quantum mechanics by J. J. Sakhurai
3)Quantum mechanics by L.I. Schiff
4)Introduction to quantum mechanics by David J. Griffith
5)Quantum mechanics by Nouredine Zettilli

M.Sc. (Physics) (Semester-I)
Paper Code: CP-1103A
Total Credits: 4-credits
Paper title: Condensed Matter Physics

Condensed Matter Physics

Unit-I:

Crystallography: (15)

Bonding in Solids-Ionic, Covalent and Metallic. Crystalline state of solids, Bravai's lattices and crystal structure , Symmetry elements(cubic),coordination number and packing fraction. Crystal structures-CsCl, ZnS, and diamond,Brag's law in reciprocal lattice, Brillouin zones, Comparison between X-Ray, Electron and Neutron diffraction, Field ion microscopy-Principal, working and applications

Unit-II:

Crystal defects: (15)

Point defects-Vacancies, Interstitisials, impurities, electronic, Expression for Schottky and Frenkel defects Line defects-Edge and screw dislocation, Interpretation of SGP (Plastic deformation) Burgur's vector and circuit, Frank-Read mechanism. Planer defects, Surface defects- Grain boundaries, Tilt boundaries, Twin boundaries, Effect of Imperfections

Unit-III

Dielectric, Magnetism & Supercondivity: (15)

Dielectric-Polarisation mechanism, Dielectric constant, Clausis-Mossoti relation, Magnetism-Comparison between dia, para,and feromgnetism ,Exchange interaction. Magnetic order(Fero,Antifero and ferri), Weiss theory of magnetism Superconductivity- High Tc superconductors, BCS theory of superconductors ,SQUID

Unit-IV **(**15)

Semiconductor theory and devices:

Energy band gap, Determination of Band gap energy, intrinsic and extrinsic semiconductors, carrier concentration, fermi level and conductivity for intrinsic and extrinsic semiconductor. Review of UJT, switching characteristics of UJT , SCR- construction and working, switching characteristics.

Reference Books:

1. Introduction to solid state physics - C. Kittel, 8thedn, 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, 2ndedn. Springer International(1994)
7. Solid State Physics – J. S. Blakemore, 2ndedn. Cambridge University Press(1985)
8. Solid State Physics-R.K.Puri, V.K.Babar- S.Chand.

M.Sc. (Physics) (Semester-II)
Paper Code: CP-1106B
Paper title: Mathematical Physics
Total Credits: 4-credits
Paper title: Atomic and Molecular Physics

Unit I: The atom Model for Two Valance Electron (15)
Revision of atomic structure and atomic spectra, Origin of spectral lines, General selection rules, Fine structure, Hyperfine Structure, Quantum numbers, Pauli's 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: Zeeman Effect, Paschen-Back Effect (15)
The magnetic moment of the atom, Zeeman Effect for two electrons, intercity rules for Zeeman Effect, Paschen-Back effect for two electrons, Principle of resonance Spectroscopy
*ESR-Principle, ESR Spectrometer, Hyperfine structure, Total Hamiltonian
*NMR-Nuclear magnetic properties, Resonance condition of nucleus, NMR instrument, Relaxation process, Chemical shift, NMR applications

Unit III: Microwave Spectroscopy (15)
Classification of molecules: linear, symmetric tops, spherical tops, asymmetric tops; rotational spectra: the rigid diatomic molecule, The non- rigid rotator, spectrum of non-rigid rotator, Techniques and instrumentations of microwave spectroscopy, chemical analysis by Microwave spectroscopy

Unit IV: Infra-Red Spectroscopy (15)
Spectroscopic characterization, Principle, Instrumentation, Working, Applications, The vibrating diatomic molecule: the energy of a diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating-rotator, techniques and instrumentation of infra-red spectroscopy.

Books:
1) Introduction to Atomic Spectra- H.E.White, Mac-Graw Hill (1934)
2) Fundamentals of Molecular spectroscopy, 4th Edition-C.N.Banwell, Tata Mac-Grew Hill (2008)
3) Molecular structure and spectroscopy, G.Aruldhas, PHI Learning Pvt.Ltd, Spectra of Diatomic Molecules, Vol.I-GHerzberg, N.J.D.van Nostrand (ESR=Article11.1 to 11.5, NMR=Article 10.1 to 10.7)
4) Introduction to Molecular spectroscopy-G.M.Barrow, MacGraw Hill (1962)
5) Molecular Spectroscopy- J.M.Brown, Oxford University Press (1998)

M.Sc. (Physics) (Semester-II)
Paper Code: CP-1107B
Total Credits: 4-credits
Paper title: Quantum Mechanics-II

Quantum Mechanics-II

Unit 1.

Time Dependent Perturbation Theory (15)

Time dependent potentials, Time dependent Perturbation theory, Applications to interactions with the classical radiation field, energy shift and decay width, Adiabatic Approximation.

Unit 2.

Scattering Theory (15)

The Lippmann-Schwinger equation, The Born approximation, Optical Theorem, Eikonal approximation, Free particle states, Partial wave formalism, Low energy scattering and bound states, Resonances, Scattering of identical particles, Symmetries in scattering, Time-dependent formulation of scattering, Inelastic electron-atom scattering, Coulomb scattering.

Unit 3.

Quantum Theory of Radiation (15)

Classical Theory of fields, classical radiation field, creation and annihilation operators, quantization of radiation field, Emission and absorption of photons by atoms.

Unite 4.

Quantum Computation (15)

Paradoxes of entanglement (EPR paradox, Bohm Paradox), Instantaneous communication, Factorization of the evolution kernel, entanglement entropy, The Bell inequalities, Quantum computation.

Text Books and References:

1. Modern Quantum Mechanics, J. J. Sakurai
2. Introduction To Quantum Mechanics, D. Griffiths
3. Quantum Mechanics-Concepts and Applications, N. Zettili
4. Quantum Mechanics, Steven Weinberg

M.Sc. (Physics) (Semester-II)
Paper Code: CP-1108B
Total Credits: 4-credits
Paper title: Statistical Mechanics

Statistical Mechanics

Unit-I-

Classical statistics-I (15)

Statistical description of system of particles, Phase space, Phase space diagram of an oscillator, Volume in phase space, Phase space cells in harmonic oscillator and three dimensional free particle.

Concept of ensembles, Ensemble average and its uses Liouville's theorem-principal of conservation of density in phase space and extension in space. Condition for stastical and thermal equilibrium.

Statistical interpretation of thermodynamic variables- Energy, work pressure, and entropy.

Unit-II-

Classical statistics-II (15)

Microcanonical ensemble and its implication in practical use, Perfect gas in Microcanonical ensemble – internal energy, entropy,

Canonical ensemble, derivation of canonical distribution (alternative method) probability density, partition and thermodynamic function for canonical ensembles. Perfect monoatomic gas in canonical ensemble

Grand Canonical ensemble-Partition function and thermodynamics, Perfect gas in Grand canonical ensemble.Comparison between Microcanonical, canonical and Grand canonical.

Unit-III-

Quantum Statistics-I (15)

Density Matrix, Liouville's theorem in quantum statistical mechanics, condition for statistical equilibrium. The Boltzman limit of Boson and Fermion gases, Evaluation of partition function . Ideal Bose system-Photon gas, Bose Einstein condensation, Liquid Helium-Landau's theory.

Unit-IV-

Quantum Statistics-II (15)

Ideal Fermi gas systems-energy and pressure of the gas, slight and strong degeneracy, free electron model, white dwarfs. Phase transition and phase diagram. Clausis-Clapeyron equation, Second order phase transition-Ferromagnetic materials .Transport phenomenon-Electrical and thermal conductivity. Thermionic emission. Photoelectric effect, Effusion, Diffusion, Einstein's relation for mobility.

Reference Books.

1)Statistical Mechanics- Gupta Kumar Pragati Prakashan- Merrut.
2)Statistical Mechanics- R.K.Pathria and PaulD. Beale-Elsevier
3)Fundamentals of Statistical Mechanics- B.B.Laud,New age International Publisher.
4)Statistical Mechanics theory and applications J.K.Sinha, Tata McGraw Hill
5) Fundamentals of Statistical and Thermal Physics-F.Reif, McGraw Hill international Edition(1985)
6) Statistical Mechanics Satya Prakash and Kedarnath Ram, Nath Publication (2008)
7) Statistical physics, L D Landu and EM Lifshitz
8) A text book of Statistical Mechanics- Suresh Chnadra-CBS publishers.

M.Sc. (Physics) (Semester-II)
Paper Code: CP-1109B
Total Credits: 4-credits
Paper title: Electrodynamics

ELECTRODYNAMICS

UNIT I

- Maxwell's equations and propagation of plane electromagnetic wave (15)

The Maxwell's equations, Maxwell's equations in free space, energy in electromagnetic field, Pointing vector (Poynting theorem); propagation of electromagnetic waves; electromagnetic waves in free space ;propagation of plane electromagnetic wave in matter; electromagnetic waves in free space ;propagation of plane electromagnetic wave in isotropic dielectric; plane electromagnetic waves in anisotropic dielectric:

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;Field due to charge in arbitrary motion

UNIT III –

Electromagnetic fields and Radiations (15)

Electric and magnetic fields of a charge in uniform rectilinear motion ; Radiation due to Relativistic and nonrelativistic charges;Directions of maximum and minimum radiation in case of linear accelerators; Cerenkov radiations; radiating systems; radiation due to an oscillating electric dipole; radiation due to a small current element

UNIT IV :

Relativistic mechanics and covariance (15)

Experimental basis for Special theory of relativity(Michelson Morley experiment); Lorentz transformations; Relativistic velocity addition; Four vector potential vector electromagnetic field tensor ;Lorentz force on charged particle

References books:

1) Classical electrodynamics – J.D.JACKSON (3rd edition)
2) Electrodynamics - KUMAR,GUPTA ,SINGH
3) Electrodynamics - B.B.LAUD (Willey Eastern)
4) Matrices and Tensors in Physics - A.W.JOSHI ; 3rd edition New age International
5) Classical electrodynamics – S.P.PURI (Tata Mcgraw Hill 1990)