**PAPER-II**

# ଓଡିଆ ସାହିତ୍ୟର ବିଶେଷ ଅନୁଶୀଳନ

ୟୁନିଟ – I : ସାରଳା ଦାସ, ବଳରାମ ଦାସ, ଜଗନ୍ନାଥ ଦାସ, ଅଚ୍ୟୁତାନନ୍ଦ ଦାସ ।

ୟୁନିଟ – II : ବତ୍ସା ଦାସ, ନାରାୟଣାନନ୍ଦ ଅବଧୂତ ସ୍ୱାମୀ, ମାର୍କଣ୍ଡ ଦାସ, ଦେବଦୁର୍ଲ୍ଲଭ ଦାସ ।

ୟୁନିଟ – III : ଦୀନ କୃଷ୍ଣ ଦାସ, ଉପେନ୍ଦ୍ର ଭଞ୍ଜ, ଅଭିମନ୍ୟୁ ସାମନ୍ତସିଂହାର, ବଳଦେବ ରଥ ।

ୟୁନିଟ – IV : ବ୍ରଜନାଥ ବଡଜେନା, ଗୋପାଳ କୃଷ୍ଣ, ବନମାଳୀ, ଭୀମ ଭୋଇ ।

ୟୁନିଟ – V : ଫକୀର ମୋହନ, ରାଧାନାଥ ରାୟ, ମଧୁସୂଦନ ରାଓ, ରାମଶଙ୍କର ରାୟ ।

ୟୁନିଟ –VI : ଗଙ୍ଗାଧର ମେହେର, ବିଶ୍ୱନାଥ କର, ନନ୍ଦକିଶୋର ବଳ୍, ନୀଳକଣ୍ଠ ଦାସ ।

ୟୁନିଟ–VII: କାଳନ୍ଦୀ ଚରଣ ପାଣିଗ୍ରାହୀ, କାଳୀଚରଣ ପଟ୍ଟନାୟକ, ସଚ୍ଚି ରାଉତରାୟ, ଗୋଦାବରୀଶ ମହାପାତ୍ର ।

ୟୁନିଟ –VIII : ଗୋପୀନାଥ ମହାନ୍ତି, ସୁରେନ୍ଦ୍ର ମହାନ୍ତି, ବିନୋଦ ଚନ୍ଦ୍ର ନାୟକ, ଗୁରୁପ୍ରସାଦ ମହାନ୍ତି ।

# Physics

**PAPER– I**

**Unit-I : Mathematical Physics**

1. Complex variable :
   Cauchy's theorem, Cauchy's integral formula, classification of singularities, branch point and branch cut, Residue theorem, evaluation of integral using residue theorem.

2. Special functions :
   Basic properties and solutions (series expansion, recurrence and orthogonality relations) of Bessel, Legendre, Laguerre functions, Solution of inhomogeneous partial differential equation by method of Green's function.

3. Group theory :
   Definitions, isomorphism and homomorphism, point group, group representation, reducible and irreducible representation, Lie group and Lie algebra with SU(2) and 0(3).

4. Tensors:
   Cartesian tensors, covariant, contravariant and mixed tensor, tensor algebra, properties of symmetric and anti symmetric tensor Levi Civita and metric tensor.

**Unit-II: Classical Mechanics**

1. Hamilton's principle:
   Hamilton's principle, Lagrange's equation from Hamilton's principle,Solution of Lagrange equation of motion for Simple harmonic oscillator. Hamilton' equations of motion, canonical equations from variational principle, principle of least action
2. Canonical transformation:
   Generating function and Legendre transformation, Integral invariant of Poincare, Lagrange and Poisson's brackets, infinitesimal canonical transformation, conservation theorems in Poisson bracket formalism, Jacobi Identity.
3. Rigid body:
   Independent coordinates, orthogonal transformation and rotations (finite and infinitesimal), Euler's angles, Euler's theorem on the motion of rigid body, Inertia Tensor and principal axis transformation, angular momentum and kinetic energy of rotation in terms of Euler's angles. Euler's equation of motion, torque free motion of rigid body,heavy symmetrical top with one point fixed. , motion in a non inertial frame of reference, Coriolis force
4. Small oscillation:
   Theory of small oscillation, Normal modes and normal frequencies, application to tri atomic molecules.
5. Hamilton-Jacobi theory:
   Hamilton-Jacobi equation for Hamilton's principal function, Harmonic oscillator problem, Hamilton's Characteristic function, Action angle variable and its application to Kepler's problem.

**Unit-III: Classical Electrodynamics**

1. Electrostatics and Magnetostatics:
   Scalar and vector potential, Gauge transformation, multiple expansion of (i) scalar potential and electrostatic energy due to static charge distribution, (ii) vector potential due to stationary current distribution, Electrostatic and magnetostatic energy, Poynting 's theorem, Maxwell's stress tensor,
2. Relativistic electrodynamics:
   Equation of motion in an electromagnetic field, electromagnetic field tensor, covariance of Maxwell's equation, Maxwell's equations as equations of motion, Lorentz transformation laws for electromagnetic field, and the fields due to point charge in uniform motion, Field invariants , covariance of Lorentz force equation of motion, and equation of motion of a charged particle in an electromagnetic field, Energy momentum tensor and conservation laws for electromagnetic field, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.
3. Dispersion:
   The oscillator model and dispersion in dielectric and conductors, anomalous dispersion and resonant absorption, Krammer- Kroning dispersion relation.

4. Radiation, scattering and Diffraction:
   Field due to localized oscillating source, electric dipole,magnetic diapole, electric quadrupole field radiation, centre-fed linear antenna with sinusoidal current,scattering by a small dielectric sphere in long wave length limit, Raleigh scattering,

5. Radiation from moving Charge:
   Lienard Wiechert potential, Field due to a charge moving with velocity, field due to accelerated charge, radiation at low velocities, total power radiated by the accelerated charge, Larmor 's formula and its relativistic generalization, angular distribution of radiation from an accelerated charge, Thomson scattering.

**Unit-IV: Quantum Mechanics-I**

1. Wave packet:
   Gaussian wave packet, spreading of wave packet, coordinate and momentum representation, **x** and **p** in these representation, Dirac delta function,
2. Operator method in Quantum Mechanics:
   Formulation of Quantum Mechanics in vector space language, uncertainty product of two arbitrary operators, one dimensional harmonic oscillator by operator method.
   Matrix representation of operators, Schrodinger, Heisenberg and interaction pictures. Dirac bracket notation.
3. Three dimensional potential well, Fermi energy, Radial solution of Hydrogen atom and its total wave function .
4. Symmetry , invariance principle and conservation Laws:
   Space translational invariance , time translational invariance and rotational invariance and conservation laws.
5. Angular momentum:
   Angular momentum algebra, addition of two angular momenta $j_1=1/2$, $j_2=1/2$. Clebsch–Gordon Coefficients, examples, matrix representation of $j_1=1/2$ and $j_2=1$. Spin angular momentum, Pauli spin matrices and their properties, eigen value and eigen function,
6. Approximation methods:
   Time independent perturbation theory, First and second order correction to energy and eigen functions, Degenerate perturbation theory, application to one electron system, relativistic mass correction, Spin-Orbit coupling, Zeeman effect, linear Stark effect. Fine structure of spectral line of H-like atom

**Unit-V: Statistical Mechanics**

1. Objectives of Classical Statistical Mechanics:
   Microstates, macro states, phase space, Liouville's theorem, concept of ensembles, Ergodic hypothesis, postulates of equal a priory probability, Boltzmann's postulates of entropy, micro canonical ensemble, entropy of ideal gas, Gibb's paradox, Sakur-Tetrode equation,
2. Canonical ensemble:
   Expression for entropy, canonical partition function, Helmholtz free energy, energy fluctuation,

3. Grand canonical ensemble:
   Grand canonical partition function, chemical potential, density fluctuation, chemical potential of an ideal gas,
4. Quantum Statistical Mechanics:
   Density matrices for micro canonical, canonical and grand canonical ensembles, B-E and F-D distribution. Equation of states for B-E system, Bose condensations, Planck's law of black body radiation, equation of state for ideal Fermi gas at low density-high temperature and at high density-low temperature, theory of white dwarf star, relation between chemical potential and Fermi energy,

5. Phase Transition:
   First and second order phase transition in matter, Landau theory of phase transition and its application to ferromagnetism.

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**Unit-I :Quantum Mechanics-II**

1. WKB Approximation:
   Connection formulae, Bohr quantization rule, barrier penetration and α-decay,
2. Variational method:
   He atom as an example, First order perturbation, exchange degeneracy.
3. Time dependant perturbation theory:
   Interaction picture, Transition probability, constant and harmonic perturbation, Fermi Golden Rule, electric dipole radiation, selection rule, Spontaneous emission, Einstein's A and B coefficients, Principle of Laser
4. Scattering theory:
   Laboratory and center of mass system, differential and total scattering cross section, scattering amplitude, scattering by spherically symmetric potential, Partial wave analysis and phase shift, scattering by rigid sphere and square well, Coulomb scattering, Formal theory of scattering, Green's function in scattering theory, Born approximation,
5. Symmetry and Conservation laws:
   space and time translational invariance, rotational invariance of the dynamical systems, Discrete symmetries- space reflection, charge conjugation and time reversal symmetries..
6. Identical Particles:
   Symmetric and anti-symmetric wave functions, Slater determinant, symmetric and anti-symmetric wave functions of two identical spin ½ particles.

**Unit-II: Relativistic Quantum Mechanics and Field theory**

1. Klein-Gordon Equation:
   Klein-Gordon equation and its drawback, need for a relativistic equation.
2. Dirac Equation:
   Dirac equation, properties of Dirac γ-matrices,Non-relativistic reduction of Dirac equation,magnetic moment of electron, Spin-Orbit coupling, Covariance of Dirac equation and bilinear covarints.

3. Solution of Dirac Equation:
   Free particle solution of Dirac equation and its physical interpretation, projection operator for spin and energy,Zitterbewegung, Hole theory.
4. Symmetry in Dirac equation:
   Charge conjugation, space reflection, time reversal symmetries of Dirac equation, Continous systems and fields, transition from discrete to continous systems, Lagrange and Hamiltonian formulation, Noether's theorem.
5. Quantization of Free field:
   Second quantization, covariant quantization of electromagnetic field, quantization of neutral scalar field and Dirac field.

**Unit-III : Electronics**

1. Amplifiers:
   Frequency response of linear amplifier, amplifier pass band, R-C, L-C and transformer coupled amplifier, feed back amplifier, book-strapping the FET, stability, noise
2. Operational amplifier: differential and integral amplifier,input and out put impendance, summing integrating and differentiating amplifier, comparators
3. Oscillators:
   Feedback criteria for oscillation, phase shift, Wien bridge, crystal controlled and Klystron oscillators, multi vibrators- astable, monostale and bistable
4. Digital Circuits:
   Logic fundamentals, Boolean theorem, Logic gates-RTL,DTL,TTL, RS flip-flop, JK flip-flops
5. Boolean algebra, De Morgan theorem, AND,NAND,NOT,NOR gates(CMOS,NMOS), MOS circuits, two phase inverter, dynamic MOS shift register.

**Unit-IV: Condensed Matter Physics**

1. Bragg-Laue formulation of X-ray diffraction, , atomic and crystal structure, Electron and neutron diffraction by crystal, binding in solids,inert gas solids,ionic crystals, covalent bond.
2. Lattice Dynamics:
   Classical theory of lattice vibration under harmonic approximation, vibration of linear mono atomic and diatomic lattices, acoustical and optical modes, optical properties of ionic crystal in the infrared region, normal modes and phonon, inelastic scattering of neutron by phonon, lattice heat capacity, models of Debye and Einstein, An-harmonic effects in crystals-thermal expansion and thermal conductivity.

3. Free Electron Theory:
   Free electron theory of metal,one dimensional infinite potential well. electron gas in three dimension, density of states, electronic specific heat, electrical conductivity and Wiedeman-Franz law, Hall effect, cyclotron resonance.
4. Band Theory of Solid:
   Bloch equation, empty lattice band, nearly free electron bands, no of states in band, tight binding method, effective mass of electron in the band, concept of holes, classification of metal, semiconductor and insulator, intrinsic and extrinsic semiconductors, intrinsic carrier concentration,

5. Dielectric Properties of solids:
   Electronic and ionic polarization of molecules, static dielectric constants of gases, Lorentz internal fields, static dielectric constant of solids, classical theory of electronic polarization and optical absorption, Clausius-Mossotti equation, elementary idea of ferroelectricity.
6. Magnetic Properties of Solids:
   Origin of Magnetism, quantum theory of diamagnetism, paramagnetism, Pauli Paramagnetism, Ferromagnetism, Curie-Weiss law, ferromagnetic domain , ferri and anti ferromagnetism,

7. Superconductivity:
   Phenomenological description of superconductivity, Meissner effect, Type-I and type-II superconductors, London's equation, outlines of BCS theory, High T_c superconductor.

**Unit-V: Nuclear and Particle Physics**.

1. Nuclear Properties:
   Basic nuclear properties: nuclear size, nuclear radius and charge distribution, nuclear form factor, mass and binding energy, Angular momentum, parity and symmetry, Magneticdipole moment and electric quadrupole moment,
2. Two body bound state;
   Properties of deuteron, Schrodinger equation and its solution for ground state of deuteron, rms radius, spin dependence of nuclear forces, electromagnetic moment and magnetic dipole moment of deuteron and the necessity of tensor forces.
3. Two-body scattering:
   Partial wave analysis and phase shifts, scattering length,
   magnitude of scattering length and strength of scattering, Significance of the sign of scattering length; Eeffective range theory, low energy p-p scattering, Nature of nuclear forces, charge independence, charge symmetry and iso-spin invariance of nuclear forces.
4. β-decay :
   β- emission and electron capture, Fermi's theory of allowed β-decay, Selection rules for Fermi and Gamow-Teller transitions, Parity non-conservation and Wu's experiment.
5. Nuclear Structure:
   Liquid drop model, Bethe-Weizsacker binding energy/mass formula, Fermi model, Shell model and Collective model.
6. Nuclear Reactions and Fission.
   Different types of reactions, Quantum mechanical theory, Resonance scattering and reactions, Breit-Wigner dispersion relation; Compound nucleus formation and break-up Optical model; Principle of detailed balance, Transfer reactions. Nuclear fission: Experimental features, spontaneous fission, liquid drop model, barrier penetration, statistical model, Super-heavy nuclei.