VBS Purvanchal University, Jaunpur

PHYSICS

M.Sc. (PREVIOUS)

The examination shall consist of six theory papers of 70 marks each and a practical of 180 marks. The minimum pass mark in both theory and practicals will be 36 percent of the aggregate separately. The details of theory and practicals courses are given below:

THEORY:

Paper I	Mathematical Physics	70 marks
Paper II	Electromagnetic Theory and Plasma Physics	70 marks
Paper III	Quantum Mechanics	70 marks
Paper IV	Group theory and Molecular Spectroscopy	70 marks
Paper V	Thermodynamics and Statistical Physics	70 marks
Paper VI	Electronics	70 Marks

PRACTICALS:

A Candidate has to perform at least seven experiments from group A and seven from group B. The candidate has to do one experiment from each group in the examination. Each experiment will be of five hours duration. The distribution of marks in examination shall be as follows.

	Regular Candidate	Ex-candidate
Experiment I	50	50
Experiment II	50	50
Viva	50	80
Record	30	- -
Total	180	180

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PAPER I

MATHEMATICAL PHYSICS

(A) TENSOR ANALYSIS AND GREEN FUNCTION:

(i) Tensor Analysis: Covariant and contravariant tensors, addition, multiplication, Contraction of tensors, Tensor density, Levi-cevita tensor density, Pseudo-tensors, Symmetry properties, Differentiation, connection and covariant differentiations, Metric tensor.
(ii) Green Function: Green function properties, Integral-differential equation, Application to linear oscillator (vibrating string), Eigen function, Eigen value equation, Green function for two and three dimensions, Expansion in spherical and cylindrical coordinates, Structural green function.

(B) COMPLEX VARIABLES AND FOURIER TRANSFORM:

(i) Complex variables: General function of complex variable, Cauchy-Riemann differential equation and analyticity, conformal mapping (translation, rotation, inversion), Cauchy's integral formula, Taylor's and Laurent's series, singularity, poles, Residue theorem, Evaluation of definite integrals (around unit circle, infinite semicircle using Jordan's lemma with poles lying on real axis and integration involving multiple valued function-branch point).
(ii) Fourier Transform: Definition, Sine and Cosine transform properties: linearity, change of scale, translation, Modulation, simple applications.

(C) NUMERICAL ANALYSIS: Interpolation: methods of interpolation, least square curve fitting, Methods of equal intervals, unequal intervals, central differences. Inverse interpolation: Iteration of successive approximation, exchange of dependent and independent variables and reversion of series. Numerical differentiation: Method based on interpolation, on finite differences operator and on undetermined coefficients. Numerical integration: Simpson's one-third and one-eighth rule, Euler-Maclaurin formula, Quadrature formulae, Numerical solution to ordinary differential equation by Euler's and Runge kutta methods, Solution of algebraic and transcendental equations: Newton-Raphson method, Iterative methods.

References:

1. Matrices and Tensors in Physics by A.W. Joshi (Wiley Eastern Ltd., New Delhi).
2. Mathematical methods for physicists by Arfken.
3. Mathematics for Physics by P. Dennery and A. Krzynicki (Harper and Row, New York).
4. Numerical Analysis by Balguruswamy.
5. Numerical Analysis by Harper.
6. Applied Numerical Analysis by Gerald.

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PAPER II

ELECTROMAGNETIC THEORY AND PLASMA PHYSICS

(A) ELECTROMAGNETIC THEORY:

(i) Maxwell Equations: Microscopic and Macroscopic fields, Maxwell equations, Fields **D** and **H**, Dielectric tensor, Principal Dielectric axes.
(ii) Potential and Gauges: Scalar and vector potentials, Gauge transformation, Lorentz gauge and Transverse gauge, Maxwell equations in terms of electromagnetic potentials.
(iii) Four Dimensional Formulation: Minkowski space, Intervals, Proper time, Lorentz transformation, Transformation of velocities, addition of velocities, relativistic Doppler effect, Four vectors, Four Tensor, Principle of least action, Four-momentum of a free particle.
(iv) Propagation of Electromagnetic Waves: Propagation of electromagnetic waves in free space, conducting and non-conducting medium, Reflection and refraction at a plane interface between dielectrics, Polarization by reflection, dispersion (Normal and anomalous), Metallic reflection, Electromagnetic waves propagation in bound media.

(B) PLASMA PHYSICS:

(i) Plasma State & its Properties: Elementary ideas of plasma state of matter, Motion of charge particles in uniform E & B fields, non-uniform fields, drifting motion, electrostatic and magnetostatic lenses, Time varying E & B fields, Adiabatic invariants, Plasma confinements (Pinch effect, Mirror confinement, Van Allen Belts), Elementary idea of fusion technology.
(ii) Hydrodynamical Description of Plasmas: Hydroynamical description, Equation of magneto-hydrodynamics, High frequency plasma oscillations, Short wavelength limit and Debye-screening distance.
(iii) Kinetic Theory of Plasma: Boltzmann-Vlasov equation, Landau damping, Collision damping.
(iv) Wave Phenomenon in Magneto-Plasma: Electromagnetic waves perpendicular to B_0, phase velocity, Polarization, Cut-off and resonances, Electromagnetic waves parallel to B_0, Magnetosonic and Alfven wave.

References:

1. The Classical Theory of Fields by L.D. Landau and E.M. Lifshitz (Pergmon Press, Oxford).
2. Foundations of Electromagnetic Theory by Reitz, Milford & Christy (Narosa, Delhi).
3. Classical Electrodynamics by J. D. Jackson (Wiley Eastern Ltd., Delhi).
4. Introduction to Plasma Physics by F. F. Chen (Plenum Press, New York).
5. Plasma Physics by A. Bittencourt

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PAPER III

QUANTUM MECHANICS

(A) BRA AND KET NOTATION:
Dirac's bra and ket notations, vector representation of states, bra and ket vectors, projection and projection operators, linear operators, eigen value equation, orthonormality and completness relation, relation between kets and wave function, concept of Hilbert space.

(B) IDENTICAL PARTICLES:
The identity, symmetric and antisymmetric wave functions and their constructions, exchange degeneracy, particle exchange operator, Distinguishability of identical particles, Pauli's exclusion principle and Slater's determinant, Electron spin hypothesis and spin matrices for electron, Pauli's eigen values and eigen function, density operator and density matrices, symmetric and antisymmetric function for hydrogen molecule.

(C) MATRIX MECHANICS:
Heisenberg matrix mechanics and its application to harmonic oscillator, Equivalence of wave mechanics and matrix machines, Angular momentum, infinitesimal rotation operator, orbital and spin momentum operators, commutation relation, Ladder operators (J_+ and J_-) and their commutation relation with themselves, J and J^2, Eigen values of J, J^2, J_+ and J_-, Explicit forms of angular momentum matrices, Eigen functions of J^2 and J, coupling of two angular momenta and Clebsh-Gordon coefficients, Addition of orbital and spin angular momentum and p-states of an electron, recursion relation of Clebsh-Gordon coefficients, Selection rules in electromagnetic transition.

(D) APPROXIMATE METHODS AND THEIR APPLICATIONS:
Stationary perturbation method: Nondegenerate and degenerate case, its application to anharmonic oscillator, normal Zeeman and Stark effects, Variational method and its application to ground and excited states of Helium atom and Vander Walls interaction, Exchange degeneracy. Time dependent perturbation: harmonic perturbation and transition probability, semi-classical treatment of radiation, Einstein coefficient, Complex Atoms, Central field approximation and Thomos-Fermi model of Atoms, Hartree-Fock method of self consistent field and Energy state.

References:

1. Principle of Quantum Mechanics by P. A. M. Dirac.
2. Quantum Mechanics by L. I. Schiff (Mc Graw Hill, New York).
3. Quantum Mechanics by J. L. Pawel and B. Craseman (Narosa Publishing House, London).
4. Introduction to Quantum Mechanics by A. K. Ghatak (MacMillan India Ltd., New Delhi).
5. Quantum Mechanics (non-relativistic theory) by L. D. Landau and E. M. Lifshitz (Pergamon Press, Oxford).
6. Quantum Mechanics and field Theory by B. K. Agrawal (Lok Bharti Publication, Allahabad)

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PAPER IV

GROUP THEORY AND MOLECULAR SPECTROSCOPY

(A) GROUP THEORY:
Symmetry elements and symmetry operations, Point group and their representation, Mathematical group, Matrix representation, Orthogonality theorem (statements and interpretation only), Reducible and irreducible representations, Direct product group, normal modes, symmetry characterization of electronic states and vibrational model of polyatomic molecules, character tables (C_{2v}, D_{3h} and D_{6h}).

(B) MOLECULAR STRUCTURE:
H_2^+ ion, Born-Oppenheimer approximation and its application, H_2 molecule, Heitler-London theory, Valence bond theory of diatomic molecules, exchange energy, Simple valence bond treatment of H_2O and C_6H_6 molecules, LCAO approximation, application to H_2 and other molecules, hybridization, Huckel approximation and its application to butadiene and benzene molecules.

(C) MOLECULAR SPECTROSCOPY:

(i) Rotation and Vibration Spectra: IR and Raman spectra of rigid rotator and harmonic oscillator, IR and Raman spectra of non-rigid rotator, anharmonic oscillator and vibrating rotator, Intensities in rotation–vibration spectra, Isotope effect in rotation and vibration spectra.
(ii) Electronic Spectra: Electronic energy and total energy, vibration structure of electronic transitions, progressions and sequences, rotational structure of electronic bands, band head formation and band origin, Intensity distribution in vibrational structure, Frank-Condon principle and its quantum mechanical formulation, intensity alternation in rotational lines.

References:

1. Elements of Group theory for Physicists by A.W. Joshi (Wiley Eastern. Ltd. New Delhi).
2. Group Theory and Quantum Mechanics by M.T. Tinkham (Tata McGraw Hill, New Delhi).
3. Chemical Applications of Group Theory by F.A. Cotton (Wiley Eastern Ltd. New Delhi).
4. Molecular Spectra and Molecular Structure by G. Herzberg (Dover Publication, London).
5. Molecular orbital Theory by A. Streitweiser.
6. Valence by C.A. Coulson.
7. Introduction to Molecular Spectroscopy by G. M. Barrow.
8. Fundamentals of Molecular Spectroscopy by C. N. Banwell.
9. Quantum Theory of Molecules and Solids, Vol-I by J.C. Slater (McGraw Hill, New York).

PAPER V

THERMODYNAMICS AND STATISTICAL PHYSICS

(A) THERMODYNAMICS:
Entropy and Probability, Thermodynamic potentials – Helmholtz free energy, Gibbs free energy, Enthalpy and Internal energy; Equilibrium conditions for an isolated system, Third law of thermodynamics.
Thermodynamics of first and second order phase transition, Clausius-Clapeyron and Ehrenfest's equations, Chemical potential and phase equilibria, Thermodynamic properties of liquid Helium II, The Lambda transition, London's theory, Quantum liquid, Tisza two fluid model, Landau structure, superfluidity, second sound.

(B) STATISTICAL MECHANICS:
Ensembles, Canonical, microcanonical and grandcanonical ensembles and their partition function, Partition function for monoatomic and diatomic gases, Gibb's paradox, Sackur-Tetrode equation, Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac statistics, Degenerate bosons and Bose-Einstein condensation, Black body radiation, electron gas and its thermodynamic properties, White dwarfs and their limiting mass, statistical (Thomas-Fermi) model of atom.

(C) FLUCTUATIONS AND COOPERATIVE PHENOMENA:

(i) Fluctuations: Mean square deviation, Fluctuation in ensembles; Concentration fluctuation in quantum statistics, one- dimensional random walk and Brownian motion, Fourier analysis of random functions, Wiener-Khintchine theorem, The Nyquist theorem.
(ii) Cooperative Phenomena: Phase transition of second kind, Ising model, Bragg-Williams approximations, Kirkwood Method, Order-disorder in alloys, structural phase change.

References:
1. A treatise on Heat by M. N. Saha and B. N. Srivastava (Indian Press Limited, Allahabad).
2. Thermodynamics for chemists by S. Glasstone (John Wiley, New York).
3. Thermal Physics by C. Kittel (John Wiley, New York).
4. Statistical Mechanics by B. K. Agrawal and Melvin Eisner (Wiley Eastern Ltd., Delhi).
5. Statistical Mechanics by R. K. Pathria (Pergmon Press).
6. Statistical Mechanics by Kerson Huang (Wiley Student Edition).
7. Statistical Physics Part I by Landau and Lifshitz (Pergmon Press, Oxford).
8. Statistical Physics Part II by Lifshitz and Pitaevskii (Pergmon Press, Oxford).
9. Fundamentals of Statistical & Thermal Physics by Reif (Mc Graw Hill, London)

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PAPER VI

ELECTRONICS

(A) POWER ELECTRONICS:

(i) Power Devices: SCR; basic structure, I-V characteristics and two transistor model, DIAC and TRIAC; basic structure, operation and equivalent and I-V characteristics, TRIAC as high power switch, DIAC as triggering device of TRIAC, UJT in over voltage protection, saw tooth wave generation using UJT.
(ii) Regulator Circuit: Load and line regulation, stabilization ratio, internal impedance and temperature coefficient of voltage regulation, linear voltage regulator circuit.
(iii) Controlled rectification: SCR controlled half and full wave rectifier circuit and their analysis, elements of SMPS, SCR control and stability in SMPS,

(B) OPERATIONAL AMPLIFIER:

Characteristics of Op-Amp, inverting and non-inverting inputs, input offset current and input offset voltage, slew rate and power band width, Op-Amp as an amplifier, Bode plot and frequency response of Op-Amp, voltage follower, current follower, Op-Amp as integrating and differentiating circuits, frequency to voltage and voltage to frequency converter, voltage controlled oscillator and wave shaping circuits (Triangular and square wave), Astable, Monostable and Bistable Multivibrators, clipping and clamping circuits.

(C) DIGITAL ELECTRONICS:

(i) Number system and Codes: Binary, Octal and Hexadecimal system and their interconversion, binary arithmetic, 1's, 2's and 9's compliments, addition and substraction, BCD and hexadecimal codes, signed numbers.
(ii) Boolean algebra and Gates: Boolean variables, Boolean algebra, composite function and their algebraic simplification, precedence rule, De-Morgans theorem, duality in Boolean algebra, logic gates, universality of NAND and NOR gates.
(iii) Logic circuit design: Standard representation of logic function, SOP and POS terms and design of logic circuits using these terms, Karnaugh Map, simplification of Boolean expression, half adder and full adder, serial and parallel adder, half and full subtractors.
(iv) Elements of logic family: Transistor as a switch, FAN IN, FAN OUT, noise immunity, propagation delay, RTL, DTL, TTL logic, sourcing and sinking logic, ECL logic.

References:

1. Integrated Electronics by Milman and Halkias.
2. Hand Book of Electronics by Gupta and Kumar.
3. Operational Amplifiers and Linear Integrated Circuits by Gaykwad.
4. Digital Electronics by Malvino and Brown.
5. Digital Electronics by R. P. Jain.

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LIST OF EXPERIMENTS

M.Sc. (PREVIOUS)

Students will be required to perform at least seven experiments from group A as well as from group B. They will have to maintain record books of experiments done for each group separately.

GROUP A: ELECTRONICS

1. Study of R-C Coupled Amplifier
2. Study of Multivibrator
3. Study of Push-pull Amplifier
4. Study the characteristics and determination of h-Parameter of PNP transistor in CE.
5. Study of Energy band gap of Semiconductor.
6. Study of High pass and Low pass Active Filter.
7. Study of saw tooth wave generator by UJT.
8. Study of TTL gates.
9. Study of Phase Shift Oscillator.
10. Study of Linear and Square wave detector.
11. (a) Study of Bias Stabilization.
    (b) Study of Temperature effect on Diode junction.
12. Study of Clipping – Clamping circuit.

GROUP B: GENERAL

1. Wavelength of Sodium light by Michelson Interferometer
2. Wavelength of Sodium light by Fabry Perot Interferometer
3. Young modulus of metal rod by Newton's Ring
4. Wavelength of Laser light and thickness of wire.
5. Lande's g factor by E.S.R
6. Activation energy of KCl crystal by Thermoluminiscence.
7. Study of Optical fibre
8. Excitation energy and wavelength by Frank Hertz experiment.
9. Study of Hall effect.
10. Study of G. M. Counter.
11. Study of Zeeman Effect (e/m).
12. Study of Lattice Dynamics.