# VBS Purvanchal University, Jaunpur

**PHYSICS**

**M.Sc. (FINAL)**

The examination shall consist of six theory papers and a practical. Six theory papers namely paper I, II, III and IV shall be compulsory and papers V and VI will be optional. The minimum pass marks in both theory and practicals will be 36 percent of aggregate separately. There shall be a practicals course for optional group. The distribution of marks shall be as following:

**COMPULSORY THEORY PAPERS:**

| | | |
|---|---|---|
| Paper I | Classical Electrodynamics and Relativistic Quantum Mechanics | 70 Marks |
| Paper II | Solid State Physics | 70 Marks |
| Paper III | Nuclear Physics | 70 Marks |
| Paper IV | Laser and Modern Optics | 70 Marks |

**OPTIONAL THEORY PAPERS:**

| | | |
|---|---|---|
| Paper V | Electronics I | 70 Marks |
| Paper VI | Electronics II | 70 Marks |

**PRACTICALS:**

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

| | Regular Candidate | Ex-Candidate |
|---|---|---|
| Experiment I | 40 | 60 |
| Experiment II | 40 | 60 |
| Viva | 40 | 60 |
| Record | 20 | - - |
| Dissertation | 30 | - - |
| Educational Tour | 10 | - - |
| Total | 180 | 180 |

In case tour is not conducted, the dissertation shall be of 40 marks.

# VBS Purvanchal University, Jaunpur

**PAPER I**

**CLASSICAL ELECTRODYNAMICS AND RELATIVISTIC QUANTUM MECHANICS**

## (A) CLASSICAL ELECTRODYNAMICS

**(i) Charges in Electromagnetic Fields:** Four Potential, Minimal coupling prescription, action of a charged particle, generalized momentum and Hamilton equation of motion, Motion in constant uniform magnetic field.

**(ii) Electromagnetic Field Equations:** Four dimensional formulation of equation of motion, Electromagnetic field tensor, Transformation properties of electric and magnetic fields, Invariants of electromagnetic field, Four dimensional formulation of first and second pair of Maxwell equations, The equation of continuity, Energy-momentum tensor of electromagnetic field.

**(iii) The Field of Moving Charges:** Retarded potentials, The Lienard-Wiechart potentials, Field due to system of charges at large distances, Dipole radiation, Quadrupole and magnetic dipole radiation, Field at near distances, Radiation from accelerated charge, Synchrotron radiation (magnetic bremsstrahlung), Radiation damping.

## (B) RELATIVISTIC QUANTUM MECHANICS

**(i) Klein-Gordon and Dirac Equation:** Klein-Gordon equation, Free particle solution and its interpretation, Dirac equation and its interpretation, $\alpha$ and $\beta$ matrices, Algebra of Dirac matrices, covariance of Dirac equation, Non-relativistic correspondence, Solution for a Free particle, Negative energy states and hole theory, Spin.

**(ii) Field Concept:** Lagrangian and Hamiltonian formulation for fields, Quantization of spin 0, ½ and 1 field, Algebra of annihilation and creation operators, S-matrix expansion, Interaction picture, Ordering theorems (statements only).
Supersymmetry and Supersymmetric Quantum Mechanics.

**References:**


1. The Classical theory of Fields by L. D. Landau and E.M. Lifshitz (Pergmon Press, Oxford).
2. Classical Electricity and magnetism by W. K. H. Penofsky and M. Phillips.
3. Classical Electrodynamics by J. D. Jackson (Wiley Estern Ltd., Delhi).
4. Quantum Field Theory by B.K. Agrawal (Lok Bharti, Allahabad).
5. An Introduction to Relativistic Quantum Field Theory by S.S. Schweber (Harper and Row, New York).

# VBS Purvanchal University, Jaunpur

**PAPER II**

**SOLID STATE PHYSICS**

**(A) CRYSTAL BINDING AND STRUCTURE:** Inert gas, Ionic, covalent, metallic and hydrogen bondings, space lattice and basis, Lattice types, Miller indices, Important crystal structure (NaCl, CsCl, ZnS, graphite and diamonds), Reciprocal Lattice and Brillouin Zone, Elementary idea of crystal structure analysis and dislocations.

**(B) LATTICE DYNAMICS AND THERMAL PROPERTIES:** Lattice vibrations of mono and diatomic chains, Infrared absorption of ionic crystals, quantization of lattice vibration and phonon, Einstein and Debye theories of specific heat, Lattice thermal conductivity, Anharmonicity and Thermal expansion.

**(C)FREE ENERGY AND ENERGY BAND THEORIES:** Sommerfield model, Density of states, Fermi and mean energy at zero and finite temperatures, specific heat and Pauli paramagnetism, origin of energy bands, Block theorem, Kroning Penny model, concept of electron dynamics in crystalline lattice, Tight binding approximation.

**(D)MAGNETIC PROPERTIES:** Magnetic ions and magnetic excited states, Paramagnetism of non-interacting magnetic ions and its application to rare-earth and transition metal ions in solids, Ferromagnetism: Magnetic domains and Landau theory of their origin, Basic features and their explanation by molecular field theory, Heisenberg explanation of internal magnetic field, spin wave theory and magnons, Basic features and Neel's two sublattice models of antiferro and ferrimagnetic materials.

**(E)FERROELECTRICITY AND SUPERCONDUCTIVITY:** Basic features and classification of ferroelectric materials, Occurrence of ferroelectricity due to polarization catastrophe and very low frequency transverse optical mode, Devonshire theory of ferroelectric phase transition, Elementary idea of Cocharan's theory of ferroelectric phase transition, Basic properties and types of superconductors, Thermodynamics of superconducting transition, London equation, Coherence length, Basic idea of BCS Theory, Elementary discussion of high Tc superconductors.

**(F)OPTICAL PROPERTIES:** Optical reflectance, Kramers-Kronig relations; Conductivity and dielectric function of collision electron gas, Basic Theories and models of luminiscence, phosphorescence, thermo-luminiscence, electroluminiscence and photo-conductivity, Exciton in ionic and Molecular crystals, EHD (Electron-hole drops) and colour centres.

**References:**


1. Solid states Physics by A-J. Dekkar (McMillan and Co., London).
2. Introduction to solid State Physics by C. Kittel (Wiley Eastern, New Delhi).
3. Elementary Solid State Physics: Principle and Application by Omar Ali (Addison Wesley, London).
4. Solid State Physics by R. Kubo and T. Nagamiya (McGraw Hill, New York).
5. Solid State Theory by W.A. Harrison (McGraw Hill, New York).

# VBS Purvanchal University, Jaunpur

**PAPER III**

**NUCLEAR PHYSICS**

**(A) NUCLEUS AND NUCLEAR MODELS:** Nuclear radius and its determination, nuclear spin and parity, quadrupole moment, magnetic moment, saturation of nuclear forces, stability of nuclii, liquid drop model, Weizsacker semi-empirical mass formula and its applications, Evidence of nuclear shell structure, Nuclear potential and sequence of energy level of nucleons, spin orbit potential and explanation of magic number, Prediction and limitation of shell model. Concept of nuclear core, Neilson unified model, optical model, elementary idea of collective and superconducting model.

**(B) NUCLEAR REACTION:** General features and concept of cross section and Q value of nuclear reaction. Example of typical nuclear reaction, compound nucleus hypothesis, Ghoshal experiment, wave mechanical picture, partial level width, resonance theory of nuclear reaction, Breit-Wigner one level formula, Direct, pickup and stripping reactions, Nuclear fission, idea of nuclear accelerators and detectors. Nuclear power reactors

**(C) NUCLEAR TRANSITIONS:** Gamow's quantum theory of α-decay and its predictions, Fermi theory of beta (β) decay, Allowed and forbidden transitions, Fermi-Curie plot and comparative half life, Neutrino properties and experimental evidence, Parity conservation in weak interaction. Electromagnetic transition, multipole order, selection rules, internal conversion, and life time of Gamma emitting states and isomerism. Pair creation and annihilation.

**(E) TWO BODY PROBLEM:** Investigation of nature of nuclear forces from simple two body problems. Ground state of a Deuteron, S and D state, neutron–proton and proton–proton scattering, central and noncentral forces. Spin dependence of nuclear forces, exchange forces.

**(F) ELEMENTARY PARTICLES:** Basic elementary particle interactions and classifications of elementary particles, Invariance and Conservation laws in relation to particle reaction and decays. Isospin formulation, Elementary idea of C, P & T symmetries, CPT theorem. Associated production and strangeness, Elementary idea of Gauge theory. Quark structure of elementary particles. Gell-Mann's eight-fold classification of Hydrons. Quark-Gluon interaction. Experimental test of quantum chromodynamics. Particle physics and thermodynamics in the early universe. Quark-Gluon plasma. Steller evolution.

**References:**


1. Introduction to nuclear physics by H. Enge.
2. Nuclei and Particles by E. Segre.
3. Atomic and Nuclear Physics Vol II by S.N. Ghoshal (S. Chand and Company Ltd, New Delhi 1994).
4. Nuclear Physics Vol I by Y M Shirikov and NP Yudin, (Mir Publisher, Moscow 1982).
5. Theory of Nuclear structure by M.K. Pal (Affiliated East West Press, New Delhi 1982).
6. Nuclear and Particle Physics by E.B. Paul (North Holland Publishing Company, Amsterdam 1969).
7. Nuclear Physics (Theory and Experiment) by R.R. Roy and B.P. Nigam (Wiley Eastern Ltd., New Delhi 1993).

**PAPER IV**

## LASER AND MODERN OPTICS

**(A) LASER:** Interactions of radiation with matter, Einstein coefficients, Light amplification, Population inversion, pumping processes, rate equation for three and four level systems, Semi-classical theory of lasers, Cavity modes, polarization of cavity media, first order theory, Quality factor of cavity and ultimate line with laser, Directionality and mono-chromaticity of laser and coherence properties, Principles of Ruby, He-Ne, $Co_2$, Dye and Semi-conductor Lasers.

**(B) QUANTUM OPTICS:** Spatial and temporal coherence, classical coherence correlation function, Basic idea of quantum coherence correlation function, coherent states and its properties.

**(C) NON-LINEAR OPTICS:** Non-linear polarizability tensors, coupled amplitude equation, optical pumping of active media, Manely-Rowe'r relationships; Parametric amplification and parametric oscillation, Phase matching, second harmonic generation.

**(D) HOLOGRAPHY:** Basic principle of holography and holograms, methods of hologram recording, reconstruction of object waveform by hologram, Basic theory of plane hologram; Typical arrangement for hologram reconstruction, practical consideration of holography and its application.

**(E) FIBRE OPTICS:** Types of fibres, Single mode and multi-mode fibres, dispersion and loss in fibre, principles of optical communication.

**(F) LIQUID CRYSTAL:** Liquid crystal Physics structure and classification, Polymorphism in theromotropic liquid crystals, orientational distribution function, symmetry and order parameters.
Optical properties of Colestric, Smectic and nematic liquid crystals, liquid crystal displays, electro-optic effect, Lyotropic liquid crystal and biological membrane.

**References:**


1. Lasers and Non-Linear Optics by B.B. Laud (Wiley Est. Ltd., New Delhi).
2. Quantum Optics by S.H. Kay and A. Maitland (Academic Press, London).
3. Non-Linear Optics by P.G. Harper and B.S. Wherret (Academic Press, London).
4. Laser and holographic Data processing by N.G. Bosov (Mir Publisher, Moscow).
5. Introduction to fiber optics by A. Ghatak and K. Thyagrajan (Cambrige University Press)
6. Optical fiber communication by Keiser.
7. Introduction to liquid crystal by E.B. Prieshley, Wojtowiez.
8. Liquid Crystals by S. Chandrashekhar (Cambridge University Press).
9. Liquid Crystals Vol. I, II & III by Birendra Bahadur (World Scientific, Singapore).

# VBS Purvanchal University, Jaunpur

**PAPER V**

**ELECTRONICS - I**

**(A) ANALOG ELECTRONICS:**
Analog computation, time and amplitude scaling, PLL, Analog to digital and digital to analog convertor.

**(B) COMBINATIONAL LOGIC DESIGN:**
**(i)** Comparator, parity generator and checking, code conversion, binary to gray and gray to binary.
**(ii)** Logic design with MSI, coder and decoder, multiplexer and demultiplexer circuit.

**(C) SEQUENTIAL CIRCUITS:**
**(i)** Basic definition, finite state model, SR, JK, T, D, Edge Triggered flip-flop, Race condition, Master Slave flip-flop, Clocked flip-flop, Characteristic table and characteristic equation, Sequential logic design, state table, state diagram, state equation.
**(ii)** Registers and Counters: Register, Shift register, Universal shift register, Ring counter, Twisted ring or Johnson counter, synchronous and asynchronous counters, UP/Down and scale of 2n counters.

**(D) MEMORY:**
Basic idea of magnetic memory. Ferrite core memory, Semi-conductor memory viz, RAM, ROM, PROM, EPROM EEPROM.

**(E) MICROPROCESSOR:**
Introduction to Intel 8085 microprocessor, microprocessor architecture, instruction and timings, assembly language programming, stack and subroutines, code conversion, interrupts, interfacing with 8255 and memory.

**(F) PROGRAMMING IN C:**

**(i) Overview of programming:** Introduction to computer based problem solving, requirements of problem solving by computers, problem definition, problems solving strategies, programme and algorithm construction of loops, basic programming, constructs, programming language classification, machine language, assembly language, high level language, assemblers, compilers, interpretors.
**(ii) An overview of C**: The origin of C language, middle level language, structure of C language, storage class specifiers and data types, constructs and variables, declaration of variables, operators and expression.
Programme Control Statements: True and false in C, C statements, conditional statements if, switch, for, while, do-while, break, exit (), continue, level and goto.

**References:**

1. Integrated Electronics by Milman & Halkias.
2. Digital Integrated Electronics by Taub & Schilling.
3. Microprocessor, Architecture, Programming and Applications by R. S. Gaonkar.
4. Fundamental of Microprocessors and Microcomputers by B. Ram.
5. Principles of Computer Programming by V. Rajaraman.
6. Digital Computer Electronics by Malvino and Brown
7. Digital Technology by Virendra Kumar.

# VBS Purvanchal University, Jaunpur

**PAPER VI**

**ELECTRONICS - II**

**(A) SIGNAL REPRESENTATION:** Time domain & frequency domain representation of signals, Fourier transform and its properties, delta function and some of its applications to communication.

**(B) NOISE:** Shot Noise, White Noise, Thermal Noise, Noise spectrum, Noise figure, Noise in communication system, S/N ratio in an analog Communication system.

**(C) INFORMATION THEORY:** Information content of message, average information content, rate of information transmission, discrete communication channels, rate of information transmission over discrete channels, Shannon-Herthy Theorem and its implications.

**(D) PULSE MODULATION:** Sampling of Analog signals, Sampling theorem, PAM, PPM, PWM and its generation detection and S/N Ratio.

**(E) CODED TRANSMISSION OF SIGNAL:**

**(i) Quantization of Analog Signals:** Uniform Quantization, Non-Uniform Quantization, A-law and U-law computing.

**(ii) Pulse Code and Digital Modulation:** Pulse Code Modulation, Binary Coding and PCM band width, DPCM, DM and ADM.

**(iii) Digital Modulation techniques:** ASK, FSK, PSK system, Transmission and detection of binary system and subroutines, code-conversion, stack and subroutine.

**(F) MICROWAVE:**

**(i) Microwave:** Propagation of EM wave in cavity, microwave generation, Gunn oscillator, tunnel diode, IMPATT, BARITT, TRAPATT.

**(ii) Microwave Components:** Isolators, attenuator, Magiet, Tuners, directional couplers.

**(iii) Antenna:** Current and voltage distribution in antenna, Short electric dipole, Linear and ground antenna, Distribution of field around vertical antenna, Half and full wave antenna, Folded dipole, Antenna arrays, Matching of antenna.

**References:**


1. Digital and Analog communication systems by K. San Shanmugan.
2. Communication system by Simmon Haykin.
3. Principle of Communication system by H. Taub & D. L. Schilling.
4. Electronic Communication Systems by Kennedy.
5. Modulation Theory by H. S. Black.
6. Microwave by K. C. Gupta.
7. Antenna Theory by Kraus

# VBS Purvanchal University, Jaunpur

**LIST OF EXPERIMENTS**

**M.Sc. (FINAL)**

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: ANALOGE**

1. Study of Amplitude modulation and demodulation.
2. Study of Frequency modulation and demodulation.
3. Study of first and Second order active band pass and band reject filter.
4. Study of Multivibrator using IC 555 timer.
5. Study of characteristics Op-Amp.
6. Study of characteristics of Emitter follower.
7. Study of Microwave.
8. Study of Transmission line.
9. Study of PLL circuit.
10. Study of Sampling theorem.
11. Study of Pulse coded modulation.
12. Study of Super heterodyne receiver

**GROUP B: DIGITAL**

1. Study of Decoder and seven segment display unit.
2. Study of Encoder.
3. Study of Mux and Demux.
4. Study of Microprocessor.
5. Study of Combinational logic.
6. Study of Sequential logic.
7. Study of Registers
8. Study of Counter.
9. Study of A/D and D/A converter.
10. Study of Memory.
11. Study of Arithmetic Logic units.
12. Programming on PC.