CHHINDWARA UNIVERSITY, CHHINDWARA

M. Sc. - PHYSICS

M.Sc. in Physics is a full time 2-year (4-semesters course). There will be four theory papers, and two laboratory courses/project in each semester. In each semester, there will be two internal examinations/assessments. Semester-wise course structure along with distribution of marks is given below:

Semester I

Name of the Paper	Marks				
	Theory		Internal		Total
	Max	Min	Max	Min	
Mathematical physics	40	15	10	4	50
Classical mechanics	40	15	10	4	50
Quantum mechanics- I	40	15	10	4	50
Electronic devices	40	15	10	4	50
Laboratory Course -A : General & Optics					50
Laboratory Course -B : Electronics					50
Total Marks					300

Total marks for Semester I = 300

Semester II

Name of the Paper	Marks				
	Theory		Internal		Total
	Max	Min	Max	Min	
Quantum mechanics-ii	40	15	10	4	50
Statistical mechanics	40	15	10	4	50
Electrodynamics and plasma physics	40	15	10	4	50
Atomic and molecular physics-i	40	15	10	4	50
Laboratory Course -A : General & Optics					50
Laboratory Course -B : Electronics					50
Total Marks					300

Total marks for Semester II = 300

Semester III

Name of the Paper	Marks				
	Theory		Internal		Total
	Max	Min	Max	Min	
Condensed Matter Physics-I	40	15	10	4	50
Nuclear and Particle Physics	40	15	10	4	50
Digital Electronics	40	15	10	4	50
Atomic and Molecular Physics	40	15	10	4	50
Laboratory Course -A : Solid State Physics					50
Laboratory Course -B : Digital Electronics					50
Total Marks					300

Total marks for Semester III = 300

CHHINDWARA UNIVERSITY, CHHINDWARA

Semester IV

Name of the Paper	Marks				
	Theory		Internal		Total
	Max	Min	Max	Min	
Condensed Matter Physics-II	40	15	10	4	50
Laser Physics	40	15	10	4	50
Digital Electronics	40	15	10	4	50
Elective Paper (A) Communication (B) Material Science (C) Computational Methods and Programming (D) Physics of Nanomaterials	40	15	10	4	50
Laboratory Course -A : Solid State Physics					50
Laboratory Course -B : Digital Electronics & Microprocessor/ Communication					50
Project/Internship					50
Total Marks					350

Total marks for Semester IV =350

In semester IV, Project/internship work in Solid State Physics / Electronics/ Physics of Nano-materials/ Digital Electronics will lead to specialization in the respective area. It will be primarily based on research oriented topics. On completion of the project, student will submit project report in the form of dissertation which will be examined by an external examiner. The examination of project work shall consist of (a) Presentation and (b) comprehensive viva-voce.

Marks-distribution for Laboratory Courses and Project Work:

(a) Laboratory courses (Semesters I,II, III):

Sessional : 10 Marks
Viva : 10 Marks
Experiment : 30 Marks

(b) Project Work (Semester IV) :

Report – Dissertation : 30 Marks
Presentation : 10 Marks
Comprehensive viva-voce : 10 Marks

Note: In semester IV Paper IV is a major elective course. Student has to opt for any one of the courses: (A) or (B) or (C) or (D). The commencement of any one of the major elective paper is subjected to the availability of basic infrastructural facilities viz. expert faculty, laboratory etc.

CHHINDWARA UNIVERSITY, CHHINDWARA
Detailed Course Content
Semester- I

PAPER- I - MATHEMATICAL PHYSICS

Unit -I

Vector space and matrices, linear independence, bases, dimensionality, linear product, Inner Product, Linear transformation, matrices, Inverse, Orthogonal and Unitary matrices Independent elements of a matrix, Eigen values and Eigen vectors, Diagonalization, complete orthogonal set of functions.

Unit -II

Differential equations: Recursion relation, generating functions and orthogonality of Bessel functions of first and second kind, Hermite, Legendre, Associate Legendre and Laguerre Polynomials, Curvilinear co-ordinate system with specific cases of Cartesian, Cylindrical, and Spherical coordinate systems.

Unit -III

Integral transforms. Fourier integral. Fourier transform and inverse Fourier transforms. Fourier transform of derivatives. Convolution theorem. Elementary Laplace transforms. Laplace transform of derivatives. Application to a damped harmonic oscillator.

Unit -IV

Green's Functions: Non- Homogenous boundary value problems, Green's function for one dimensional problem, eigen function expansion of Green's function, Fourier transform. Method of constructing Green's functions, Green's function for electrostatic boundary value problems and quantum-mechanical scattering problem.

Unit .V

Complex variables: Analyticity of complex functions. Cauchy Riemann equations. Cauchy theorem. Cauchy integral formula. Taylors, Maclaurin, Laurent series & mapping.

Theorem of residues. Simple cases of contour integration. Jordan's lemma Integrals involving multiple valued unctions (Branch points).

Books Recommended :

1. L. A. Pipes Mathematics of Engineers and Physicists
2. Arfken Mathematical Methods for Physicists
3. P.K. Chattopadhyay Mathematical Physics
4. H.K.Dass Mathematical Physics
5. Ghatak, Goyal & Guha Mathematical Physics
6. M.R Spiegel (Schaum Series) Complex variable & Laplace Transform

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- I
PAPER- II – CLASSICAL MECHANICS

Unit – I

Newtonian mechanics of one and many particles systems: Conservation laws, Constrains and their classification, Principle of Virtual work; D'Almbert's principle in generalized coordinates, The Lagrange's equation from D'Alambert's principle. Configuration space, Hamilton's principle deduction from D'Almberts principle. Generalized momenta and Lagrangian formulation of the conservation theorems, Reduction to the equivalent one body problem; the equation of motion and first integrals, the differential equation for the orbit.

Unit - II

Variational Principle: Lagrang's and Hamilton's equations – Hamilton's principle, Dedilecion of Lagrang's equations of motion from Hamilton's principle.Applications of Lagrang's equations of motion- Linear harmonic oscillator, simple pendulum, spherical pendulum, Particle moving under a central force. Superionty of Langraugian approach over Newtonian approach.

Unit - III

The equations of canonical transformation and generating functions: The Hamilton -Jacobi Action and Angel variables. Poisson.s brackets; simple algebraic properties of Poisson.s brackets. The equation of motion in Poisson.s Brackets notation. Poisson theorem; principle of least action. The Kepler problem, central force field, Rutherford scattering.

Unit - IV

Theory of small oscillations, Equations of motion, Eigen frequencies and general motion, normal modes and coordinates, Applications to coupled pendulum and linear bistable molecule. Rotating coordinate systems. Acceleration in rotating frames. Coriolis force and its terrestrial astronomical applications, Elementary treatment of Eulerian co-ordinates and transformation matrices. Angular momentum inertia tensor. Eular equations of motion for a rigid body. Torque free motion for a rigid body.

Unit -V

Symmetries of space and time. Invariance under galilion transformation, Covariant four dimensional formulation, 4- Vectors and 4- scalers. Relativistic generalization of Newton's laws, 4- Momentum and 4 –force variance under Lornetz transformation relativistic mechanics. Covariant Lagrangian, covariant Hamiltonian, Examples.

Books Recommended

1. H.Goldstein (Addison Wesley) Classical Mechanics
2. N.C.Rana & P.S.Jog Classical Mechanics
3. Landu & Lifshitz (Pergamann Press) Classical Mechanics
4. A. Sommarfield (Academic Press) Classical Mechanics
5. R.G.Takwale & P.S. Puranik Introduction to Classical Mechanics

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- I
PAPER- III – QUANTUM MECHANICS -I

Unit . I

Basic Postulates of quantum Mechanics, equation of continuity, Schrodinger time dependent and time independent equations, Probabilities interpretations of wave function , Normality, orthogonality and closure properties of eigen functions, expectation values and Ethrentest theorems, solution of Schrodinger equation for one dimensional (a) potential well (b) potential step and (c) Potential barrier.

Unit . II

Linear vector space, concept of Hibert space, bra and ket notation for state vector, representation of state vectors and dynamical variables by matrices and unitary transformation (Translation and rotation), creation and annihilation operators, matrices for x and p. Heisenberg uncertainty relation through operators (Schwartz inequality).

Unit -III

Solution of Schrodinger equation for (a) linear harmonic oscillator (b) hydrogen - like atom (c) square well potential and their respective application to atomic spectra, molecular spectra and low energy nuclear states(deuteron).

Unit - IV

Angular momentum in quantum mechanics, Eigen values and Eigen function of L^2 and Lz in term of spherical harmonics, commutation relation. Obtaining mariecs for L^+,L -, Lx, Lz, L^2, and [L+, L-], Stern- Gerlach experiment, spin wave function and operator.

Unit -V

Time independent Perturbation theory, Non-degenerate and degenerate cases. The WKB Approximation, classical limit, Approximate Solutions, Asymptotic Nature of the solutions,

Text Books and reference-book:

1. L I Schiff, Quantum Mechanics
2. A.K. Ghatak and Loknathan, Quantum Mechanics
3. B Craseman and J D Powell Quantum Mechanics
4. A P Messiah Quantum Mechanics
5. J. J. Sakurai Modern Quantum Mechanics
6. Mathews and Venkatesan Quantum Mechanics

CHHINDWARA UNIVERSITY, CHHINDWARA

Semester- I

PAPER- IV – ELECTRONIC DEVICES

Unit- I

Transistors: JFET, BJT, MOSFET and MESFET, structure derivations of the equations for I-V characteristics under different condition, microwave devices, tunnel diode, transfer electron devices (Gunn diode), avalanche transits time devices, Impatt diodes and parametric devices.

Unit - II

Photonic devices: radiative and non-radiative transitions, optical absorption, bulk and. Thin film photo conductive devices (LDR), diode Photo detectors, Solar cell (open circuit voltage and short circuit current, fill factor), LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), semi-conductors; diode lasers (conditions for population inversion in active region, light confinement factor, optical gain and threshold current for lasing.

Unit - III

Memory Devices: Read Only Memory (ROM) and Random Access Memory(RAM).Types of ROM: PROM, EPROM, EEPROM and EAPROM, Static and dynamic RAMs (SRAM & DRAM), characteristics of SRAM and DRAM. Hybrid Memories : CMOS and NMOS memories, Nonvolatile RAM, ferro-electric memories, charge coupled devices (CCD), storage devices: Geometry and organization of magnetic (FDD & HDD) and Optical (CD-ROM, CD-R, CD-R/W, DVD) Storage devices.

Unit - IV

Electro-optics, Magneto-optic and Acousto-optic effects, materials properties related to get these effect, important ferro electric, l iquid crystal and polymeric materials for these devices, piezoelectric, electrostrictive and magnetostrictive effects. Important materials for these properties and their applications in sensors and actuator devices, acoustic delay lines, piezoelectric resonators and filters, high frequency piezoelectric devices-surface, acoustic wave devices,

Unit - V

Solar Energy

Fundamentals of photovoltaic Energy Conversion Physics and Material Properties, Basic to Photovotaic Energy Conversion: Optical properties of Solids. Direct and indirect transition semiconductors, interrelationship between absorption coefficient and band gap recombination of carriers.

Types of Solar Cells, p n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current, Brief descriptions of single crystal silicon and amorphous silicon solar cells, elementary ideas of advanced solar cells e.g. Tandem Solar Cells. Soid Liquid Junction Solar Cells, Nature of Semiconductor, Electrolyte Junction, Principles of Photo electrochemical solar cells.

Text books and reference books:

1. SM Sze Willey (1985) Semiconductors devices - physics technology
2. MS tyagi Introduction to semiconductors devices
3. M Sayer and A Manisingh Measurement instrumentation and experimental design in physics and engineering
4. Ajoy Ghatak and Thyagrajam Optical Electronics
5. Millman Halkias: Electronic Devices

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- II
PAPER- I – QUANTUM MECHANICS-II

Unit - I

Approximation method for bound states : Time independent Perturbation theory, Non-degenerate case. First and second order perturbation, perturbation of linear Harmonic oscillator and first order stark effect in hydrogen. Variation method and its application to ground state helium, W K B Approximation method, connection formulae, ideas on potential barrier with applications to theory of alpha decay.

Unit - II

Time dependant perturbation theory: Methods of variation of constants and transition probability, adiabatic and sudden approximation, wave equation for a system of charged particles under the influence of external electromagnetic field, absorption and induced emission, Einstein's A and B coefficients and transition probability.

Unit- III

Theory of Scattering, Physical concepts, scattering amplitude, scattering cross section. Born Approximation and partial waves, scattering by perfectly rigid sphere, complex potential and absorption, scattering by spherically symmetric potential, identical particles with spin, Pauli's, spin matrices.

Unit- IV

Schrödinger's relativistic equation (Klein-Gordon equation), Probability and current density, Klein - Gordon equation in presence of electromagnetic field, hydrogen atom, short comings of Klein-Gordon equation,

Unit - V

Dirac's relativistic equation for free electron, Dirac's Matrices. Dirac's relativistic equation in electromagnetic field, negative energy states and their interpretation, hydrogen atom. Hyperfine splitting.

Text Books and reference book:

1. LI Schiff Quantum Mechanics
2. B Craseman and J J Powell Quantum Mechanics (Addison Wessley)
3. A .Messiah Quantum Mechanics
4. J.J. Sakurai Modern Quantum Mechanics
5. Mathews and Venkatessan Quantum Mechanics
6. A .K.Ghatak and Loknathan Quantum Mechanics

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- II
PAPER- II – STATISTICAL MECHANICS

Unit - I

Foundation of statistical mechanics, specification of states of a system contact between statistics and thermodynamics, classical ideal gas entropy of mixing and Gibb.s paradox. Micro canonical ensemble, phase space, trajectories and density of states, Liouville theorem, canonical and grand canonical ensembles, partition function, calculation of statistical quantities, energy and density fluctuations.

Unit-II

Statistics of ensembles, statistics of indistinguishable particles, density matrix, Maxwell -- Boltzmann, Fermi Dirac and Bose- Einstein statistics, properties of ideal Bose gases, Bose . Einstein condensation, properties of ideal Fermi gas, electron gas in metals, Boltzman transport equation.

Unit-III

Cluster expansion for a classical gas, Virial equation of state, mean field theory of Ising model in 3,2 and 1 dimension. Exact solution in one-dimension, Landau theory of phase transition, scaling hypothesis for thermodynamics.

Unit -IV

Thermodynamics fluctuation spatial correlation Brownian motion, Langevin theory, fluctuation dissipation theorem, the Fokker-Planck equation, Onsager reciprocity relations

Unit - V

Phase Transition- Phase transition of first and second kind, Yong and Lee theory methods of producing low temperature, Approach to absolute zero by adiabatic demagnetization.

Text Books and reference book:

1. F Reif Statistical and thermal Physics

2. K Huang Statistical Mechanics

3. R K Pathria Statistical Mechanics

4. R Kubo Statistical Mechanics

5. Tandan Statistical Physics

6. B. B. Loud: Statistical Mechanics

CHHINDWARA UNIVERSITY, CHHINDWARA

Semester- II

PAPER- III – ELECTRODYNAMICS AND PLASMA PHYSICS

Unit - I

Review of Basics *of* electrostatics and magnetostatics (electric field, Gauss's law, Laplaces and Poisson equations, method of images, Biot-Sawart law, Ampere law, Maxwell's equations, scalar and vector potentials, gauge transformation, Lorentz gauge, Coulomb Gauge, Solution of Maxwell equations in conducting media radiations by moving charges, retarded potentials, Lienard Wiechrt potentials, fields of charged particles in uniform motion, fields of arbitrarily moving charge particle.

Unit-II

Fields of an accelerated charged particles at low velocity and high velocity, angular distribution of power radiated, Review of four vector and Lorentz transformation in 4-dimensional spaces, Invariance of electric charge, relativistic transformation properties of E and H fields. Electromagnetic fields tensor in 4-dimensional Maxwell equation,

Unit -III

Four Vector current and potential and their invariance under Lorentz transformation, covariance of electrodynamics. Langragian and Hamiltonian for a relativistic charged particle in External EM field; motion of charged particles in electromagnetic fields, uniform and non uniform E and B fields.

Unit . IV

Elementary concept of occurrence of plasma. Gaseous and solid state plasma. Production of gaseous and solid state plasma. Plasma parameters. Plasma confinement pinch effect instability in a pinched- plasma column. Electrical neutrality in a plasma. Debye screening distance. Plasma oscillations: Transverse oscillations and longitudinal oscillations.

Unit - V

Domain of Magneto-hydrodynamics and plasma Physics : Magneto-hydrodynamic equations, magnetic hydro-static pressure hydrodynamic waves: Magneto-sonic and Alfven waves, particle orbits and drift motion in a plasmas, Experimental study of Plasma, the theory of single and double probes.

Text Books and reference book:

1. Bitteneerort Plasma Physics
2. Chen Plasma Physics
3. Gupta, Kumar, Singh Electrodynamics ;
4. Sen Plasma state and matter
5. Jackson Classical electrodynamics
6. Pamolsky & Philips Classical electricity and Magnetism

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- II
PAPER- IV – ATOMIC AND MOLECULAR PHYSICS-I

UNIT -I

Quantum states of one electron atom. Atomic orbitals. Hydrogen spectrum, Paulis principle, Spectra of alkali elements, Spin orbit interaction and line structure of alkali Spectra . Methods of molecular quantum mechanics, Thomas Fermi statistical model, Hartree and Hartree fock method, Two electron system. Interaction energy in L-S and J-J coupling, hyperfine structure (qualitative), line broadening mechanisms(general ideas).

UNIT - II

Types of molecules. Diatomic linear. Symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules as a rigid rotator, Energy level and Spectra of non-rigid rotator, intensity of rotational lines,

UNIT- III

Vibrational energy of diatomic molecule, diatomic molecule as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, Vibration spectrum of diatomic molecule PQR branches, IR spectrometer(qualitative)

UNIT-IV

Introduction to ultraviolet, visible and infra-red spectroscopy, Raman spectroscopy: Introduction, pure rotational and vibrational spectra, Techniques and instrumentation, Photo electron spectroscopy, elementary idea about photoacoustic spectroscopy and Mossbauer spectroscopy (principle).

UNIT-V

Advances in Atomic and Molecular Nanotechnology- Atomic and Molecular Basis of Nanotechnology, Atoms by inference, Some Recent Key Inventions and Discoveries, Electron microscopes -Scanning electron microscope, Transmission electron microscope, Atomic force microscope.

Text and reference Books:

1. H.E. White Introduction to atomic spectra
2. C.B. Banwell Fundamental of molecular spectroscopy
3. Walker and Strnghem Spectroscopy vol. I, II and 111
4. G.M.Barrow Introduction to molecular spectroscopy
5. Herzberg Spectra of diatomic molecules
6. Jeanne L and McHale Molecular Spectroscopy
7. J.M.Brown Molecular Spectroscopy
8. P.F.Bemath Spectra of atoms and molecules
9. J.M. Halian Modern Spectroscopy
10. Principles of Nanotechnology: Molecular-based Study of Condensed Matter in Small System, By G. Ali Mansoori, World Scientific
11. Nanotechnology Basic Science and Emerging Technologies by Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, and Burkhard Raguse, [CHAPMAN & HALL/CRC].

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- III
PAPER- I – CONDENSED MATTER PHYSICS -I

UNIT -I

Crystal structure:

Bravais lattice in two and three dimension. Simple crystal structures: Hexagonal close packed structure, Diamond structure, zinc blende structure, sodium chloride structure, cesium chloride structure, Structure and properties of liquid crystal and Amorphous solid.

UNIT -II

Crystal diffraction by X-Ray:

Reciprocal lattice, Reciprocal lattice of bcc and fcc lattice. Relation between crystal lattice axes and crystal reciprocal lattice axes. Bragg diffraction. Condition in term of reciprocal lattice vector. Brillouin zones. Interaction of X-rays with matter, absorption of X-ray, elastic scattering from a perfect lattice. The reciprocal lattice and its application to diffraction technique in the laue, powder and rotating crystal method.

UNIT -III

Elastic properties of solids:

Stress and strain components, elastic compliance and stiffness constants, elastic energy density, reduction of number of elastic constants, elastic stiffness constants for isotropic body, elastic constant for cubic isotropic bodies, elastic waves, waves in (100),(110),(111) directions, experimental determination of elastic constants.

UNIT -IV

Lattice vibration and phonons:

Lattice dynamic of a diatomic linear lattice. Lattice vibrational spectrum. The concept of phonons momentum of phonons. Inelastic scattering of photons by phonons. Inelastic scattering of neutrons by phonons. Inelastic scattering of X-Ray.

UNIT -V

Thermal properties and band theory of solids:

Anharmonicity, thermal expansion, thermal conductivity, equation of state of solids, Gruneisen constant. Band theory, classification of solids, concepts of effective mass. Fermi surfaces, anomalous skin effect, De Hass van alphen effect, cyclotron resonance, magneto resistance.

Text and reference Books:

1. Verma and Srivastava: Crystallography for solid State physics.
2. Azaroff: Elementary to Solids.
3. Omar: Introduction Solids state physics.
4. Kittle: Solids state physics
5. Huong: theoretical solids state physics
6. Weertman and weertman: Elementary dislocation theory
7. Buerger: Crystal structure physics.
8. Made lung: introduction to solids state physics.

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- III
PAPER- II –NUCLEAR AND PARTICLE PHYSICS

UNIT -I

Nuclear Interactions :

Nucleon-nucleon interaction, Two-nucleon system, The ground state of the deuteron, Tensor forces, Nucleon-nucleon scattering at low energy, Scattering length, Effective range theory, Spin dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces, Iso-spin formalism, Exchange forces, Meson theory of nuclear forces and the Yukawa interaction.

UNIT -II

Nuclear Reactions :

Reaction energetics: Q-equation and threshold energies,Reactions cross sections, Resonance: Breit-Wigner single-level formula, Direct and compound nuclear reactions, Formal reaction theory: Partial wave approach and phase shifts, Scattering matrix, Reciprocity theorem,

UNIT -III

Nuclear Decay :

Beta decay, Femi's theory of beta decay, Shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, Selection rules, Parity violation, Two component theory of neutrino decay, Detection and properties of neutrino Gamma decay, Multiple transitions in nuclei, Angular momentum and Parity selection rules, Internal conversion, Nuclear isomerism.

UNIT -IV

Nuclear models :

Liquid drop model, Bohr-Wheeler theory of fission, Shell Model, Experimental evidence for shell effects, Single particle shell model, Spin-orbit interaction and magic numbers, Analysis of shell model predictions, Magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson.

UNIT -V

Elementary particle Physics:

The fundamental interactions, Classification of elementary particles, Leptons and Hadrons, Symmetries, groups and conservation laws, Quark model, Properties of Quarks, the standard model.

Cosmic Rays:

Nature composition, Charge and energy spectrum of primary cosmic rays, production and propagation of secondary cosmic rays. Soft penetrating and nucleonic components Origin of cosmic rays, Rossi curve, Bhabha- Heitler theory of cascade showers.

Text and reference Books:

1. A.Bohr and B.R.Mottelson, Nuclear structure, vol. 1 (1969) and vol.2, Benjamin, Reading, A, 1975.
2. Kenneth S.Kiane, Introductory Nuclear Physics, Wiley, New York, 1988.
3. Ghoshal, Atomic and Nuclear Physics vol.2.
4. P.H.Perking, Introduction to high energy physics, Addison-Wesley, London, 1982.
5. Shriokov Yudin, Nuclear Physics vol.1 & 2, Mir Publishers, Moscow, 1982.
6. D.Griffiths, introduction to elementary particles, harper and row, New York, 1987.
7. H.A.Enov, introduction to Nuclear Physics, Addison-Wesley, 1973.
8. G,E.Brown and A.D.Jackson, Nucleon-Nucleon interaction North-halland Amsterdam, 1976.
9. S.D.Benedetti, Nuclear interaction, John Willey and sons, NewYork, 1964.
10. M.K.Pal, theory of Nuclear structure, affiliated East West, Madras, 1982.
11. Y.R.Waghmare,introductory nuclear physics, Oxford, IBH, Bombay, 1981.
12. J.M.Longo, elementary particles, McGraw Hill, New York, 1971.
13. R.R.Roy and B.P.Nigam, Nuclear Physics, Wiley-Easterm Ltd. 1983.

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- III

PAPER- III – DIGITAL ELECTRONICS -I

UNIT -I

Number system (Binary, Octal, Decimal, hexadecimal) and conversion between them. Boolean arithmetic, signed and unsigned binary numbers, I's complement, 2's complement,

UNIT -II

Codes: BCD, Gray, ASCII, EBCDIC, Demorgans theorem, Gates: OR, AND, NOT, NOR, OR, NAND, XOR, XNOR, Boolean algebra, karnaugh map, adder and subtractor circuit design.

UNIT -III

Multiplexer, demultiplexer, encoder, decoder, parity checker and generator, Flip-Flops: R-S,D, J-k, J-k Master slave flip flop, race around condition registers, shift registers (left and right shift)

UNIT -IV

Counters-asynchronous (ripple) counter, synchronous (parallel) counter, MOD-5 counter and MOD-10 counter, BCD counter, Up-Down counter, Shift Register counter (Ring counter)

UNIT -V

Digital to analog conversion (Binary weighted register method, R-2R ladder network method, complete DAC structure. Analog to digital converters (Stair case or counter method, single slope, equal slope, successive approximation ADC)

Text and reference Books:

1. "Digital principles and applications" by A.P.Malvino and Donald P.Leach, Tata Megraw-Hill company, New Delhi, 1993.
2. "Microprocessor Architecutre, Programming and Applications with 8085/8086 by Rames S. Gaonkar, Wiley-eastern Ltd. 1987 (for unit V)"
3. Digital electronics –S.N. Ali
4. Digital electronics –Morries Mano
5. Microprocessor and Microcomputers-B.Ram-Dhanpat Rai publications V edition.

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- III

PAPER- IV –ATOMIC AND MOLECULAR PHYSICS-II

UNIT -I

Nuclear Magnetic Resonance Spectroscopy:

Concept of Nuclear Magnetic resonance spectroscopy, Interaction between nuclear spin and magnetic field, population of energy level, relaxation processes, spin-spin interaction and spin-spin coupling between two and more nuclei (Qualitative)

UNIT -II

Electronic spectra of Diatomic Molecules:

Franck Condon principles, dissociation and pre-dissociation, dissociation energy. Born-Oppenheimer-approximation, vibrational coarse structure of electronic spectra (bands progression and sequence).

UNIT -III

Raman Spectra

Raman effect, quantum theory of Raman effect, Molecular Polarizability in Raman effect, Vibrational Raman spectra, vibration-rotation Raman Spectra of diatomic molecules, application of Raman and infrared spectroscopy in the structure determination.

UNIT -IV

Mossbauer Spectroscopy:

Mossbauer effect, principles of Mossbauer spectroscopy, recoil less emission of gamma emission, line width and resonance absorption, application of Mossbauer spectroscopy (Isomer shift, Quadra pole splitting magnetic field effect).

UNIT -V

Electron Spin Resonance spectroscopy:

Elementary Idea about ESR, Principle of ESR, ESR spectrometer, splinting of electron energy levels by a magnetic field, g-Values, simple experimental setup of ESR. ESR spectra of free radicals in solution, An Isotropic system.

Text and reference Books:

1. Fundamentals of Molecular Spectroscopy-C.B. Banwell.
2. Spectra of Diatomic Molecules-Herzberg.
3. Mossbauer Spectroscopy-M.R.Bhide
4. NMR and Chemistry-J.W.Akitt
5. Modern Spectroscopy-J.M.Hollons

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- IV
PAPER- I –CONDENSED MATTER PHYSICS-II

UNIT -I

Super Conductivity:

Concept of super conducting state, persistent current, critical temperature, meissner effect, thermodynamics of the super conducting transitions, London equation and penetration depth, coherence length, Type I and Type II superconductors, B.C.S. theory of superconductivity. AC and DC Josephson effects, Josephson Tunneling.

UNIT -II

Magnetism:

Weiss theory of ferromagnetic Heisenberg model and molecular field theory, Domain and Bloch wall energy, Spin waves and mangnons, curie weiss law for susceptibility, Ferri and anti ferromagnetism, Neel temperature.

UNIT -III

Imperfection in crystals:

Imperfection in atomic packing, point defects, interstitial Schottky and frenkel defects, lattice vacancies, colour centres, F centres, F' centres, coagulation of F centres, production of colour centres and V centres, explanation of experimental facts, line defects, edge and screw dislocation, mechanism of plastic deformation in solids, stress and strain fields of screw and edge dislocation, elastic energy of dislocation, slip and plastic deformation, shear strength of single crystal, burgers vector stress fields around dislocation.

UNIT -IV

Thin film:

Study of surface topography by multiple beam interferometers, conditions for accurate determination of step height and film thickness (Fizeau frings) Electrical conductivity of thin films, expression for electrical conductivity of thin films, Hall-coefficient quantum size effect in thin film.

UNIT -V

Nano structure:

Definition and properties of nano structured material, different method of preparation of nano materials, plasma enchanted chemical vapour deposition, electro deposition. Structure of single wall carbon nano tubes (classification, chiral vector Cn, Translational vector T, Symmetry vector R, Unit Cell, Brillouin Zone) Electronic, mechanical, thermal and phonon properties.

Text and reference Books:

1. Kittel: Solid State Physics
2. Huang: Theoretical Solid State Physics
3. Weertmon and Weertman: Elementary Dislocation theory
4. Thomes: Multiple Electron microscopy
5. Tolansky: Multiple Beam Interferometer
6. J.P. Shrivastava, Solid State Physics.

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- IV
PAPER- II –LASER PHYSICS

UNIT -I

Basic principles of laser:
Introduction to laser, spontaneous and stimulated emission. Einstein coefficients. Idea of light amplification. Population inversion, laser pumping schemes for two and three level system with threshold condition for laser oscillation.

UNIT -II

Properties of Laser Beams and Resonators:
Properties of Laser-Temporal coherence, spatial coherence, directionality and monochromatic of laser beam, resonators, vibrational mode of resonators, laser amplification, open resonator.

UNIT -III

Types of lasers:
Solid state lasers i.e. Ruby Laser, Nd-Yag Laser, Semiconductor laser, Gas laser i.e. Carbon dioxide Laser, He-Ne Laser, Basic idea about liquid laser, Dye laser and chemical laser i.e. HCI and HF lasers.

UNIT -IV

Application of Lasers
Holography and its principle, theory of holograms, reconstruction of image, characteristics of Holographs, Application of lasers in chemistry and optics laser in Industry i.e. laser Belding, Hole drilling, laser cutting, application of lasers in medicine.

UNIT -V

Basic idea about non-linear optics
Harmonic generation, second and third harmonic generation, phase matching, optical mixing, parametric generation of light, self-focusing of light.

Text and reference Books:

1. Laser-syelto
2. Optical electronics-Yarive
3. Laser spectra scopy-demtroder
4. laser spectroscopy and instrumentation demotroder
5. Molecular spectra scopy-King
6. Non linear optics by B.B. Loud

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- IV
PAPER- III –DIGITAL ELECTRONICS-II

UNIT -I

OP-AMP:- Differential amplifier circuit configurations: dual input balanced output dual input, single input unbalanced output (ac analysis) only, block diagram of a typical op amp analysis, schematic symbol of an op- amp.

UNIT -II

OP-AMP Parameters:- Ideal op-amp., Op-amp parameters; input offset voltage, input offset current, input bias current, CMRR, SVRR, large signal voltage gain, Slew rate, Gain band width product, output resistance, supply currents power consumption, inverting and non-inverting inputs.

UNIT -III

Application of OP-AMP: Inverting and non-inverting amplifier, summing, scaling and averaging amplifier, integrator and differentiator. Oscillator Principles: oscillator types, frequency, stability response, the phase shift oscillator, Wein-bridge oscillator, L-C tunable oscillator, square wave generator.

UNIT -IV

Microprocessors and Micro Computers: Microprocessor and Architecture: Intel 8086, Microprocessor architecture modes of memory addressing, 8086/8088 Hardware specification: Pin-outs and pin functions, clock generator (8284A) Bus buffering and latching, Bus timing, Ready and wait state, Minimum mode versus maximum mode.

UNIT -V

Programming the Microprocessors: Addressing modes: Data addressing modes, program memory addressing modes, stack memory-addressing modes. Instruction set: data movement Instructions, Arithmetic and login instructions, program control instructions. Programming example: Simple assembly language programs table handling direct table addressing, searching a table sorting a table using pseudo ops.

Text and reference Books:

1. Digital Principles and Application : A. P. Melvino & D. P. Leech
2. Op-Amps & Linear Integrated circuits : R. A. Gayakwad
3. Electronics : D. S. Mathur
4. Digital Principles & Applications : Malvino & Leech
5. Microprocessor Architecture, Programming & Applications with 8085/8086 : R.S. Gaonker
6. Microprocessor & Digital Systems : D.V. Hall
7. Fundamentals of Electronics : Borker

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- IV

PAPER- IV – OPTIONAL (A)
COMMUNICATION ELECTRONICS

UNIT -I

Communication Electronics: Amplitude modulation – generation of AM waves demodulation of AM waves, DSBSC modulation, Generation of DSBSC waves, coherent detection of DSBSC waves, SSB modulation, generation and detection of SSB waves, vestigial sideband modulation.

UNIT -II

Propagation of Waves: Ground Waves, sky wave, space wave, propagation, maximum usable frequency, skip distance, virtual height, fading of signals, Satellite communication: orbital satellite, geostationary satellites, orbital pattern, look angles, orbital spacing, satellite system, link modules.

UNIT -III

Microwave: Advantages and disadvantages of microwave transmission loss in free-space, propagation of microwaves, atmospheric effects on propagation, Fresnel Zone problem used in microwave communication systems.

UNIT -IV

Digital Communications: Pulse-Modulation system, sampling theorem, Low pass and Band pass signals, PAM, channel BW for a PAM signal, Natural Sampling, Flat top sampling, signals Recovery through Holding, Quantization of signals, Quantization, Differential PCM Delta Modulation, Adaptive Delta Modulation, CVSD.

UNIT -V

Data Transmission: Base-band signal receiver, probability of error, optimum filter, white noise, matched filter and probability of error, coherent reception correlation, PSK, FSK, non coherent detection of FSK, differential PSK, QPSK, calculation of error probability for BPSK, BFSK, and QPSK .

Text and reference Books:

1. Digital Communications : W. Tomasi
2. Microwave : K. C. Gupta
3. Microwave Devices & Circuits : S.Y. Lio
4. Principle of Communication system : Taub & Schiling

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- IV
PAPER- IV – OPTIONAL (B)
MATERIAL SCIENCE

UNIT -I

Classification of Materials: Types of materials: Crystalline, Polycrystalline, Amorphous (Introduction and their structure), Elementary idea of polymers (structure and properties methods of polymerization, Glasses: Structure and properties, Type of Glasses, Fracture in glasses, Composite Materials: Introduction, their types and properties, Different types of bonding, Medalung energy for ionic crystal.

UNIT -II

Phase Transitions:- Thermodynamics of phase transformation, Free-energy calculation, I and II order transformation, Hume-Rother rule, solid solid solution and types of solid solutions, phase rule, One, Two component systems, Eutectic and peritectic phase diagrams, Lever rule, phase diagrams of Mg-Al, Fe-C Kinetics of transformations, Homogeneous and heterogeneous nucleation, Growth kinetics.

UNIT -III

Diffusion in Materials:- Mechanism of diffusion, Energy of formation and motion, long distance motion, Rate theory of diffusion, Einstein relation (relation between diffusivity and mobility), Fick's laws of diffusion and solution of Fick's second law, Kirkendal effect, Diffusion of vacancies in ionic crystals, Experimental determination of Diffusion coefficient.

UNIT -IV

Elastic and Inelastic Behaviour:- Atomic models for elastic behaviour, Elastic deformation in single crystals, Elastic anisotropy, Elastic constant and elastic module (Cubic system, isotropic body), Rubber like elasticity, anelastic behaviour, Thermo-elastic effect and relaxation process, Idea of visco elastic behaviour (Spring-Dashpot model), Determination of elastic constant of cubic crystaly by ultrasonic wave propagation

UNIT -V

Transport Properties of Solids:- Electrical conductivity of metals and alloys, Extrinsic, intrinsic semiconductors and amorphous semiconductors, Scattering of electrons by phonons, impurity, etc, Relaxation time, Carrier mobility and its temperature dependence, Mathiessio's rule for resistivity, temperature dependence of metallic resistivity.

Text and reference Books:

1. Introduction to Solids : L. V. Azaroff
2. Introduction to Solid State Physics : C. Kittle
3. Materials and engineering : Raghawan
4. Diffusion Kinetics for Atoms in Crystals : Manning
5. Theoretical solid State Physics : Huang
6. Materials Science and engineering :Callister VI Ed.

CHHINDWARA UNIVERSITY, CHHINDWARA
Semester- IV
PAPER- IV – OPTIONAL (C)
COMPUTATIONAL METHODS AND PROGRAMMING

UNIT -I

Programming : Elementary information about digital computer principles, compilers, interpreters and operating system. BASIC programming, Flow charts, integer and floating point arithmetic expressions, built in functions, executable and non-executable statements, assignments, control and input-output elements, subroutines and functions, operations with files, Graphics, statements.

UNIT -II

Methods for determination of zeros of linear and nonlinear algebraic equation and transcendental equations, convergence of solutions. Solutions of simultaneous linear equation, Gaussian elimination, pivoting, iterative method, matrix inversion.

UNIT -III

Eigen values and Eigen vectors of matrices, power and Jocobi method, finite differences, interpolation with equally spaced and unevenly spaced points. Curve fitting, polynomial least squares and cubic spline fitting. Numerical differentiation and integration, Newton-Cotes formulae, Error estimates, Gauss method.

UNIT -IV

Random variables, Monte Carlo evaluation of integrals, Methods of importance sampling, Random walk and metropolis method, Numerical solution of ordinary differential equation, Euler and Runge- Kutta Methods, Predictor and corrector method, Elementary ideas of solution of partial differential equation.

UNIT -V

This unit will have four questions based on tutorial problems covering all the four units. The students will have to answer any two questions out of four some sample problems are-

(1) Explain the use of sequential formatted data files. What are Random data files.

(2) How is a sequential data file created in Basic.

(3) Write a program to obtain the roots of a quadratic equation with the provision that if the roots are complex, the execution should stop.

(4) Invert and diagonalize 3×3 and 4×4 symmetric matrices for example.

$$\begin{pmatrix} 2 & 0.5 & 0.1 \\ 0.5 & 3 & 0.1 \\ 0.1 & 0.1 & 4 \end{pmatrix} \qquad \begin{pmatrix} 3 & 1 & 1 & 0.5 \\ 1 & 4 & 1 & 1 \\ 1 & 1 & 5 & 1 \\ 0.5 & 1 & 1 & 6 \end{pmatrix}$$

(5) Find equations for the coefficients a and b of the curve $y_ = _ ae^{bx}$ by the least squares method.

(6) Use the Lagrange from to find the quadratic interpolation polynomial to the function f(x) having values.

X :	1	2	3
F(x) :	2	3	7

(7) Find out C_0, C_1, X_0 and X_1 such that the Gaussion quadrature rule

$$f(x)dx = c_0f(x_0) + c_1f(x_1)$$

is exact for polynomials of degree upto three. Hence evaluate the integral of exp(x) over x from x = 0 to x = 2.

(8) What are the methods to solve partial differential equations? Write down the difference analogue of the Laplace equations.

$$U_{xx\_} +\_ U_{yy\_} =\_0$$

(9) Write a program to solve the Laplace equations using Lattice method.

(10) Give In addition to above, the tutorial will also consist of Solving problems given in the Text and Reference books.

Text and reference books

1. Introductory Methods of Numerical Analysis : Sastry
2. Numerical Analysis : Rajaraman
3. Fortran Programming : Rajaraman
4. Numerical Recipes : Utter mind Teukolsky, Press and Flattery
5. Programming with Basic : Gottfried (Schema Series)
6. Programming with Basic : Balaguruswamy
7. Numerical Analyses : Balagurswamy

CHHINDWARA UNIVERSITY, CHHINDWARA

Semester- IV

PAPER- IV – OPTIONAL (D)

PHYSICS OF NANOMATERIALS

UNIT -I

Applications of nano-materials

Quantum wells, wires and dots. Organic Semiconductors, Organic Light Emitting Diodes (OLEDs), self assembly of complex organic molecules, molecular switches, thermochromic switches, Motor molecules and bio-mimetic components, charge transfer complexes, molecular connections, contact issues, conducting polymers, light emitting polymers, polymer-polymer heterostructures, plastic FETs, photodiodes & solar cells, Nano Robotics: Nano robots and NEMS, Sensors and actuators, Artificial molecular machines, Biomotors, Other nano machines, Propulsion, Control, Communication, Programming and coordination.

UNIT -II

Applications of CNT

Applications of Carbon NanoTubes (CNTs) in field emission, fuel cells, CNT FETs, Light Emitting Displays (LEDs) and Flat Panel Displays (FPD), hydrogen storage, solar panels. Application of functional nanomaterials: clean energy (Hydrogen Production from Biomass, Catalytic coal hydrogasification), environmental technologies (clean water and air), health care (tissue and bone repairs, bio medical sensors)

UNIT -III

Nano Sensors and Biomedical applications

Nanosensors: Gas sensors, Pollution sensor, Photo sensor, Temperature sensor, IR detector, Biosensor, nanomaterial gas discharge devices, CNT based fluid velocity sensor. Nanoparticle in Drug delivery, Targeting Legends, Cancer Treatment, Mediated Delivery of Sirna, Nanonephrology, Nanosystems in Inflammation, Targeting Macrophages to Control Inflammation, Tissue Regeneration, Growth And Repair, Tissue Bioengineering, Future Understanding for Treatment, nanosurgery, Drug Delivery Technology Significance, Impact and Development.

UNIT –IV

Nano-Lithography

Photolithography Principles; Phase Shifting Optical Lithography; Electron Beam Lithography (EBL); Neutral Atomic Beam Lithography; Ion-Beam Lithography (IBL); X-ray Lithography (XRL); Proximal Probe Lithography, Proximal Probes, STM based Electron-Beam Lithography, Soft Lithography. Nano lithographic applications and current research.

UNIT –V

Sustainable Nanotechnology and Human Health

Application of industrial ecology to nanotechnology, Fate of nanomaterials in environment, environmental life cycle of nano materials, environmental and health impacts of nano materials, toxicological threats, eco-toxicology, exposure to nano particles – biological damage, threat posed by nano materials to humans, environmental reconnaissance and surveillance. Corporate social responsibility for nanotechnology,Nano materials in future - implications.

Text and reference books

1. Nano materials: Synthesis properties ,characterization and application: A.S Edelstein and R.C Cammaratra
2. Nanoelectronics and Nanosystems , Karl Goser, Peter Glosekotter, Jan Dienstuhl., Springer, 2004
3. Nanomaterial Systems Properties and Application, A.S.Eldestein and R.C.Cammarata.
4. Handbook of Nanotechnology: Bhushan (Ed), Springer Verlag, New York (2004).
5. Nanostructures and Nanomaterials- Synthesis properties and Applications by Guozhong Cao (Empirical College Press World Scientific Pub., 2004).
6. Nanocomposite Science and Technology, Ajayan, Schadler and Braun
7. Piezoelectric Sensors: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi.
8. Block Copolymers in Nanoscience Massimo Lazzari
9. Supramolecular Chemistry, Jonathan W. Steed, Jerry L. Atwood
10. Nanotechnology: Importance and Application by M.H. Fulekar, IK International,2010.
11. Nanotechnology in Biology and Medicine: Methods, Devices and Application by TuanVo-Dinh, CRC press, 2007.
12. Nanosystem characterization tools in the life sciences by Challa Kumar. Wiley-VCH, 2006.
13. Nanolithography M.Gentili et al.(edits),Springer.
14. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
15. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
16. Na notechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.
17. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca
18. The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation by Dirk Bouwmeester, Artur K. Ekert, Anton Zeilinger
19. Problems And Solutions in Quantum Computing And Quantum Information Yorick Hardy Willi-Hans Steeb