Department of Physics

SANT GURUGHASIDAS, Govt. P G College, Kurud
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Course outcome

Semester - I
PAPER-I: MATHEMATICAL PHYSICS

Objectives

To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.

Learning Outcomes:
At the successful completion of the course the student is expected to the following.

CO1: Revise the knowledge of calculus, vectors, vector calculus, probability and probability distributions. These basic mathematical structures are essential in solving problems in various branches of Physics as well as in engineering.

CO2: Learn about the complex numbers and their properties, functions of complex numbers and their properties such as analyticity, poles and residues. The students are expected to learn the residue theorem and its applications in evaluating definite integrals.

CO3: Training in mathematical tools like calculus, integration, series solution approach, special function will prepare the student to solve ODE; PDE's which model physical phenomena.

CO4: Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their differential equations and their applications in various physical problems such as in quantum mechanics which they will learn in future courses in detail.

CO5: Learn about the Fourier transform, the inverse Fourier transform, their properties and their applications in physical problems. They are also expected to learn the Laplace transform, the inverse Laplace transforms, their properties and their applications in solving physical problems.

(i) Course learning outcome:
In the laboratory course, learn the fundamentals of the C and C++ programming languages and their applications in solving simple physical problems involving interpolations, differentiations, integrations, differential equations as well as finding the roots of equations.

PAPER-II: Classical Mechanics

Objectives

The course aims to develop an understanding of Lagrangian and Hamiltonian formulation which allow for simplified treatments of many complex problems in classical mechanics and provides the foundation for the modern understanding of dynamics.

Learning Outcomes:

At the successful completion of the course the student is expected to the following.

CO1: Revise the knowledge of the Newtonian, student know to modern dynamics Lagrangian and Learn to define generalised coordinates, generalised velocities, generalised force and write Lagrangian for mechanical system in terms of generalised coordinates. Student also able to be learn D'Alembert's principle and Lagrange's equations,

CO2: Student has developed the knowledge of modern mechanics like Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems. The students also will be able to apply Legendre transformations and the Hamilton's equations of motion, cyclic coordinates and Conservation Theorems, Hamilton's equations from Hamilton's principle, the principle of least action.

CO3: Student able to be learn Canonical transformations with examples of harmonic oscillator, Poisson's brackets, Equations of motion and conservation theorems in the Poisson Bracket formulation. Hamilton-Jacobi (HJ) theory:

CO4: Learn to the Central force: Two-body central force problem and its reduction to the equivalent one-body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The differential equation of the orbit, Closure and stability of orbits, The Kepler problem, Scattering in a central force field: Rutherford scattering.

CO5: Formulate the problem of small amplitude oscillation and solve them to obtain normal modes of oscillation and their frequencies in simple mechanical systems. Rigid body dynamics, The Euler angles, Euler's theorem on the motion of a rigid body, Rate of change of a vector, The Coriolis force, Angular momentum and Kinetic energy of motion about a point, The Euler equations of motion of rigid bodies.

PAPER-III: Electrodynamics & Plasma Physics

Objectives

To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method and provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences. Also provide new concept of plasma physics.

Learning Outcomes:

At the successful completion of the course the student is expected to the following.

CO1: Achieve an understanding of the Maxwell's equations, role of displacement current, gauge transformations, scalar and vector potentials, Coulomb and Lorentz gauge, four-vectors, mathematical properties of the spacetime in special relativity, matrix representation of Lorentz transformation, covariance of electrodynamics, and transformation of electromagnetic fields.

CO2: Review the retarded potentials, potentials due to a moving charge, Lienard Wiechert potentials, electric and magnetic fields due to a moving charge; power radiated Larmor's formula and its relativistic generalization. Students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.

CO3: Student understands to different types of radiated emission like Bremsstralung: emission from single-speed electrons, thermal Bremsstralung emission and absorption, Synchrotron radiation: spectrum of synchrotron radiation, spectral index for power law electron distribution, transition from Cyclotron to Synchrotron emission, Cherenkov radiation

CO4: Student able to learn Plasma physics, Debye shielding phenomenon and criteria for plasma,motion of charged particles in electromagnetic field; Uniform E & B fields, Electric field drift, Non-uniform magnetostatic field, Gradient B drift, Parallel acceleration and magnetic mirror effect, Curvature drift, adiabatic invariants.

CO5: Students have good Understanding of Elementary concepts of plasma kinetic theory, the Boltzmann equation, the basic plasma phenomena, plasma oscillations. Fundamental equations of magneto-hydrodynamics (MHD), Hydrodynamics Waves; Magneto sonic and Alfven waves, Magnetic viscosity and magnetic pressure, plasma confinement schemes.

PAPER-IV: Electronics

Objectives

To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that is part of the technologies.

Course learning outcome:

At the successful completion of the course the student is expected to the following.

CO1: Learn the basics of Operational Amplifier- Basic Op. Amp. Differential amplifier, the emitter coupled Difference Ampl, Transfer characteristics of a Diff. Ampl, an example of an IC Op.-Amp., off set error voltage and currents, measurement of Op.-Amp. Parameters, frequency response of Op-amp. Linear analog systems: Basic Op.-Amp. Applications, Analog integration and differentiation, Electronic analog computation, Non-linear analog systems: Comparators, Waveform generators.

CO2: Learn fundamental of Sequential Logic, Flip-flops: RS Flip-flop, level clocking, Edge triggered Flip Flops, D Flip flops. JK Flip-flops, J.K.master slave Flip-flops, Registers: buffer, shift and control shift registers, counters: ripple synchronous & ring counters, tri-state registers, Buffer: controlled buffer Register, Bus organized structure, Latch, multiplexer, Demultiplexer, decoder, ALU Memories: RAM, ROM, PROM, EPROM, A/D and D/A converters.

CO3: Learn about Combinational Logic –Basic logic gates: OR, AND and NOT gates, NOR and NAND gates, Boolean algebra, DeMorgan's theorems, exclusive OR gate, characteristics of logic families, saturated logic families: RTL, DCTL, nonsaturated logic families: TTL and ECL, Unipolar logic families.

CO4: Understand basics of microprocessor and assembly language programming with examples. Microprocessors – Building concept of microprocessors, developing inside of microprocessor , Instruction codes ,Instruction Register ,Introducing RESET Pin, Introducing on chip oscillator, Interfacing I/O devices, Introducing Interrupt lines :Stack,Push,Pop operation ,delay in servicing interrupts, multiply interrupts, location for interrupts .Introducing slow and fast data transfer, Status of microprocessor, interrupt pins, General purpose Register, flag Register, Increment/decrement register. Features of 8085 microprocessor. Pin diagram of 8085, block diagram of 8085. CPU of a microprocessor, timing and control, system timings and interrupt timings of 8085, registers in 8085, interfacing memory and I/O devices- preliminary ideas. Number system, Floating Point notation.

CO5: Learn basic Instructions set of 8085, types of instructions- Data transfer group, Arithmetic logic, branch group, stack I/O machine control group, addressing mode of Intel 8085, examples of Assembly language programs of 8085, summing of two 8-bit numbers to result a 16-bit number, summing two 16-bit number, multiplying two 8-bit number to result a 16-bit product, block transfer of data from one memory block to other, BCD to hexadecimal data, finding the largest number in a series.

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Laboratory Course

LAB I-A: General & Optics

1. Determination of band gap of semiconductor by four prob method.
2. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration.
3. Determination of wavelength of mercury light by constant deviation spectrometer using Hartmann formula.
4. Ultrasonic velocity in a liquid as a function of temperature using ultrasonic interferometer.
5. Experiment on transmission line (A) Determination of characteristics impedance,
(B) Study of voltage distribution.
6. Determination of the Curie temperature of ferromagnetic material.
7. Determination of forbidden gap of a diode by plotting reverse saturation current as a function of temperature.
8. Determination of ionization potential of Lithium/Mercury.
9. Determination of e/m of electron by Normal Zeeman Effect using Febry –Perot Etalon.
10. Measurement of wavelength of He-Ne Laser light using a ruler and thickness of thin wire by the laser.

LAB I-B: Electronics

1. Design & Study of Regulated Power supply.
2. Study of Transistor Amplifiers in CE, CB, and CC modes.
3. Study of Transistor Bias Stability.
4. Study of Astable, Monostable and Bistable Multivibrator.
5. Study of Silicon Controlled Rectifier.
6. Experiment of Uni – Junction Transistor and its application.
7. Experiment of FET and MOSFET characterization and application as an amplifier.
8. Study of Differential. Amplifier.
9. Basic Logic gates and verification of their Truth- Tables.
10. Combinational logic gates and verification of De-Morgan's Theorem.
11. Study of Basic Operational Amplifier (741).
12. Study of Opto- Electronics Devices.

SEMINAR & GROUP DISCUSSION

CO1: Understands advance problem based on topics related to all paper of semester-I.
CO2: The ability to communicate their ideas effectively, both orally and in writing.
CO3: Understands function effectively in multidisciplinary teams and topics.

Semester – II
PAPER - I: QUANTUM MECHANICS-I

Objectives
This course will enable the student to get familiar with quantum mechanics formulation.

Course learning outcome:
At the successful completion of the course the student is expected to the following.

CO1: Students are understands the Inadequacy of classical mechanics, Plank quantum hypothesis and radiation law, Photoelectric effect, de-broglie's theory. Schrödinger equation, continuity equation, Ehrenfest theorem, admissible wave functions, stationary states, one-dimensional problems; walls and barriers, Schrödinger equation for harmonic oscillator and its solution, uncertainty relations, states with minimum uncertainty product.

CO2: students learn about Superposition principle, general formalism of wave mechanics, representation of states and dynamical variables, commutation relationship, completeness and normalization of eigen functions, Dirac-delta function, Bra & Ket notation, matrix representation of an operator, harmonic oscillator and its solution by matrix method, Heisenberg equation of motion.

CO3: student able to learn some quantum mechanical mathematical tools like Angular momentum in quantum mechanics, commutation relationships, eigen values, Spin angular momentum, Pauli`s matrices, addition of angular momentum, Clebsch-Gordon coefficients.

CO4: students able to apply application of quantum mechanics for example Central force problem, spherically symmetric potentials in three dimensions, separation of wave equation, parity, three-dimensional square-well potential and energy levels, the hydrogen atom; solution of the radial equation, energy levels and stationery state wave functions, discussion of bound states, degeneracy.

CO5: students have knowledge of approximation method of quantum mechanics, that is Time-independent perturbation theory, non-degenerate case, first order and second perturbations with the example of an oscillator, degenerate cases, removal of degeneracy in second order, Zeeman effect without electron spin, first-order Stark effect in hydrogen, perturbed energy levels, correct Eigen function, occurrence of permanent electric dipole moments.

PAPER – II: STATISTICAL MECHANICS

Objectives
To develop an understanding of fundamentals of statistical mechanics and enhance the concepts of statistical mechanics.

Course learning outcome:

At the successful completion of the course the student is expected to the following.

CO1: Understand the concepts of statistical mechanics: macroscopic and microscopic states, Contact between statistics and thermodynamics, physical significance of Ώ(N,V, E), the classical gas, entropy of mixing and Gibb's paradox, phase space of classical system, Lowville's theorem and its consequences, quantum states and phase space.

CO2: Understand the concepts of Elements of ensemble theory – A system in micro canonical, canonical, and grand canonical ensembles, partition functions, physical significance of statistical quantities, example of classical system, energy and energy-density fluctuations and mutual correspondence of various ensembles.

CO3: Understand the Formulation of quantum statistics – Quantum mechanical ensemble theory, Density matrix, statistics of various quantum mechanical ensembles, system composed of indistinguishable particles.Theory of simple gases –Ideal gas in various quantum mechanical ensembles, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions, statistics of occupation number.

CO4: Learn the importance of Ideal Bose and Fermi gases -Thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation and, elementary excitations in liquid helium II, nonrelativistic and relativistic degenerate electron gas, theory of white dwarf stars.

CO5: Learn the importance of Statistical Mechanics of interacting systems – the method of cluster expansion for a classical gas, Virial expansion of the equation of state. Theory of phase transition – general remark on the problem of condensation, Fluctuations: thermodynamic fluctuations, spatial correlation in a fluid Brownian motion: Einstein Smoluchowski theory of Brownian motion.

PAPER –III: ELECTRONIC & PHOTONIC DEVICES AND OPTICAL MODULATORS

Objectives

To develop an understanding of semiconductor devices and get the practical knowledge of electronics devices which are part of the technologies.

Course learning outcome:

At the successful completion of the course the student is expected to the following.

CO1: Understand the component of electronics like Special Bipolar devices: Thyristors- the four-layer diodes and their basic characteristics, Shockley diode, three terminal thyristor, Diac & Triac, SCR, UJT, and Field controlled Thyristors.

CO2: Understand the basics of Unipotar Devices : JFET, MESFET and MOSFET, basic structure, working and device I-V characteristics, small signal equivalent circuit for Microwave performance Introduction to MIS and MOS diodes, charge coupled devices (CCDs), basic structure and working principle , MOSFET-basic device characteristics, types of MOSFET.

CO3: Understand the Special Microwave Devices: Tunnel diode and backward diode- basic device characteristics, IMPATT diodes and their static and dynamic characteristics, Transfer electron devices-transferred electron effect, Gunn diodes.

CO4: Understand about Photonic Devices: Radiative transitions, LEDs, Visible and infrared SC lasers; Photo detectors; Photo conductor, & Photodiode, Solar cells, Solar radiation and ideal conversion efficiency, p-n junction solar cells, Hetero junction. Interface thin film solar cells.

CO5: Understand the basic concept of Optical Modulators and Display Devices: Modulation of light-Birefringence, Optical activity, Electro-optic, Magneto-optic and Acoustic- optic effects, Materials exhibiting these properties, Non-linear optics. Display devices: Luminescence, Photo-luminescence, Electro-luminescence, Liquid crystal displays, Numeric displays.

PAPER – IV: COMPUTATIONAL METHODS AND PROGRAMMING

Objectives

The student should acquire the knowledge of Windows, LINUX operating system and the students also should be learn the skills for writing a flow chart and then writing the corresponding program for a specific problem using the C/ C++/FORTRAN language.

Course learning outcome:

At the successful completion of the course the student is expected to the following.

CO1: Learn the Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative method, matrix inversion.

CO2: Learn the 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.

CO3: Students solve the problem and find out the Numerical solution of ordinary differential equations, Euler and Runga-Kutta methods, predictor-corrector method, and elementary ideas of solutions of partial differential equations.

CO4: Students Have a developed a working knowledge about the digital computer principles, compilers, interpreters and operating systems(Windows/Linux) , Learn how to plan for writing the algorithm and flow charts for solving problem by using Fortran programming, integers and floating point arithmetic, expressions, built in functions.

CO5: Students able to learn basic of Executable and non-executable statements, assignments, control and input output statements, subroutines and functions; The statement functions, main features of functions and subroutines ,subprogram, function subprogram, overall structure of FORTRAN programe, external statement, subroutine subprogram ,common statement, equivalence statement, operations with files-open and close statement, Format statements, field specifications.

Laboratory Course
LabII-A: Numerical Analysis & Computer Programming

In the laboratory course, learn the fundamentals of the using the C/ C++/FORTRAN programming languages and their applications in solving simple physical problems involving interpolations, differentiations, integrations, differential equations as well as finding the roots of equations.

Following practical should be performed in computer lab

1. To solve simultaneous Linear equation by Gauss Elimination method.
2. To calculate the root of a transcendental equation by Newton – Raphsons method.
3. Solving the system of linear simultaneous equation by Gauss Sedel method.
4. Numerical Integration by Simpson's 1/3 Rule.
5. Solving simultaneous Linear equation by Gauss-Jordon method.
6. Solution of Differential equation by Euler's Method.
7. To invert a given matrix by Gauss-Jordon Method.
8. Solution of Differential equation by Runga Kutte Method.
9. WAP to find the Largest of n number of series.
10. To write a program to compute the Eigen values of a given matrix.
11. To integrate a given function by: (a) Trapezoidal method or by (b) Gauss Quadrature.
12. To find solutions of Ist order, ordinary differential equation by Taylor method

Lab II-B: Digital Electronics & Microprocessor

1. Study of R-S, D/T, J-K Flip-Flops.
2. Study of counters: Ripple, Mode 3, Mode 5 counters.
3. Study of Shift Register.
4. Study of R-2R D/A Converter.
5. Study of Random Access Memory (RAM) Read Only Memory. (ROM)
6. Study of A/D Converter.
7. Experiment with Microprocessor:- I
(a) Convert BCD in to HEXADECIMPL
(b) To transfer group of date blocks from one location to another location.
8. Experiment with microprocessor: - II
(a) To write programs for addition of two 1 byte data giving results of 2 bytes.
(b) To write programs for multiplication of two 1 byte data giving results of 2 bytes.
9. (a) To add 2 16-BIT numbers stored in locations from x x x x to x x x x + 3 and add them store the results from x x x x + 4 to x x x x+6 memory location
(b) To find the largest of n numbers of a series.
10. To arrange N numbers in an ascending orders.
11. Experiments with Microprocessor.
(a) Convert BCD in to binary and vice-versa.
(b) To transfer group of data blocks from one location to another location.
(c) To write programs for addition of two 1byte data giving result of 2byte data
(d) To write programs for multiplication of two 1 byte data giving result of 2byte data.

SEMINAR & GROUP DISCUSSION

CO1: Understands advance problem based on topics related to all paper of semester-II.
CO2: The ability to communicate their ideas effectively, both orally and in writing.
CO3: Understands function effectively in multidisciplinary teams and topics.

Semester – III
PAPER –I: QUANTUM MECHANICS –II

Objectives
To develop a new concept of quantum mechanics specially on relativistic quantum mechanics and some approximation method which is help to solve the problem.

Course learning outcome:

At the successful completion of the course the student is expected to the following.

CO1: Develop the knowledge of approximation method of quantum mechanics. Variational method, expectation value of energy, application to excited states, ground state of He-atom, Zero point energy of one dimensional harmonic oscillator, Vander-waals interaction, the W.K.B. approximation, approximate solutions, asymptotic nature of the solution, solution near turning point, connection formulae, energy levels of a potential well and quantization rule.

CO2: Develop a knowledge of theory of scattering: differential and total scattering cross section, wave mechanical picture of scattering & the scattering amplitude, Green's functions and formal expression for scattering amplitude, The Born approximation and its validity, Partial wave analysis, asymptomatic behavior of partial waves and phase shifts, optical theorem, scattering by a square well potential, scattering by a hard sphere, scattering by a Coulomb potential.

CO3: Learn the time-dependent perturbation theory, first order perturbation, Harmonic perturbation, Fermi`s Golden rule, Ionization of a H-atom, absorption and induced emission, Selection rules. Identical particles, symmetric and anti-symmetric wave functions.

CO4: students able to learn relativistic quantum mechanics, formulation of relativistic quantum theory, the Klein-Gordon equation; plane wave solutions, charge and current densities, The Dirac equation for a free particle, matrices alpha and beta, Lorentz covariance of the Dirac equation, free particle solutions and the energy spectrum, charge and current densities.

CO5: Develop a knowledge and understanding of the spin of the Dirac particle, Dirac particle in electromagnetic fields and the significance of the negative energy state, Dirac equation for a central field: Spin angular momentum, approximate reduction, and spin –orbit energy, separation of equation, the hydrogen atom, classification of energy levels and negative energy states.

PAPER –II: ATOMIC AND MOLECULAR PHYSICS

Objectives

To enhance the knowledge of atomic physics and atomic models which is play a important role in modern physics.

Course learning outcome:

At the successful completion of the course the student is expected to master the following.

CO1: Understand the basic concept of atomic physics and learn about quantum states of one electron atoms-atomic orbitals, Hydrogen spectrum, spin orbit (l-s) interaction energy, fine structure of hydrogen spectrum including l-s interaction and relativistic correction, spectra of alkali elements, fine structure in alkali spectra, penetrating and non-penetrating orbits, and intensity rules.

CO2: Understand many electron atoms and interaction of spins i.e. interaction energy in L-S. And J-J. Coupling. Pauli's principle, equivalent and non-equivalent electrons, ground state (basic level of different elements), Hyperfine structure, line broadening mechanisms (general ideas).

CO3: Understand effect of external fields to spectra like, Normal and anomalous Zeeman effect, Paschen-Back (PB) effect – principal series effect, Zeeman and PB effects in hydrogen, Stark effect-discovery, Stark effect in Hydrogen, early discoveries and developments, vector models of one electron system in a weak magnetic field, magnetic moment of a bound electron, magnetic interaction energy, orbital model, weak and strong effect in Hydrogen. Selection rules, intensity rules.

CO4: Learn to basic idea of molecular spectra and molecular types. Also learn about types of molecules: linear and diatomic molecules, symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules: rigid rotator model, energy levels, Eigen functions, spectrum, comparison with observed spectrum and non-rigid rotator model, Intensities of spectral lines, microwave spectrometer, Raman spectrum; classical and quantum theory of Raman Effect, pure rotational Raman spectrum. Understand rotational, vibrational, electronic and Raman spectra of molecules and their applications.

CO5: Able to describe vibrational spectra of diatomic molecules: simple harmonic model, energy levels and spectrum, comparison with observed spectrum and anhormonic model, Vibrating rotators, Interaction of rotations and vibrations, fine structures and P-Q-R branches, IR spectrometer, Vibrational Raman spectrum, Vibrational rotational Raman spectrum, and their applications.

PAPER – III: SOLID STATE PHYSICS-I

Objectives

Condensed matter physics is part of material science which is help to know the properties of solid materials.

Course learning outcome:

At the successful completion of the course the student is expected to the following.

CO1: student understand how to band is formation in solid as well as **Electronic Properties.** Energy bands: nearly free electron model, origin of energy gap and its magnitude, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, restatement of Bloch theorem, crystal moment of an electron, solution of Central equation, Kronig-Penny model in reciprocal space, empty lattice Approximation, approximate solution near zone boundary, Number of orbitals in a band, metals and insulators.

CO2: student able to know **Fermi surfaces and metals,** Effect of temperature on F-D distribution, free electron gas in three dimensions. Different zone schemes, reduced and periodic zones, construction of Fermi surfaces, nearly free electrons, electron, hole, open orbits, Calculation of energy bands, Tight binding, Wigner-Seitz, cohesive energy, pseudo potential methods. Experimental methods in Fermi surface studies, quantization of orbits in a magnetic field, de Haas van Alphen Effect, External orbits, Fermi surface of copper.

CO3: student are acquire the knowledge of **Crystal vibration and thermal properties** Lattice dynamics in monoatomic and diatomic lattice: two atoms per primitive basis, optical and acoustic modes, quantization of elastic waves, phonon momentum, inelastic neutron scattering by phonons, Anharmonic crystal interactions-thermal expansion, thermal conductivity, thermal resistivity of phonon gas, umklapp processes, imperfections.

CO4: student are knowing about **Electron-Phonon interaction- superconductivity,** Experimental survey: occurrence of superconductivity, Destruction of superconductivity by magnetic field, Meissner effect, heat capacity, energy gap, MW, and IR properties, isotope effect. Theoretical survey: thermodynamics of superconducting transition, London equation, Coherence length, Cooper pairing due to phonons, BCS theory of superconductivity, BCS ground state, flux quantization of superconducting ring, duration of persistent currents, Type II superconductors, Vortex states, estimation of H_{c1} and H_{c2}, single particle and Josephson superconductor tunneling, DC/AC Josephson effect, Macroscopic quantum interference. High temperature superconductors, critical fields and currents, Hall number, fullerenes ring.

CO5: recapitulation of **Semiconductor,** Band gap, equation of motion, physical derivation of equation of motion, holes, effective mass, physical interpretation of effective mass, effective masses of semiconductors Si and Ge, intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor and acceptor states, thermal ionization of donors and acceptors, thermo-electric effects.

Paper – IV (B) ELECTRONICS (Communication)-I

Objectives

To develop basic knowledge of Radars and microwave devices which are used in signal processing and communication system.

Course learning outcome:

At the successful completion of the course the student is expected to master the following.

CO1: Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering. Student are learn to Microwave devices like Klystron, magnetron & traveling wave tubes, velocity modulation, basic principal of two cavity klystrons & relex klystrons, principle of operation of magnetrons, helix traveling wave tubes.

CO2: able to learn microwave propagation technique in guided medium which are used in microwave applications and learn to Microwave wave guides & components like (Wave modes) rectangular wave guides: solution of wave equation in rectangular coordinates, TE modes in rectangular wave guides, TM modes in rectangular wave guides, excitations of modes in rectangular wave guides. Circular wave guides: solutions of wave equation in Cylindrical coordinates, TE modes in Circular wave guides, TM modes in Circular wave guides, TEM modes in Circular wave guides, excitations of modes in Circular wave Guides.

CO3: able to learn microwave communication technique, Microwave cavites: rectangular cavity resonator, circular –cavity resonator &semi –circular –cavity resonators Q- factor of a cavity resonator.Transferred Electrons devices (TEDs) Gunn effect diodes, principle of operation, modes of operations, read diodes, IMPATT diodes, TRAPATT diodes. Microwave communications: advantages of microwave transmission, loss in free space, propagation of microwave, components of antennas used in MW communication system.

CO4: student are develop the knowledge of Radar system: Radar block diagram & operation, radar frequencies ,pulse consideration, radar range equation, derivation of radar range equation , minimum detectable single receiver noise, signal to noise ratio ,integration of radar pulses ,radar cross sections ,pulse reflections frequency ,antenna ,parameters ,systems losses & propagation losses ,radars transmitters receivers ,antennas displays

CO5: students acquire the knowledge of Satellite communication, Orbital Satellite, geostationary satellite, orbital patterns, look angles, orbital spacing, satellite system, link modules.

Lab III-A: Materials Science & General

At least ten experiments should be performed from the following list of experiments or parallel level experiment depending upon the facilities available.

1. To determine activation energy of ionic/superionic solid by Temperature depended conductivity measurement.
2. To study Electron Spin (ESR) Resonance in DPPH (Diphenyl Pricyl Hydrazy) sample.
3. To study I-V characteristics of photovoltaic solar cell and find the efficiency.
4. To study the decay of photoconductivity of given sample and find out trap depth.
5. Study of decay of photoluminescence of a given sample.
6. Measurement of electrical conductivity using Impedance Spectroscopy technique.
7. To determine drift velocities of Ag+ ion in AgI from temperature dependence of ionic transference number study.
8. Electrical conductivity of Ball milled/Mechano-chemical synthesized materials.
9. Determination of strength of a given radioactive source.
10. Study of complete spectra of radioactive sources, and study of photo peak efficiency of NaI(Tl) crystal for different energy gamma rays.
11. Structural analysis of powder sample by XRD and particle size determination using Scherrer's formula.
12. Study of Op-Amp.-IC-741 is inverting/ Non inverting amplifier and draw frequency response curve.
13. Construction of Schmitt triggers using IC-741 and study of its characteristics.
14. Study of Astable and monostable Multi Vibrator using IC 555.
15. Digital electronics experiments on bread board using IC-7400.

III -B: Electronics

(1) Experiments with microprocessor.
(a)Convert BCD in to binary & vice versa.
(b) Study of BCD to seven segment Decoder.
(c) To write programme for addition & subtraction.
(d) To write programme for multiplication & division.
(2) Logic gate study DTL & RTL.
(3) To study& verify the Demorgon's Theorem.
(4) Study of Adder/ Subtractor.
(5) Study of Encoder & Decoder.
(6) Study of Multiplexer & Demultiplexer
(7) Study of digital to analog converter.
(8) Study of analog to digital converter.
(9) Study of 4-bit Counter/ ripple Counter.
(10) Study of left/right shift register.

Semester – IV
PAPER – I: NUCLEAR AND PARTICLE PHYSICS

Objectives:

Skills to describe and explain the properties of nuclei. Explain and derive the various theoretical formulations of nuclear properties as well as nuclear decay like α decay, β decay and gamma decays. Students have developed the basic knowledge of elementary particles as fundamental constituent of matter.

Course learning outcome:
At the successful completion of the course the student is expected to master the following.

CO1: Learn about the 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.

CO2: Learn the basic aspects of 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.

CO3: Learn about the process of radioactivity, the radioactive decay law 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.

CO4: Know about the nuclear models and their roles in explaining the ground state properties of the nucleus**.** We have different nuclear models like 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.

CO5: Gain knowledge on the basic aspects of Elementary particle Physics: The fundamental interactions, Classification of elementary particles, Leptons and Hadrons, Symmetries, groups and conservation laws, SU(2) and SU(3) multiplets and their properties, Quark model, Properties of Quarks, the standard model.

PAPER – II LASER PHYSICS AND APPLICATIONS

Objectives:

Laser physics is part of modern optical physics which are play important role in medical field, defense field, communication etc.

Course learning outcome:

At the successful completion of the course the student is expected to master the following.

CO1: Familiar with optical phenomena and technology, **Laser Characteristics –**Spontaneous and stimulated emission, Einstein's quantum theory of radiation, theory of some optical processes, coherence and monochromacity, kinetics of optical absorption, line broadening mechanism, Basic principle of lasers, population inversion, laser pumping, two & three level laser systems, resonator, Q-factor, losses in cavity, threshold condition, quantum yield.

CO2: learn to types of **Laser Systems**
Solid state lasers- the ruby laser, Nd:YAG laser, ND: Glass laser, semiconductor lasers – features of semiconductor lasers, intrinsic semiconductor lasers, Gas laser -neutral atom gas laser, He-Ne laser, molecular gas lasers, CO2 laser, Liquid lasers, dye lasers and chemical laser.

CO3: develop to knowledge of advances in laser Physics, Production of giant pulse -Q-switching, giant pulse dynamics, laser amplifiers, mode locking and pulling, Non-linear optics, Harmonic generation, second harmonic generation, Phase matching, third harmonic generation, optical mixing, parametric generation and self-focusing of light.

CO4: Multi-photon processes; multi-quantum photoelectric effect, Theory of two-photon process, three-photon process, second harmonic generation, parametric generation of light, Laser spectroscopy : Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect, Coherent anti-stokes Raman Scattering, Photo-acoustic Raman spectroscopy.

CO5: familiar with Laser Applications **–** ether drift and absolute rotation of the Earth**,** isotope separation, plasma, thermonuclear fusion, laser applications in chemistry, biology, astronomy, engineering and medicine**.** Communication by lasers: ranging, fiber Optics Communication**,** Optical fiber, numerical aperture, propagation of light in a medium with variable index, pulse dispersion.

PAPER – III: SOLID STATE PHYSICS- II

Objectives:

Solid state physics is part of material science .in this course student learns about different properties of solid materials like Plasmons, Polaritons, Excitons, Dielectric, & ferroelectrics, Optical Processes, dia- and para- magnetisms, Ferromagnetism and anti-ferromagnetism etc.

Course learning outcome:

At the end of the course the student is expected to learn and assimilate the following.

CO1: A brief idea about Plasmons, Polaritons, Dielectric function of the electron gas, Plasma optics, Dispersion relation for EM wave, Transverse optical modes in Plasma, Transparency of Alkali metals in the ultraviolet, Longitudinal Plasma oscillations, Plasmon, electrostatic screening and screened Coulomb potential, Mott metal-insulator transition, screening and phonons in metals, Polaritons, LST relation .

CO2: Knowledge of Dielectric and ferroelectrics Maxwell's equations, polarization, macroscopic electric field, depolarization filed, E1;local electric field at an atom, Lorentz filed E2, fields of dipoles inside cavity E3; dielectric constant and polarizability, electronic polarizability; structural phase transition; ferro-electric crystals, classification; displacive transition, soft optical phonons, Landau theory of phase transitions, first and second order transition, antiferro-electricity, ferroelectric domain, piezoelectricity, ferro-elasticity, optical ceramics.

CO3: At knowledge of different types of magnetism from Ferromagnetism and anti-ferromagnetism Ferromagnetic order, Curie point and exchange integral, temp dependence of saturation magnetization, saturation magnetization at absolute zero; magnons, quantization of spin waves, thermal excitation of magnons; neutron magnetic scattering, Ferrimagnetic order, Curie temp and susceptibility of ferrimagnets, iron garnets. Antiferromagnetic order, susceptibity below neel temp, antiferromagnetic magnons, ferromagnetic domains.

CO4: understanding about the Magnetism General ideas of dia- and para- magnetisms, quantum theory of paramagnetism, rare earth ions, Hund rule, iron group ions, crystal field splitting, quenching of orbital angular momentum, spectroscopic splitting factor, van vleck temperature dependent paramagnetism, Cooling by isentropic demagnetization, nuclear demagnetization, paramagnetic Susceptibility of conduction electrons.

CO5: Learn basics of Optical Processes & Excitons and defects Optical reflectance, excitons, Frenkel and Mott-Wannier excitons, Alkali Halides and Molecular crystals Defects: lattice vacancies, Schottkey and Frenkel point effects, colour centers, F and other centres, Line defect. Shear strength of single crystals, dislocationsedge and screw dislocations, Burger vectors, Stress fields of dislocations, low angle grain boundaries, dislocation densities, dislocation multiplication and slip, strength of alloys, dislocations and crystal growth, hardness of materials.

Paper – IV (B) Electronics II (Communication)

Objectives:

Communication system is heart of modern generation, in these course students learn about different communication techniques.

Course learning outcome:
At the end of the course the student is expected to have an idea/concept of the following,

CO1: Fundamental of Digital communications Pulse modulation systems, Sampling Theorem, Low pass &Band pass signal, PAM- Channel BE for PAM signal, Natural Sampling, Plat-top sampling, Signal through holding, Quantization of signals, quantization error. Concept of Discrete-Time Fourier Transform and Z-transform on signals and its properties.

CO2: Concept of Digital modulation techniques like PCM, Differential PCM, Delta modulation, Adaptive, delta modulation (CVSD). BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK

CO3: Fluency in Mathematical representation of noise
Sources of noise, Frequency domain representation of noise , Effect of filtering on the probability density of Gaussian noise, Spectral component of noise, Effect of a filter on the power spectral density of noise, Superposition of noise, Mixing involving noise, binear filtering, Noise bandwidth, Quadrature component of noise, Power spectral density of n_c (t) n_s (t) & their time derivatives.

CO4: Understanding of Data Transmission I
Base band signal receiver, Probability of error optimum filter, White noise: Matched filter & probability of error, Coherent reception correlation, PSK, FSK, Non-Coherence detection on FSK, Differential PSK, QASK, Calculation of error probability for BPSK,BSFK,QPSK.

CO5: understanding of Data Transmission II
Noise in pulse code & delta modulation system, PCM transmission, Calculation of quantization noise output signal power, Effect of thermal noise, output signal to noise ratio in PCM, DM, Quantization noise in DM, output signal power, DM output signal to quantization noise ratio, effect of thermal noise in delta modulation, output signal to niose ratio in DM.

PHYSICS WORKSHOP/project SKILLS

After the successful completion of the M.Sc. course the student is expected to acquire skills/hands on experience / working knowledge on various machine tools, lathes, shapers, drilling machines, cutting tools, welding sets, various machine etc. and working with wooden and metal blocks. He /she will also acquire skills in the usage of various instruments for making electrical and electronics measurements using multimeter, oscilloscopes, power supply, electronic switches etc..