SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics

Course: US06CPHY21

Quantum Mechanics

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objectives:

- To give basic and preliminary knowledge of quantum mechanics and its mathematical details of computing observable physical quantities through examples.
- To train the students in the physical interpretations of the wave functions, their asymptotic behavior, the energy Eigen values and Eigen functions etc.

UNIT- I Stationary States and Energy Spectra

Stationary States: The time independentSchrödinger wave equation, A particle in a square well potential, Bound state in a square well potential (E< 0): Admissible solutions of wave equation, The energy eigen values – Discrete spectrum, The energy eigen functions, parity, Penetration into classically forbidden regions, Square well: Non-localized states (E>0), The square potential barrier: Quantum mechanical tunneling, Reflection at potential barriers and wells

UNIT – II General Formalism of Wave Mechanics

The Schrödinger equation and probability for N-particle system, The fundamental postulates of wave mechanics, The adjoint of an operator and self adjointness, The eigen value problem: Degeneracy, Eigen values and eigen functions of self adjoint operators, The Dirac delta function, Observables: Completeness and normalization of eigen functions, Closure, Physical interpretation of eigen values, eigen functions and expansion coefficients, Momentum eigen functions: wave functions in momentum space

UNIT- III Uncertainty Principle & SHO

The uncertainty principle, States with minimum value for uncertainty product, Commuting observables; removal of degeneracy, Evolution of system with time; constants of the motion, Non-interacting and interacting systems, Systems of identical particles **The Simple Harmonic Oscillator:** The Schrödinger equation and energy eigen values, The energy eigen functions: Series solution; Asymptotic behavior

UNIT- IV Exactly Soluble Eigen value Problem

Angular Momentum and Parity: The angular momentum operators, The eigen value equation for L^2; Separation of variables, Admissibility conditions on solutions; eigen values, The eigen functions: Spherical harmonics, Physical interpretation **Angular momentum in stationary states of system with spherical symmetry:** The rigid rotator, A particle in a central potential; The radial equation, The radial wave function, The Hydrogen Atom: Solution of the radial equation and energy levels, The Anisotropic oscillator, The Isotropic oscillator

Learning Outcomes:

After the successful completion of the course students will be able to

- Understand the basic concepts of quantum mechanics.
- Study the Bound State problems.
- Understand the requirement of normalization of the wave function, interpretation of the normalized wave function etc.
- Get familiar with the methods of solving exactly solvable problems in quantum mechanics.

Books Recommended:

1. A Textbook of Quantum Mechanics
   P M Mathews and K Venkatesan (2nd Edition)
   Tata McGraw Hill, New Delhi
2. Introduction to Quantum Mechanics
   David J Griffiths (2nd Edition)
   Pearson
3. Quantum Mechanics Theory and applications
   Ajoy Ghatak and S Lokanathan,
   McMillan Publishers India Limited, Delhi
4. Quantum Mechanics
   Leonard I Schiff
   McGraw Hill Book Co.

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics

Course: US06CPHY22

Atomic and Molecular Spectroscopy

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objective

- To provide a quantum mechanical understanding of atomic and molecular processes through spectroscopy and the applications to understand the structure of different types of matter.
- To enable the students to study the macroscopically observable physical phenomena through the microscopic constituents of atoms and molecules and their interactions.
- To enable the students to understand various applications of spectroscopic techniques.

UNIT- I Spectra of Atom

Spectrum of Hydrogen atom and spectral series, Observation of Hydrogen spectrum, Failure of electromagnetic theory of radiation, Bohr's theory and spectrum of Hydrogen atom, Franck-Hertz Experiment, Short coming of Bohr's theory, Larmor's theorem, Stern-Gerlach Experiment, Fine structure of Hydrogen lines, Positronium, Different series in Alkali spectra: main features, Ritz combination principle, explanation of salient features of Alkali spectra, Related Numerical.

UNIT- II Spectra of Molecule

Separation of Electronic and Nuclear Motion: The Born-Oppenheimer approximation, Types of molecular energy states and associated spectra, Types of spectra, Salient features of rotational spectra, The molecule as a rigid rotator: Explanation of rotational spectra(Rotational energy only), Diatomic molecule as a Non-rigid rotator, Validity of the theory: Determination of the inter-nuclear distance(Bond length) and moment of inertia, Isotope effect in rotational spectra, Rotational spectra of polyatomic molecules, Related Numerical.

UNIT- III Infrared Spectroscopy

Salient features of vibrational - Rotational spectra, Vibrating diatomic molecule as a harmonic oscillator, Vibrating diatomic molecule as anharmonic oscillator(without force contant for HCl molecule), Molecule as a vibrating rotator: fine structure of Infra red bands: Ignoring interaction of vibrational and rotational energies, Molecule as a vibrating rotator: fine structure of Infra red bands: considering interaction of vibrational and rotational energies, Applications of vibrational spectroscopy, General experimental arrangement for studying infra red spectra, Related Numerical

UNIT-IV Raman Spectra

Raman Effect and its salient features, experimental study, Apparatus, Result, Raman effect in liquids, Raman effect in gases, Raman effect in solids, Intensity of Raman lines, Polarization of Raman lines, Nature of Raman Effect, Relation between the Raman and infra red absorption spectra, Importance of Raman effect, Applications of Raman Effect in Physics: Molecular structure, Nature of liquid state, Crystal Physics, Nuclear Physics, Classical theory of Raman Effect, Quantum theory of Raman Effect, Related Numerical

Learning Outcomes:

At the end of the course, the students will be able to:

- Understand and be able to apply atomic and molecular spectroscopy.
- Understand the motions of atoms and molecules within a macroscopic substance.
- Understand infrared and Raman Spectra through Classical and quantum theory and their potential applications.

Books Recommended:

1. Elements of Spectroscopy
   S L Gupta, V Kumar, R C Sharma, (30^{th} Edition)
   Pragati Prakashan, Meerut
2. Atomic Physic
   J B Rajam (7^{th} Edition)
   S. Chand publication, Delhi
3. Molecular structure and Spectroscopy
   G Aruldhas
   PHI Private Limited, Delhi

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics

Course: US06CPHY23

Solid State Physics & Nuclear Physics

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objectives:

- To train the students in various methods like X-ray diffraction to understand the structure and symmetry of crystalline materials.
- To create awareness about basic theoretical approaches and approximations to study the electrical and thermal conductivity of materials.
- To provide an exposure to general properties of nucleus, nuclear reactions, estimation of energy release during nuclear reactions like fission, the Q-value equation
- To understand the nucleus and its properties by treating it as a charged liquid drop model.
- To create awareness about functions of nuclear detectors and accelerators.

UNIT - I X-ray diffraction

Introduction, Reciprocal lattice, Bragg's law, Laue's interpretation of X-Ray diffraction by crystal, construction of reciprocal lattice, relation between a , b , c and a^*, b^*, c^*, Application to some crystal lattice (SC, BCC HCP) , Measurement of diffraction pattern of crystal, The Ewald construction, Experimental methods (The Laue method, The Oscillation method, The powder method), Analysis of X-ray diffraction pattern from crystal, Structure factor for bcc crystal, Structure factor of mono atomic FCC crystal, Measurement of diffraction pattern of crystals, The Ewald construction, Experimental methods (The Laue method, The Oscillation method, The Powder method), Selection of incident beam (X-rays, Neutrons, Electrons)

UNIT - II Free electron Fermi Gas

Introduction of the free electron gas, Drude model, DC electrical conductivity of metals, Thermal conductivity of metals, Lorentz modification of the Drude model, Energy level in one dimension, Effect of temperature on the Fermi-Dirac distribution, Free electron gas in three dimensions, Heat capacity of the electron gas, Experimental heat capacity of metals, Electrical Conductivity and Ohm's Law, Experimental Electrical resistivity of metals, Motion in magnetic field, Hall effect

UNIT- III General Properties of Nucleus, Q –Equation and Liquid Drop Model of Nucleus

Constituents of Nuclei and their intrinsic properties, Nuclear size, Nuclear mass - Aston's mass spectrograph and Dempster's mass spectrometer, Angular momentum, Magnetic moment, Electric quadrupole moment, Wave mechanical properties - parity and statistics, Non-existence of electron in nucleus, Neutron-proton hypothesis, Binding energy, Types of nuclear reactions, Balance of mass and energy in nuclear reactions, The Q equation, Solution of Q equation, Weizsacher's semi empirical mass formula.

UNIT – IV Detectors and Accelerators

Accelerators: Introduction, Cockcroft and Walton Generator, Van de Graff Accelerator, Tandem accelerator, Linear Accelerator or Drift Tube accelerator, Magnetic resonance accelerators or cyclotron Betatron, Synchrocyclotron or frequency modulated cyclotrons.

Detectors: Introduction, Gas filled detectors, Ionization chamber, Griger-Mueller counter, Cloud chamber, Bubble chamber, Spark chamber

Learning Outcomes:

After the successful completion of the course the students will be able to understand:

- The application of X-ray diffraction techniques to determine the structure and symmetry of various solid materials.

- The electrical and thermal conductivity of metals based on free electron gas model and the effect of free charge carriers under electric and magnetic fields.
- The basic properties of nucleus, different types of nuclear reaction processes and Q- value equation through which the energy release in nuclear reactions like fission can be estimated.
- Properties of nucleus as a charged liquid drop and the success and failures of liquid drop model.
- The experimental techniques used to produce highly energetic nuclear and sub nuclear particles in accelerators.
- The functions of and applicability of different detectors used to detect nuclear and sub nuclear particles.

Recommended Books:

1. Elements of Solid State Physics
   J. P. Srivastava (4th Edition)
   PHI Learning Pvt. Ltd.
2. Introduction to Solid State Physics
   Charles Kittel (8th Edition)
   Wiley India Pvt. Ltd.
3. Solid State Physics
   S.O.Pillai (7th Edition)
   New Age International Publisher
4. Nuclear Physics – An Introduction
   S B Patel, BPB Publications
5. Fundamentals of Nuclear Physics
   JagdishVerma, R C Bhandari and D R S Somayajulu
   BS Publishers & Distributers Pvt. Ltd.
6. Nuclear and Particle Physics
   V K Mittal, R C Verma, S C Gupta (2nd edition)
   PHI Learning Pvt. Ltd.

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics

Course: US06CPHY24

Electrodynamics and Plasma Physics

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objectives:

- To learn the effect of electric and magnetic fields in matter.
- To learn various electromagnetic processes and meaning and the importance of Maxwell's equation.
- To learn the basic properties of Plasma state of matter and the motion of charged particle under different electric and magnetic field conditions.
- To learn the properties of plasma as a multi species fluid and to learn the origin and behavior of different waves in plasma.

UNIT – I Conductors and Electric Fields in Matter

Conductors: Basic properties, Induced charges, Surface charge and the force on a conductor, Capacitors, **Laplace's equation:** Laplace's equation in one, two and three dimension, Separation of variable by Cartesian and Spherical polar co ordinates, **Electric Fields in Matter:** Di electrics, Induced Dipole, Alignment of Polar molecules, Polarization, **The Field of a polarized object:** Bound Charges, Physical interpretation of Bound Charges, The field inside a Dielectric, **The Electric displacement:** Gauss's law in the presence of Dielectrics, Deceptive parallel, Boundary Conditions, Related numerical

UNIT – II Magnetic Fields in Matter

Magnetic Fields in Matter: Diamagnets, Paramagnets, Ferromagnets, Torques and forces on magnetic dipoles, Effect of magnetic field on atomic orbits, Magnetization, **The field of a magnetized object:** Bound currents, Physical interpretation of bound currents, **The auxiliary Field of H:**Ampere's law in magnetized materials, **Electromotive Force:** Ohm's Law, Electromotive Force, Motional emf, **Electromagnetic Induction:** Faraday's Law, The Induced Electric Field, Inductance, Energy in Magnetic Fields, **Maxwell's Equations:** Electrodynamics Before Maxwell, Ampere's Law fixed by Maxwell, Related numerical

UNIT- III Plasma and Applications of Plasma Physics, Single Particle Motions

Introduction, Occurrence of plasma in nature, Definition of plasma, Concept of temperature, Debye shielding, The plasma parameter, Criteria for plasma, **Applications of plasma physics:** Gas discharges (gaseous Electronics), Controlled thermo nuclear fusion, Space physics, Modern astrophysics, MHD energy conversion and ion propulsion, Solid state plasma, Gas laser, **Single particle motions:** Introduction, Uniform **E**&**B** Fields, **E**=0, Finite **E,** Gravitational field, Non uniform **B** field, $\nabla \boldsymbol{B} \perp \boldsymbol{B}$:Grad-**B** Drift, curved **B**: Curvature drift,$\nabla \boldsymbol{B} \parallel \boldsymbol{B}$: Magnetic Mirrors, Non uniform **E** field, Time varying **E** field, Time varying **B** field

UNIT- IV Plasmas as Fluids

Introduction, Relation of plasma physics to ordinary electromagnetic: Maxwell's Equations, Classical Treatment of Magnetic Materials, Classical treatment of dielectrics, The dielectric constant of a plasma, The fluid equation of motion, The convective derivative, Pressure (only definition), Collision, Comparison with ordinary hydrodynamics, Equation of continuity, Equation of state, The complete set of fluid equations, Fluid drift perpendicular to **B**, Fluid drift parallel to **B**, The plasma approximation, **Waves in plasmas:** Concept of phase velocity and group velocity, Plasma oscillations, Sound waves, Ion waves, Validity of the plasma approximation

Learning Outcomes:

At the successful completion of the course, the students will be able to understand

- The behavior of electric and magnetic fields in matter.
- Various laws of electro statics and magneto statics, electromotive force, electromagnetic induction and their applications.
- The contribution of Maxwell in the formation of Maxwell's equations and its physical implications.
- The basic plasma properties, motion of charged particles in various conditions of electric and magnetic fields and its plasma waves

Books Recommended:

1. Introduction to Electrodynamics
   David J. Griffiths (4th Edition)
   Prentice Hall of India Pvt. Ltd. New Delhi
2. Classical Electrodynamics
   J D Jackson, John Wiley & Sons, New York
3. Introduction to Plasma Physics
   Francis F Chen (2nd Edition)
   Plenum Press, New York & London
4. Elements of Plasma Physics
   S N Goswami
   New Central book Pvt. Ltd. Calcutta

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics Practical

Course: US06CPHY25

(Six Credit Course –12 Hours per week)

(Effective from June-2020)

Course Objectives:

- To impart practical knowledge by performing experiments based on the principles of theory courses.
- To provide hands on experience with equipments such as CRO, Interferometer, electronic circuits etc.
- To provide training how to analyze the experimental observations and draw conclusions with quantitative measurements.

Section: A

List of Practical:

1. Hall effect (constant probe current)
2. Mutual inductance by Carey-Foster method
3. High resistance by leakage
4. L - by Owen's bridge
5. 'e/m' of an electron by magnetron method
6. Susceptibility of paramagnetic /ferromagnetic solution by quink's method
7. LVDT characteristics
8. Simulation of harmonic oscillator

Section: B

List of Practical:

1. Wein-bridge oscillator
2. Bistable Multivibrator
3. Characteristics of UJT
4. Power amplifiers
5. Operational amplifier applications(Integrator, Differentiator, Adder, Substractor, log amplifiers and Comparator)
6. Measurements of Op-Amp parameters(Input offset voltage, input offset current, CMRR, Slew rate)
7. Four Bit Binary Up and Down Counters
8. Computer simulation of Digital electronic circuits

Section: C

List of Practical:

1. Febry-Parot Etalon
2. Determination of lattice parameter from a photograph (electron diffraction ring pattern)
3. Planck's constant by solar cell
4. To study Hydrogen spectrum and determination of Rydberg's constant
5. Searl's Goniometer (Variable distance)
6. Square well potential
7. Characteristics of LDR
8. Numerical integration(computer related)

Note: Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective college.

Learning Outcomes:

By the end of the course, the students will be able to understand

- The basic principles of Physics related to their courses in a practical way.
- The operational details of CRO, Interferometer and electronic circuits etc.
- The experimental design aspects to determine various properties of materials like resistivity, Hall coefficient, energy band gap, thickness of film etc.
- The process to analyze the observations and infer the outcome of the experiment.

Books Recommended:

1. Advanced Practical Physics for students
   B L Wosnop and H T Flint, Methuen and Co. Ltd., London
2. B.Sc. Practical Physics
   C L Arora, S.Chand & Co. Ltd., New Delhi
3. Advanced Practical Physics
   M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4. Advanced Practical Physics
   S L Gupta and V Kumar, Pragati Prakashan, Meerut
5. An advanced course in practical Physics
   D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd.

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics

Course: US06DPHY26

Transducers and Sensors

(Two Credit Course –2 Hours per week)

(Effective from June-2020)

Course Objectives:

- To learn the construction, working principle and applications of Cathode Ray Oscilloscope.
- To familiarize and acquaint the students with different types of analog transducers used for measurements of various physical parameters such as temperature and pressure at different levels.
- To make the students aware of different types of optical fibre sensors used for measurements of various physiological parameters like blood pressure, blood flow rate, oxygen saturation in blood etc.

UNIT- I CRO and Transducers

CRO: Introduction to Cathode Ray Oscilloscope, CRO Block diagram, Electrostatic Deflection (parabolic deflection of electrons) in CRT, Deflection Sensitivity and Deflection factor of a CR.

Transducers: Introduction, Analog Transducers, Electromechanical Type Transducer, Potentiometric resistance type Transducer, Inductive Type Transducer, Capacitive Type Transducer

UNIT- II Transducers & Pressure Measurements

Transducers: Resistance Strain Gages, Unbonded Strain Gages, Bonded Resistance Strain Gages, Balanced Strain Gage Bridge, Ionization Transducers, Mechno-Electronic Transducer, Opto-Electrical Transducers. **Pressure Measurements**: Introduction, Moderate Pressure Measurements, Manometers, High Pressure Measurements, Low Pressure (Vacuum) measurements, McLeod Gauge, Thermal conductivity or Pirani Gauge, Ionization Gauge

UNIT - III Temperature Measurements

Non-Electrical Methods, Solid Rod Thermometer, Bimetallic Thermometer, Electrical Methods, Electrical Resistance Thermometer, Metallic Resistance Thermometers, Semiconductor Resistance Sensors (thermistors), Thermoelectric Sensors, Laws of thermoelectricity, Thermocouple materials

UNIT- IV Acoustic Measurements and Optical Fiber Sensors

Acoustic Measurements: Introduction, Characteristics of Sound, Decibel, Sound Pressure Level, Sound Power levels, Microphones, Capacitor type microphone, Piezo-electric crystal type microphone, Electrodynamics type microphone, Carbon microphone, **Optical Fiber Sensors**: Introduction, Advantages of Optical Fiber Sensors, Types of Optical Fiber Sensors, Photometric, Physical and Chemical sensors

Learning Outcomes:

After the successful completion of the course, the students will be able to

- Use the cathode ray oscilloscope for measurements of various quantities of electrical signals like, frequency, phase and amplitude.
- Identify and design the required transducers for measurements of various physical parameters like pressure and temperature at different level.
- Understand how to use optical fibre as sensors for various physiological parameters like blood pressure, blood flow rate, oxygen saturation in blood and etc.

Books Recommended:

1. Modern Electronic Instrumentation and Measurement Techniques
   W D Cooper and A D Helfrick
   PHI (Prentice Hall of India) learning Pvt. Ltd, New Delhi
2. Instrumentation Measurement and Analysis
   B C Nakra and K KChaudhary
   Tata McGraw Hill, New Delhi
3. Biomedical Instrumentation
   R S Khandpur
   Tata McGraw Hill, New Delhi
4. Basic Electronics (Solid State)
   B L Theraja
   S. Chand Pub. Ltd, New Delhi

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 6)

Subject: Physics

Course: US06DPHY27

Electronic Communications

(Two Credit Course –2 Hours per week)

(Effective from June-2020)

Course Objectives:

- To provide the basic technical knowledge of electronic communications and the various types of modulation methods.
- To introduce the basics concepts of satellite communications and data transfer techniques with different network applications.

UNIT- I Introduction to Electronic Communication (EC) and Amplitude Modulation

Electronic Communications: Introduction, Importance of Communications, The Elements of a communication system, Types of Electronic Communications, Communications applications, Electromagnetic Spectrum, Bandwidth **Amplitude Modulation**: Amplitude Modulation Principles, Modulation Index and Percentage of Modulation, Sidebands and Frequency Domain, Sidebands, Single-Sideband Communication

UNIT- II Amplitude, Frequency & Phase Modulation

Amplitude Modulation Circuits, Amplitude Modulators**,** Analog Multiplication, Non-Linear Mixing, Amplitude Modulator Circuit (with a diode), Diode detector AM modulator. Frequency Modulation Principles, Phase Modulation, FM versus AM, Noise immunity, Pre-emphasis and De-emphasis, Transmission efficiency, Disadvantages of FM, Frequency Modulators, Voltage variable capacitor, Varactor modulator, Phase Modulators, Basic phase shift circuit

UNIT- III Introduction to Satellite Communications

Satellite Orbits: Orbit Fundamentals, Orbit Shape, Satellite Speed and Period, Satellite angles, Satellite Repeater, Geosynchronous Satellites; Station keeping, Attitude control, Satellite Launching.

Satellite Communications systems: Transponders, Satellite frequency allocations Satellite bandwidth. Applications overview

UNIT- IV Data Communications

Digital Communication concepts, Modems , FSK, Introductions to networks, wide Area Network, Metropolitan Area Networks, Local Area Network, Network Topologies, The Internet, Internet applications, How the internet works

Learning outcomes:

At the end of the course, students will be able to understand

- Various components of electronic communication systems, the importance of modulations, and the advantages of amplitude, frequency and phase modulation etc.
- The basics of satellite communications and types of data communication and network analysis.

Books Recommended:

1. Communication Electronics,
   Louis E Frenzel
   Tata McGraw Hill Publications, New Delhi
2. Digital Computer Electronics
   P Malvino and J A Brown
   Tata McGraw Hill Publishing Co. Led., New Delhi
3. Electronic Devices and Circuits
   G K Mittal
   Khanna Publishers, New Delhi