SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2018-19

M.Sc. (Physics)

Semester III

Course No. PS03CPHY21
ADVANCED QUANTUM MECHANICS

Unit: 1

Scattering theory –Kinematics of the scattering process, Differential and total cross-sections. Wave mechanical picture of scattering, Scattering amplitude and its formal expression by Green's function. The Born approximation and its validity through examples, Partial wave analysis, Asymptotic behaviour of partial waves, phase shifts and the scattering amplitude, Optical theorem. Phase shifts- relation with the potential. Potential of finite range.The eikonal approximation.Applications.

Unit: 2

Time Independent Perturbation theory: Perturbation theory for discrete levels, Equation in various orders of perturbation theory, The non-degenerate case for first order and second order corrections, The degenerate case –Removal of degeneracy, Applications.

The variation method: Upper bound on ground state energy.Application to excited states.The ground state of a two electron atom.The Hydrogen molecule– Exchange interaction.

The WKB approximation: The one dimensional Schrödinger equation, the asymptotic solution.Solution near turning point,matching at turning points and connection formulae.The Bohr-Sommerfeld quantum condition.WKB solution of the radial wave equation.Problems on above approximations.

Unit: 3

Evolution of system with time, The Schrödinger equation and general solution, propagators, sudden approximation, perturbative solution for transition amplitude, First and second order transition scattering of a particle by a potential, Harmonic perturbations, amplitude transition with, change of energy, Interaction of an atom with electromagnetic radiation– the Dipole approximation, Einstein coefficients. Alternative pictures of time evolution, the Schrödinger picture the Heisenberg picture and the interaction picture.

Unit: 4

Relativistic wave equations, generalization of the Schrödinger equation, the Klein-Gordon equation and its plane wave solutions. Dirac's relativistic Hamiltonian and the Dirac equation, position probability density and expectation values, Dirac matrices, plane wave solution of the Dirac equation, the spin of the Dirac particles, significance of the negative energy states, Relativistic electron in central potential, electron in magnetic field and spin magnetic moment.

Books:

- A text book of Quantum Mechanics, by Mathews &Venkatesan, TMH Publication (2010).
- Quantum Mechanics by V. K. Thankappan
- Quantum Mechanics by Ghatak&Loknathan; McMillan India Publication.
- Quantum Mechanics by G. Aruldas, Prentice-Hall India, Pvt., Ltd.

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M. Sc. Physics Semester - III
Course No. PS03CPHY22
Nanoscience and Thin-Film Physics

Unit: 1 Introduction : Nanoscience and nanotechnology, nanostructures in nature, quantum structures, quantum confinement, surface effects of nanomaterials, Nanomaterials synthesis : Arc discharge method, laser ablation, aerosol synthesis, inert gas condensation, high energy ball milling, chemical vapour deposition, Reverse micellar/microemulsion method, sol-gel method, Preparation of quantum nanostructures by lithography: photo, X-ray ,ion beam (FIB), neutral beam, and electron-beam,dip pen lithography. Characterization techniques of Nanostructures: Transmission electron microscopy (TEM), High Resolution TEM (HRTEM), Particle Size Analyzer, Scanning tunneling microscopy (STM), Atomic-force microscopy (AFM).

Unit: 2 Characterization techniques of Nanostructures : Scanning near field optical microscopy (SNOM), Spectroscopy of semiconductors: Excitons, Infrared surface spectroscopy, Raman Spectroscopy, Brillouin spectroscopy and Luminescence. Applications of nanostructures: Single electron tunneling, IR detectors, quantum dot lasers, , medicine, targeted drug delivery ,high energy density batteries, next generation computer technology, Electronics, phosphors for high definition TV, low cost flat panel displays, water purification, communication sector, food, fabric industry, environment, automobiles, tougher and harder cutting tools.

Unit: 3 Physics and chemistry of evaporation, evaporation rate, vapour pressure of elements, evaporation of compounds, evaporation of alloys, Deposition technology, Thermal deposition in vacuum, kinetic theory of gases and emission condition, distribution of deposit, resistance heating, thermal evaporation, flash evaporation, multievaporation sources, RF and Induction heating, electron beam method, sputtering-ion surface

interactions, sputter yield, sputtering of alloys, cathodic sputtering, glow discharge sputtering, low pressure sputtering, reactive sputtering.

Unit: 4 Hybrid and modified PVD processes : Ion plating, reactive evaporation processes, Ion beam assisted deposition processes, Ionized cluster beam deposition. Introduction to chemical vapour deposition and its reaction types : Pyrolysis, reduction, oxidation, compound formation, disproportionation, reversible transfer, Optical methods of measuring thin film thickness : FET, FECO, VAMFO, step gauges, ellipsometry, Mechanical methods for measuring thin film thickness : Stylus profilometry, weight measurement, Quartz crystal oscillators.

Books:

- Principles of nanoscience and nanotechnology by M.A. Shah, Tokeer Ahmad(Narosa publishing house)
- Nanomaterials : An introduction to synthesis,properties and applications by Dieter Vollath
  (Wiley-VCH Verlag GmbH & Co.KGaA)
- Nanotechnology : Principles and practices : S. K. Kulkarni(Capital publishing company).
- Nano-science and Technology by V.S. Muralidharan and A. Subramania (Ane Book Pvt. Ltd.).
- Introduction to Nanotechnology by Charles P. Poole, and Frank J. Owens (Wiley India Pvt. Ltd).
- Handbook of thin film technology by L.I. Maissel and R. Glang (McGraw-Hill).
- The Materials Science of thin films by Milton Ohring (Academic press).
- Nano: The Essentials –Understanding Nanoscience and Nanotechnology by T. Pradeep (McGraw- Hill Education).
- Thin film fundamentals by A. Goswami(New age international limited publishers)

M. Sc. Physics Semester - III

Course No. PS03EPHY21

Crystallography and Materials Science

Unit:1

Salient feature of Reciprocal lattice, Graphical construction, Vector- algebraic discussion, Relation to inter-planar spacing, Ewald construction, Interpretation of Bragg's law, Reciprocal lattice & X- ray diffraction, Laue equation – equivalence of Laue equation and Bragg's law, Projection-Spherical, stereographic & gnomonic. Reciprocal lattice and electron diffraction Electron diffraction pattern and Indexing of polycrystalline and single crystal specimen.

Unit: 2

Scattering of X- rays by crystal, Structure factor Equation for an electron, an atom and a unit cell, Structure factor calculation for different structures, X-ray optics, wavelength dispersion, Chemical analysis by X-ray spectrometer.

Ferroelectric crystals: Rochelle Salts & $BaTiO_3$, Classification of Ferroelectric, electric displacive transition: Polarization catastrophe, 'Frozen in' Transverse Optical Phonons, Thermo dynamic theory of ferroelectric transition, ferroelectric domain, Piezoelectricity, piezoelectric co-efficient, simple application with respect to piezoelectric slab.

Unit: 3

Polaritons, LST relation, Electron-electron interaction, electron-phonon interaction: polarons, , optical reflectance, Kramers-Kroning relations, electronic interband transitions,Excitions, Frenkel excitons and Wannier-Mott exciton, Raman Effect in crystals.

Integral and Fractional Quantum Hall Effect, Josephson tunneling, supercurrent quantum interference,High temperature superconductors :Rare earth, Bi and Tl-based cuprates and their properties, GMR-CMR materials.

Unit: 4

Amorphous semiconductors – Band structure, electronic conduction, optical properties, switching and Xerography. Amorphous Ferro-magnets, Liquid crystals, classification of liquid crystals, properties and applications of liquid crystals, Quasi crystals, Carbon : diamond,graphite,fullerenes and carbon nanotubes,Polymers, classification of polymers, structures of long chain polymer, Nanofluids for improved heat transfer, Ferrofluids: general consideration, properties of ferrofluids,applications of ferrofluids.

Books:

- Nanomaterials : An introduction to synthesis,properties and applications byDieter Vollath

  (Wiley-VCH Verlag GmbH & Co.KGaA)

- Solid state physics:An introduction to solid state electronic devices by Ajay kumar Saxena(Macmillan publishers India limited)

- Introduction to Solid State Physics - C. Kittel
- Principles of Solid State Physics - R. A. Levy
- Solid State Physics- S.O. Pillai
- Elements of X-Ray diffraction - B.D. Cullity
- Elementary Solid State Physics - Ali Omar
- Elements of Solid State Physics - J.P. Srivastava
- Nano; The Essentials By T. Pradeep (Tata McGraw Hill Publ)
- Materials Science and Engineering an introduction by William D.Callister.Jr.

M. Sc. Physics Semester - III

Course No. PS03EPHY22

Magnetic and Optical Properties of Condensed Matter

Unit: 1

Luminescence :Introduction, Excitation and emission, The Franck-Condon principle, Radiation-less transitions, Temperature dependence of luminescence, Decay mechanisms-Temperature independent exponential decay, Temperature dependent exponential decay, power-law decay, Thermo luminescence and glow curves, Thallium activated alkali halides, emission spectra, concentration dependence of the luminescence efficiency, The sulphide phosphors, electroluminescence, The Gudden-Pohl effect, The Destriau effect, carrier injection luminescence, Applications.

Unit: 2

Mossbauer effect **:** Introduction, Resonant absorption, recoil energy, natural broadening, Doppler broadening, cross-section of resonance processes, attempts to observe resonance fluorescence, mechanism of Mossbauer effect, the experiment of Mossbauer effect, Debye-Waller factor and its temperature dependence, General importance of Mossbauer effect, Mossbauer effect and lattice dynamics, quadruple interactions, magnetic hyperfine interactions, isomer shift.

Unit: 3

Optical properties: Propagation of light in conducting media, Anamalous skin effect, Drude model, absorption processes, exciton absorption, free carrier absorption, absorption processes involving impurities, photoconductivity, response time and gain factor, p-n junction photovoltaic cells, characteristics and applications, photovoltaic detectors.

Dielectrics: Polarizability and its dependence on frequency, dielectric constant and dielectric loss, effect of alternating fields, complex dielectric constants of non-polar solids, dipolar relaxation, energy absorption and losses, some important insulating materials.

Unit: 4

Magnetism :Ferromagnetic order, Curie point, temperature dependence of saturation magnetization, magnons, thermal excitation of magnon, neutron magnetic scattering, ferrimagnetic order, Curie temperature and susceptibility of ferrimagnets, anti-ferromagnetic order, susceptibility below Neel temperature, anti-ferromagnetic magnons, Magneto-Achostic effect.

Resonances: Magnetic resonance, paramagnetic resonance, resonance with relaxation, nuclear magnetic resonance, line width, hyperfine splitting, Knight Shift, nuclear quadruple resonance, ferromagnetic resonance, anti-ferromagnetic resonance, spin wave resonance, electron paramagnetic resonance, cyclotron resonance and size effect, the de Haas-Van Alphen effect.

Books:

- SolidState Physics by C. Kittel
- SolidState Physics by A.J.Dekker
- Principles of theory of Solids by J.M.Ziman
- Introduction to Semiconductor theory by A.I.Anselm
- SolidState Physics by Streetman
- Principle of SolidState Physics by R.A. Levy
- SolidState Physics by S.O. Pillai
- Mossbauer effect by V.G.Bhide
- Mossbauer effect and applications by G.K. Weirdheim
- Solid State Physical Electronics by Aldert van der Ziel.
- Molecular Structure and Spectroscopy by G. Aruldhas
- Solid State Physics by N. W. Aschroft and N.D. Mermin

M. Sc. Physics Semester - III

Course No. PS03EPHY23

Microwave Communication: Electronics and Technology

Unit: 1 Transmission Lines and Wave Guides

Fundamentals of Transmission lines- parallel wire, co-axial cable, equivalent circuits, Characteristics impedance, Primary line constants, Phase velocity, Voltage Standing Wave Ratio (VSWR)

Design aspects of waveguides- rectangular and circular, Choice of the type of wave guide, Waveguide dimensions. Methods of exciting waveguides, Waveguide joins- cylindrical and rectangular, Magic- tee, Applications of magic- tee, Attenuators, Flanges.

Unit: 2 Vacuum Tube and Solid State Microwave Devices

Microwave tubes: Klystrons- Reflex Klystrons. Performance characteristics and applications Cavity magnetron, Travelling Wave Tube (TWT),

Microwave Transistors: Constructional features of BJT and MESFET, Varactor diode, PIN diode, Schottky diode, Negative Resistance Microwave Devices- Tunnel diode, Gunn diode and Impatt diodes.

Unit: 3: RF Wave Propagation and Communication

Wave-Propagation in free space, Propagation characteristics, Ground waves, Space waves, Idea about tropospheric propagation and its range, Ionospheric layers, Ionospheric propagation and its range, Radio horizon, Critical frequency, critical angle, Maximum usable frequency, Virtual height, Fading, multiple hope transmission, satellite communication.

Unit: 4 Antenna

Antennas- Classification of antennas, Radiation fields and antenna patterns, Vertical antennas, Folded antennas, construction and working of Loop antennas, Ferrite rode antennas, structure and operation of Driven arrays.

VHF, UHF and Microwave antenna- structure and working of Horn antenna, Parabolic antenna, Structure of Dish Antenna, radiation mechanism in dish antenna, operation of dish antenna.

Books:

- Electronic Communication
  D. Roody and J. Coolen Prentice Hall.

- Electronic Communication Systems
  G. Kennedy, Mc-Graw Hill.
- Electronic Communication Systems
  F. R. Dungan, Delmar Publishers Inc.
- Microwave Principles
  H. J. Reich, J. G. Skalnik, P. F. Ordung and H. L. Krauss,
  East-West Press
- Modern Microwave Technology
  V. F. Velley, Prentice Hall.

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M. Sc. Physics Semester - III

Course No. PS03EPHY24

Microprocessors: Programming, Interfacing and Applications

Unit: 1 Introduction to 8085

Introduction to microprocessors; Organization and Architecture of Intel-8085, PIN diagram, Op-Code and Operands, Instruction word size. Fetch and Execute Operations. Timing diagrams

Instruction set of Intel 8085: Data transfer group, Arithmetic group, Logical group, Branch control group, Stack I/O and Machine control group. Subroutine. Assembly language programming of 8085

Address space partitioning, Schemes of allocation of addresses, Memory and I/O interfacing.

Unit: 2 Data Transfer and Peripheral Devices

Data transfer schemes; Synchronous, Asynchronous and Interrupt driven schemes. Interrupts of Intel-8085, Interrupt circuits and programming,

Interfacing Devices and I/O Devices, I/O ports INTEL-8255, Architecture and operating modes of INTEL-8255. Programmable DMA controller Intel-8257, Programmable interrupt controller Intel-8259. Programmable counter/interval timer INTEL-8252.

Unit: 3 Data Acquisition using 8085

Microprocessor based data acquisition system: A/D converter, Clock for A/D converter, sample and hold circuit IC LF-398, Analog multiplexer, ADC 0800- Interfacing and programming, Interfacing and Programming of ADC-0800, Analog Multiplexer AM-3705 and Sample and Hold circuit LF-398, ADC 0801 Series. D/A converter, Operating Principle, DAC0800-Interfacing, Realization of A/D converter using D/A converter.

Unit: 4 Microprocessor Applications

Delay subroutine, Display of decimal numbers, Display of Alphanumeric characters, Multiple Digital Display, Measurement of electrical and physical quantities: Frequency, Frequency Measurement using SID line, Phase angle and Power Factor Measurement, Voltage, Current, Resistance measurement, Temperature measurement and control. Introduction to microcontroller Intel-8051.

Books:

- Fundamentals of Microprocessors and Microcomputers, B. Ram (Dhanpat Rai and Sons, Delhi).
- Microprocessor Architecture, Programming and Applications with the 8085/8080A

  R. S. Gaonkar, Wiley Eastern Ltd.
- Microprocessors: Theory and Applications, M. Rafiquzzaman, Printice Hall International Inc.
- Introduction to Microprocessors, A. P. Mathur, Tata Mac Graw Hill Publishing Co. Ltd. New Delhi.
- The 8051 Microcontroller, Architecture, Programming and Application, Kenneth J Ayala, Penram International.

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M.Sc. III Semester
PS03EPHY25
Theoretical Physics - I

Unit - I

Principle of equivalence – Principle of general covariance, metric tensor Riemanntensor – Ricci tensor, Einstein's field equations: Newtonian limit – Equations of motion – Gravitational waves – centrally symmetric gravitational fields. Motion of Schwarzschild metric – circular orbits – Gravitational capture of particles – Motion of planets – Deflection of light – Schwarschild radius. Relativistic equation of stellar structures – Newtonian stars with polytropic equations of state – White-dwarfs and neutron stars.

Unit – II

Introduction to lattice dynamics, Wave propagation in lattices, Longitudinal vibrations, Transverse vibrations, consideration for a finite lattice. Fixed end point boundary condition, Frequency distribution function Periodic boundary condition Time development of lattice vibrational states Vibrational modes with a basis Enumeration of modes Excitation of the optical branch and infrared absorption in ionic crystals. Normal modes and their quantizations, Distribution of energy among the normal modes.

Unit – III

Dispersion relation and quantization of lattice vibrations, equations of motion, central forces, Angular forces, Secular determinant for a face centered cubic lattice, Covalent, molecular and metallic crystals, Quantization of lattice, vibrations. Normal co-ordinates of a lattice phenomenological theory of lattice dynamics thermal properties of micro crystallites.

Unit - IV

Atomic & Molecular Physics – Resume of partial waves and calculation of scattering phase shifts. Absorption processes and scattering by complex potential. Electron-Hydrogen scattering in the 1st order calculations Ground state and the potential energy curves of H2 molecule electronic structure of H2O, CO2, CH4, and C6H6 molecules. Fullerenes (Introductory).

Basic Text & Reference Books:-

- An introduction to General RelativityBy S. K. Bose, Wiley Eastern Ltd. 1985
- Introduction to Cosmology, J. V. Narlikar, Cambridge University Press, Cambridge, 1993
- An Introduction Lattice Dynamics, A. K. Ghatak and L. S. Kothari Addison-Wesley Publishing Company (London)
- Quantum theory of the Solid State, by Joseph Callaway
- Quantum Collision theory, C. J. Joachain (North Holland)
- Physics of Atoms & Molecules, B. Bransden & C. J. Joachain (Longman)

M.Sc. III Semester
PS03EPHY26
Computational Physics - I

Unit - I

Simple computer programming C: C – Language. Writing a program Input statement. Numerical constants and variables Arithmetic expressions Input and output in C, Conditional statements Loops in program. Defining and manipulation, of arrays. Logical expression and control statements C-program examples Functions.

Unit - II

Iterative Solution of Linear equations: Jacobi Iteration method, gauss-Seidal Method, Method of relaxation, Convergence of Iteration methods. Roots of nonlinear Equations: Methods of solutions, Iterative methods, Bisection method, Newton-Raphson Method, Fixed point method.

Unit – III

Numerical solution of ordinary differential equations: Taylor series method Eulers method. Fourth order Range – Kutta methods Milne – Simpson method Accuracy of multistep methods Systems of differential equations.

Unit - IV

Boundary value and Eigenvalue problems: Finite difference method. Solving eigenvalue problems Polynominal method, Solutions of partial differential Equations: Laplace's equation, Poisson's equation Solution of heat equation. Hyperbolic equations

Basic Text & Reference Books:-

- Computer Programming in Fortran 90 and 95 – V. Rajaraman Prentice-Hall India, 1997
- Computer programming in C – V. Rajaraman Prentice-Hall of India, 1998
- Object oriented programming with C++- E. Balaguruswamy Tata McGraw-Hill Pub. Co., New Delhi, 1999
- Numerical methods – E-Balaguruswamy Tata McGraw Hill Pub. Co., New Delhi, 1999

M.Sc. III Semester
PS03EPHY27
Solar Energy & Geothermal Energy

Unit - I

Introduction and application of solar energy, Essential subsystem in a solar energy plants. Solar energy routes and their prospects Terms and definitions, Units of solar power and solar energy, Merits and limitations of solar energy conversion and utilization, Phenomenon of light and energy, Energy from Sun. Solar constant, Power density for various wavelength of sunlight, Clarity index, solar insolation, Tilt angle of the fixed flat plate collector, solar calculations, Local apparent time.

Unit - II

Solar thermal collectors, Parabolic through collectors, Paraboloidal dish collectors, Fresnel lens point focus collector and heliostate with central receiver, Heat transfer fluid, Thermal energy storage. Solar distributed collector thermal power plants, Solar boiler/steam generator with large reflector and a central receiver, Solar pond, Solar thermo-electric converter, Introduction to Photovoltaic systems, Merits and limitations of solar PV system, Prospects of solar PV system. Principle of a photovoltaic cell, V-I characteristics of a solar cell, Interconnections of solar cells.

Unit - III

Efficiency of a solar cell and spectral response, Configuration of a solar PV panel, Small solar PV system for residence - typical ratings of small PV systems, Large solar PV systems – PV cell technology, Selective surfaces – basic requirements and basic principles – Types of selective surfaces. Applications of selective coatings to the flat plate collector.

Unit - IV

Introduction to the Geothermal energy Applications, Geothermal energy resources, Origin of geothermal resources, Non-uniform geothermal gradients, hydrogeothermal resources, Geopressure geothermal resources, Hot dry geothermal resources, Geothermal fluids for electrical power plants, Principles of photoelectrochemical solar cell.

Basic Text & Reference Books:-

- Energy Technology (Non conventional, Renewable and conventional) By S. Rao and Dr. P. B. Perulkar
- Solar Energy conversion, An introductory course By A. E. Dikon and J. D. Loslie
- Photoelectrochemical Solar Cells By Suresh Chandra
- Principles of Energy Conversion By Archie W. Cupl Jr.

M.Sc. III Semester
PS03EPHY28
Wind Energy & Ocean Energy

Unit – I

Description in detail Weightage (%) I Introduction to wind energy, Application of wind energy and historical back ground, Merits and limitations of wind energy conversions, Nature of wind and origin of wind, Wind energy quantum and variables in wind energy conversion systems, Wind power density, Power in a wind stream, Wind turbine efficiency, Power of a wind turbine for given incoming wind velocity. Forces on the blades of a propeller, Wind velocities and height from ground and site selection, Examples of wind farm site, Mean wind velocity, and wind velocity duration curve, Energy pattern factor and wind power duration characteristics

Unit - II

Introduction to wind turbine generator and terms and definitions, Types and characteristics of wind turbine generators, Horizontal axis propeller type wind turbine generator, Three blade HAWT. Dimensioning of HAWT, Vertical axis wind turbines, Vertical axis-Darreus rotor wind turbine, Vertical axis wind turbine with H-rotor, Wind turbine rotor speeds, Practical P.V. characteristics, Power coefficients versus tip speed ratio for various types of wind turbines, Operation and control of wind turbine generator unit, Wind to electrical energy conversion system, Power versus velocity characteristics of WTG unit

Unit - III

Advantages and limitations of ocean energy conversion technologies, Introduction to the ocean wave energy conversion, Ocean waves and parameters of a progressive wave, Equation of a progressive and energy and power ocean waves, Summary of equations, Motion of water particles in the wave and wave data collection. Wave machine, Dolphin-buoy type ocean wave energy converter, Three-raft energy converter – Nodding Duck oscillating cam wave machine – ring-cam roller follower design, Oscillating hydraulic piston-accumulator wave machine-oscillating hydraulic piston wave energy pumped storage plant – Dam-Atoll wave machine.

Unit - IV

Forces on the wave machines and associated structures-mooring systemsrecent advances in ocean wave energy technology, some recent wave machine concepts, Merits of ocean wave energy – limitations and demerits of wave energy and wave energy plants. Introduction to the tidal energy conversion- tidal currents- tidal energy conversion, Tidal power – average theoretical power per tide-ocean tidal energy schemes-terms and definitions, Single basin tidal schemes – double basin schemes and multi-basin schemes.

Basic Text & Reference Books:-

- Energy Technology (Non conventional, Renewable and conventional) By S. Rao and Dr. P. B. Perulkar
- Solar Energy conversion, An introductory course By A. E. Dikon and J. D. Loslie
- Photoelectrochemical Solar Cells By Suresh Chandra
- Principles of Energy Conversion By Archie W. Cupl. Jr.