SYLLABUS

POST GRADUATE DEGREE IN PHYSICS

(M.Sc. Physics)

Department of Physics

Sardar Patel University, Balaghat

Sardar Patel Knowledge City, Dongariya, Balaghat (M.P.)
Unit-I: Elementary numerical analysis
Numerical differentiation, numerical integration by Simpson and Trapezoid rules, numerical solution of differential equations by Euler and Runge-Kutta method, finite difference method, linear and non-linear least square fitting, generation of random numbers, Monte-Carlo technique, integration, simulations.

Unit-II: Special functions
Bessel function of first and second kind, generating function, integral representation and recurrence relations for Bessel’s functions of first kind, orthogonality, Legendre function: generating function, recurrence relations and special properties, orthogonality; various Legendre polynomials, associated Legendre functions: recurrence relations, parity and orthogonality; Hermite functions and Laguerre function: generating function.

Unit-III: Fourier series and integral transforms
Fourier series, general properties, advantages and applications, Gibbs phenomenon; development of the Fourier integral, inversion theorem, Fourier transform, Fourier transforms of derivatives, applied optics momentum representation; Laplace transforms, Laplace transforms of derivatives, properties of Laplace transform, inverse Laplace transformation.

Unit-IV: Integral equations
Definitions and classifications: Fredholm, Volterra equations of first and second kind, transformation of a differential equation into an integral equation, Neumann series, Separable kernels, Hilbert-Schmidt theory: symmetrisation of Kernels, orthogonal eigenfunctions, non-homogeneous integral equation, Green’s function in one dimension.

Unit-V: Group theory
Basic definitions, multiplication table, conjugate elements and classes, subgroups, direct product of groups, isomorphism and homomorphism, permutation groups, definition of representation and its properties, reducible and irreducible presentation, Schur’s Lemmas (statements only), orthogonal theorem, characters of a representation, Lie groups, three dimensional rotation group, unitary groups: SU(2), O(3), SO(2).

Textbooks
3. P.K. Chattopadhyay, Mathematical Physics, Wiley Eastern, New Delhi, 2005

Unit-I : Devries, Mathews
Unit-II : Arfken and Weber, Chattopadhyay, Harper
Unit-III : Arfken and Weber, Chattopadhyay, Harper
Unit-IV : Arfken and Weber, Chattopadhyay, Harper
Unit-V : Joshi, Chattopadhyay

References

2. B.S. Rajput, Mathematical Physics, Pragati Prakashan, 2015.
Unit-I: General formalism
Inadequacy of classical physics, wave-particle duality, wave packets, postulates of quantum mechanics, wave function and its physical interpretation (eigen values and eigenvectors, orthonormality, completeness closure), time-dependent Schrodinger equation, time-independent Schrodinger equation, continuity equation, Dirac notation, dynamical variables and operators, Hermitian operators, expectation values, generalized uncertainty relation, change of basis and unitary transformations, Ehrenfest theorem.

Unit-II: Quantum dynamics
Time evolution operator, Schrodinger and Heisenberg pictures of time evolution, time variation of expectation values, one-dimensional barrier, quantum tunneling effect, infinite and finite square well, harmonic oscillator in one dimension, analytic method, abstract operator method.

Unit-III: Symmetries and quantum mechanics in three dimensions
Symmetries in quantum mechanics-overview, spatial translation-continuous and discrete, time translation, parity, time reversal; Schrodinger equation in spherical, polar coordinate system.

Unit-IV: Hydrogen atom
Angular equation, Legendre polynomials and spherical harmonics, radial equation, spherical trap, Laguerre polynomials (in connection with H-atom), energy quantization, hydrogen atom spectrum.

Unit-V: Theory of angular momentum
Angular momentum operators, ladder operators, commutation relation among operators, eigen values and eigen functions, space quantization, spin angular momentum, Pauli spin matrices and their eigen values and eigenvectors, addition of angular momentum, introduction to Clebsch-Gordon coefficients, irreducible tensor operators and Wigner-Eckart theorem.

Textbooks

Unit-I : Griffiths, Mathews & Venkatesan, Liboff
Unit-II : Griffiths, Mathews & Venkatesan, Thankappan
Unit-III : Mathews & Venkatesan, Griffiths, Shankar
Unit-IV : Griffiths, Thankappan, Shankar
Unit-V : Griffiths, Mathews & Venkatesan, Thankappan

References
UNIT-I: Crystals
Crystal lattices, Bravais lattices, lattices with basis, Wigner Seitz unit cells, reciprocal lattice, Brillouin zone, X-ray and electron diffraction; Ewald’s sphere, structure factors.

UNIT-II: Bonding in crystals and elastic constants
Crystals of inert gases, ionic crystals, covalent crystals, metals, hydrogen bonds, atomic radii, analysis of elastic strains, elastic compliance and stiffness constants, elastic waves in cubic crystals.

UNIT-III: Crystal vibrations and thermal properties
Vibrations of crystals with monatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonons, phonon heat capacity, anharmonic crystal interactions, thermal conductivity.

UNIT-IV: Free electron theory
Energy levels in one dimension, effect of temperature on the Fermi, Dirac distribution, free electron gas in three dimensions, heat capacity of the electron gas, electrical conductivity and Ohm’s law, thermal conductivity of metals, electrical conductivity, relation between them.

UNIT-V: Energy bands
Nearly free electron model, Bloch functions, Kronig-Penney model, wave equation of electron in a periodic potential, number of orbitals in a band, tight binding approximation, Orthogonal Plane Wave (OPW) method, pseudo potential method, explanation of negative potential energy, work function.

Textbooks

Unit-I : Kittel
Unit-II : Kittel
Unit-III : Kittel
Unit-IV : Kittel, Mahan
Unit-V : Kittel, Wahab

References
SARDAR PATEL UNIVERSITY, BALAGHAT
Session - 2018-19 & Onwards
Semester-II
MPH2041: Statistical Mechanics and Thermodynamics

Unit-I: Thermodynamics
Principles of thermodynamics, first law of thermodynamics, heat and work, isothermal and adiabatic process, second law of thermodynamics, concept of entropy, entropy change in reversible and irreversible process, entropy of mixing and Gibb’s paradox, Sackur-Tetrode equation, Carnot’s cycle, Carnot’s engine and its efficiency, third law of thermodynamics, thermodynamic potentials: internal energy, enthalpy, Helmholtz free energy, Gibbs free energy, Maxwell relations.

Unit-II: Elements of statistical mechanics
Review of elementary probability theory, random variables, Binomial, Poisson and normal distributions, central limit theorem, postulates of statistical mechanics, thermodynamic limit, connection between statistics and thermodynamics, partition function of an ideal monatomic and diatomic gas, Third law of thermodynamics.

Unit-III: Ensemble description
Phase space, trajectories and density of states, Liouville's theorem, ensemble descriptions: microcanonical, canonical ensemble, partition function, thermodynamic properties, energy fluctuations, grandcanonical ensemble, grand partition function, density fluctuation in grandcanonical ensemble, equivalence of canonical and grandcanonical ensemble, Degree’s of freedom, equipartition theorem and virial theorem.

Unit-IV: Statistical distributions
Distinguishable particles: Maxwell-Boltzmann distribution, indistinguishable particles: Fermi-Dirac and Bose-Einstein statistics, examples: Bose-Einstein condensation, elementary excitations in liquid helium II, superconductivity, the electron gas, blackbody radiation and Planck's distribution law.

Unit-V: Phase transitions and fluctuations
First order phase transitions, Clausius-Clapeyron equation, phase diagrams; Landau theory of phase transition: Landau free energy, derivation in simple models, Ising model: definition, the Bragg-William approximation, one dimensional Ising model. Fluctuations: thermodynamic fluctuations, random walk and Brownian motion and formula (Not derivation), diffusion equation.

Textbooks

References
Unit-I: Conservation laws and symmetries
Review of concepts of spin, parity, isospin in particle physics, example of pion; charge conjugation invariance, G-parity, time reversal, CP-violation and CPT theorems, introduction to symmetries: discrete and continuous symmetries, examples, Young’s tables and their relation to group theory, symmetry groups O(3), SU(2), SU(3) and SU(6), applications of symmetry groups to hadron spectroscopy: meson mixing, mass formulae.

Unit-II: Quark model
Introduction to constituent quark model, quantum number of quarks & valence quark contents of hadrons, introduction to quarkonia (charm and bottom systems), simple applications to hadron phenomenology, e.g., unitary spin & spin hadron wave function of mesons and baryons, baryon masses.

Unit-III: Electromagnetic interactions
Low energy electron nucleon scattering and form factors, electromagnetic form factors of nucleons, deep inelastic structure functions and introduction to parton model, gauge invariance; local, global transformations and charge conservation, Introduction of Noether’s Theorem.

Unit-IV: Weak and strong interactions
Strong: Introduction to gauge field theories, including non-abelian gauge field Yang-Mills theory, elements of QCD, Feynman diagrams.

Unit-V: Unification schemes

Textbooks

Unit-I: Griffiths, Cottingham and Greenwood, Hughes
Unit-II: Griffiths, Cottingham and Greenwood, Hughes
Unit-III: Cottingham and Greenwood, Close, Khanna
Unit-IV: Cottingham and Greenwood, Close, Khanna
Unit-V: Cottingham and Greenwood, Close, Khanna
References
List of experiments:
1. To study and draw the V – I characteristic of LED Red, Blue, Green and to determine the plank’s constant.
2. To determine the refractive index of given liquid material with help of Newton’s Ring method.
3. To determine the deviation angle for (Red, Blue, Green, violet) colour of main spectral lines of mercury lamp with the help of plane transmission grating.
4. Determination of Stefan-Boltzmann’s constant by studying the radiation received from a blackbody radiator as a function of time.
5. Paramagnetic susceptibility of a FeCl3 solution at variable magnetic fields using Quincke’s tube method and deducing the magnetic moment of the ion.
6. Temperature characteristics of a Thermistor using Wheatstone network and to determine the band gap of the material of the thermistor.
7. Determination of compressibility of a liquid using ultrasonic interferometer.
8. To plot the current-voltage characteristics of a photo-resistor at constant irradiance and to measure the photo-current as a function of irradiance at a constant voltage.
9. Measurement of numerical aperture and attenuation characteristics of the optical fiber for variable lengths.
10. Measurement of Hall voltage and magnetic field by Hall probe method.

Virtual lab: Choose one virtual experiment from physical sciences at http://vlab.co.in/.

Textbooks
Computer laboratory
Introduction, computer hardware, software, C++/Fortran programming language, algorithms, structured programming, data and statements, I/O statements, control statements, unconditional and conditional looping, break and continue statements, nested loops, arrays and structures.

List of numerical problems
1. Generation of waves on superposition like stationary waves and beats.
2. Fourier analysis of square waves.
3. To find the roots of quadratic equations.
5. Find first order derivative at given x for a set of 10 values with the help of Lagrange interpolation.
6. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
7. Perform numerical integration on 1-D function using Simpson and Weddle rules.
8. To find determinant of a matrix - its eigen values and eigenvectors.
9. To demonstrate the frequency and amplitude modulation.
10. Motion of one-dimensional simple harmonic oscillator using Euler’s method.
11. To study the motion of electron in cathode ray tube.
12. Choose a set of 15 data points and find the least squared fitted curve.
13. Solution of n simultaneous linear equations using Gauss elimination method.
15. Nuclear radioactive decay using Monte Carlo method.
16. Monte Carlo determination of pi.

Textbooks
Sardar Patel University (SPU) is a public state university in Gujarat, India. It is named after Vallabhbhai Patel, and was founded in December 1955 by an Act of the Legislative Assembly of the then-Bombay Province and was UGC recognized under 2(f) of the UGC Act in October 1968. Originally it had the status of a rural university but now it has diversified with the motto of “Excellence Matters”. Sardar Patel University (SPU) - public higher education institution in India. SPU started accepting students in 1955. Being outside Vallabh Vidyanagar, nothing could distract the students from studying. SPU has affordable bachelor’s programs that cost less than 1,000 USD/year. SPU students can take their studies to the next level and obtain a master’s degree for 1,000 USD per year. In addition to low tuition fees the university provides the students with extra financial assistance in the form of scholarships. Sardar Patel University - [SPU], Vallabh Vidyanagar, Gujarat. Admission News for M.Sc, PG Diploma in Science, M.Phil/Ph.D in Science. Sardar Patel University offers a wide variety of Under-Graduate, Post Graduate, M.Phil and Ph. D. courses under different specialisations. The University also offers special M.Ed. and B.Ed. courses. The University also offers Post Graduate Diploma courses for the graduate students. SPU offers online mode of application to the candidates. About Sardar Patel University, Vision and Mission, Recognition and Approvals. The Visitor His Excellency Governor of Madhya Pradesh. Message From The Honorable Chancellor of The University. Message From Pro - Chancellor of The University. All these students are hereby informed that, by keeping in view of students safety due to COVID-19, University is deciding to take Theory Semester Examinations by Online Mode. Schedule of Examination is same and Time of Exam is from 11:30 pm to 01:30 pm. India > Sardar Patel University web ranking & review including accreditation, study areas, degree levels, tuition range, admission policy, facilities, services and official social media. University Overview. Established in 1955, Sardar Patel University is a non-profit public higher-education institution located in the rural setting of the large town of Vallabhidyanagar (population range of 10,000-49,999 inhabitants), Gujarat.