SYLLABUS

POST GRADUATE DEGREE IN PHYSICS

(M.Sc. Physics)

Department of Physics

Sardar Patel University, Balaghat

Sardar Patel Knowledge City, Dongariya, Balaghat (M.P.)

SARDAR PATEL UNIVERSITY, BALAGHAT

Session - 2018-19 & Onwards

Semester-II

MPH201: Mathematical Physics-II

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 Lagurerre 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, Schurs' Lemmas (statements only), orthogonal theorem, characters of a representation, Lie groups, three dimensional rotation group, unitary groups: SU(2), O(3), SO(2).

Textbooks

1. J.H. Mathews, Numerical Methods: for Mathematics, Science and Engineering, 2nd Ed., Prentice-Hall International, 1992.
2. G. Arfken and H.J. Weber, Mathematical Methods for Physicists, Academic Press, 6th Ed., SanDiego, 2005.
3. P.K. Chattopadhyay, Mathematical Physics, Wiley Eastern, New Delhi, 2005
4. C. Harper, Introduction to Mathematical Physics, Prentice Hall of India, New Delhi, 2004.
5. P.L. Devries, A First Course in Computational Physics, Wiley, New York, 1994.
6. A.W. Joshi, Matrices and Tensors in Physics, Wiley Eastern, New Delhi, 2002.

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

1. L.A. Pipes, Applied Mathematics for Engineers and Physicists, McGraw-Hill, 1958.
2. B.S. Rajput, Mathematical Physics, Pragati Prakashan, 2015.
3. M.L. Boas, Mathematical Methods in the Physical Sciences, 3rd Ed., John Wiley, 2005.
4. B.D. Gupta, Mathematical Physics, 4th Ed., Vikas Publishing House, 2009.
5. S. Hassani, Mathematical Physics: A Modern Introduction to Its Foundations, 2nd Ed., Springer, 2013.

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Semester-II

MPH202: Quantum Mechanics-I

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

1. D.J. Griffiths, Introduction to Quantum Mechanics, 2nd Ed., Pearson Publication, 2009.
2. P.M. Mathews, K. Venkatesan, A Textbook of Quantum Mechanics, 2nd Ed., McGraw Hill, 2010.
3. R.L. Liboff, Introductory Quantum Mechanics, 4th Ed., Pearson Education, 2003.
4. V.K. Thankappan, Quantum Mechanics, 4th Ed., New Academic Science, 2005.
5. R. Shankar, Principles of Quantum Mechanics, 2nd Ed., Plenum Press, 1994.

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

1. Y. Peleg, R. Pnini, E. Zaarur, E. Hecht, Schaum's Outline of Quantum Mechanics, 2nd Ed., McGraw Hill, 2010.

2. L.I. Schiff, Quantum Mechanics, 3rd Ed., McGraw Hill Book Company, 1968.
3. J.J. Sakurai, Modern Quantum Mechanics, 2nd Ed., Pearson, 2014.
4. E. Merzbacher, Quantum Mechanics, 3rd Ed., Wiley India Pvt. Ltd, 2011.
5. B.H. Bransden, C.J. Jochain, Quantum Mechanics, 2nd Ed., Pearson Education, 2007.
6. S. Prakash, Advanced Quantum Mechanics, Revised Ed., Pragathi Prakashan Publishing Limited, 2008.

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Semester-II

MPH203 Condensed Matter Physics-I

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

1. C. Kittel, Introduction to Solid State Physics, 8th Ed., J. Wiley and Sons, 2005.
2. M.A. Wahab, Solid state Physics, 2nd Ed., Narosa Publishing House, 2006.
3. G.D. Mahan, Condensed Matter in a Nutshell, 1st Ed., Princeton University Press, 2010.

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

References

1. N.W. Ashcroft and D.M. Mermin, Solid State Physics, Holt, Rinehart and Winston, 1976.
2. A.J. Dekker, Solid State Physics, Macmillan, 2009.
3. M.A. Omar, Elementary Solid State Physics, Addison-Wesley, 2009.
4. H.P. Myers, Introduction to Solid State Physics, Taylor and Francis, 1997.
5. S.O. Pillai, Solid State Physics, New Age International Publishers, 2002.
6. F. Han, Problems in Solid State Physics with Solutions, World Scientific, 2011.

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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

1. M. Zemansky, and R. Dittman, Heat and Thermodynamics, 8th Ed., McGraw-Hill Education, 2011.
2. R.K. Pathria, P.D. Beale, Statistical Mechanics, 3rd Ed., Elsevier, 2011.
3. F. Reif, Fundamentals of Statistical and Thermal Physics, Waveland Press, 2009.
4. K. Huang, Statistical Mechanics, 2nd Ed., Wiley, 2008.

References

1. L.D. Landau and E.M. Lifshitz, Statistical Physics, 3rd Ed., Pergamon Press, 1980.
2. R.E. Sonntag, G.J. Van Wylen, Introduction to Thermodynamics: Classical and Statistical, 3rd Ed., Wiley, 1991.
3. J.M. Seddon and D. Julian, Thermodynamics and Statistical Mechanics, 3rd Ed., RSC publication, 2001.

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Semester-II

MPH2042:High Energy Physics

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 hardrons, 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

Weak: Introduction to four fermion Fermi theory, Fermi transitions. Gamow-Teller transitions, development of V-A theory, weak neutral current and Glashow-Iliopoulos-Maiani (GIM), neutrino-nucleon scattering, electroweak unification.

Strong: Introduction to gauge field theories, including non-abelian gauge field Yang-Mills theory, elements of QCD, Feynman diagrams.

Unit-V: Unification schemes

Global symmetry breaking and Goldstone bosons, mass term, local symmetry breaking and the Higgs boson, introduction to Glashow-Weinberg-Salam model, introduction to the Standard Model and Lagrangian.

Textbooks

1. D. Griffiths, Introduction to Elementary Particles, 2nd Ed., Wiley VCH, 2008.
2. W.N. Cottingham, D. A. Greenwood, An Introduction to the Standard Model of Particle Physics, 2nd Ed., Cambridge University Press, 2007.
3. D.H. Perkins, An Introduction to High Energy Physics, 4th Ed., Cambridge University Press, 2000.
4. I.S. Hughes, Elementary Particles, 3rd Ed., Cambridge University Press, 1996.
5. F.E. Close, Introduction to Quarks and Partons, Academic Press, London, 1981.
6. M.P. Khanna, Introduction to Particle Physics, 3rd Ed., Prentice-Hall of India, New Delhi, 2004.

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

1. Bettini, Introduction to Elementary Particle Physics, Cambridge University Press, 2014.
2. C. Quigg, Gauge Theories of Weak, Strong and Electromagnetic Interactions, Gorden & Breach, New York, 1994.
3. T.P. Cheng and L.F. Li, Gauge Theory of Elementary Particle Physics, Oxford University Press, Oxford, 1982.
4. D.C. Joshi, Introduction to Quantum Electrodynamics and Particle Physics, I.K. International Publishing House Pvt. Ltd., New Delhi, 2006.

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MPH206P General Physic Laboratory (Lab - A)

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.
11. Measurement of Hall coefficient.

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

Textbooks

1. D. Chattopadhyay, P.C. Rakshit, and B. Saha, An Advanced Course in Practical Physics, 6th Ed., 2002.
2. Worsnop and Flint, Advanced Practical Physics for Students, 2nd Ed., Methuen Publishers, 2007.
3. J. Singh, Semiconductor Devices: Basic Principles, John Wiley, 2001.
4. D.R. Behekar, S.T. Seman, V.M. Gokhale., and P.G. Kale, Practical Physics, Kitab Mahal Publication, 2000.
5. A.C. Mellissinos, Experiments in Modern Physics, 2nd Ed., Academic Press, 2003.
6. D.P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publishing House, 2002.
7. G.L. Squires, Practical Physics, 4th Ed., Cambridge University Press, 2001.

SARDAR PATEL UNIVERSITY, BALAGHAT

Semester-II

MPH207P Computer Laboratory (Lab - B)

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.
4. Construction of wave packet and verification of uncertainty principle.
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.
14. Brownian motion using Monte Carlo method.
15. Nuclear radioactive decay using Monte Carlo method.
16. Monte Carlo determination of pi.

Textbooks

1. W.H. Press et al., Numerical Recipes in C++: The Art of Scientific Computing, 2nd Ed., Cambridge University Press, 2002.
2. E. Balagurusamy, Object Oriented Programming with C++, 2nd Ed., Tata McGraw-Hill, 2002.
3. P.L. DeVries, A first course in Computational Physics, 2nd Ed., Wiley, 2011.
4. S. Chandra, Computer Applications in Physics, 2nd Ed., Narosa Publishing House, 2008.
5. R.C. Verma, P.K. Ahluwalia and K.C. Sharma, Computational Physics, 1st Ed., New Age, 2005.

Sardar Patel University was confirmed by an Act of the Legislative Assembly of the then Bombay Province in December 1955 and was recognized under 2f of the UGC Act in October 1968. The University has completed 56 golden year of existence.Â Notification for Document Verification for Sardar Patel University B.Ed Admission 2020. Notification Sardar Patel University B.Ed Admission 2020 Application Form. Sardar Patel University B.Ed Admission 2020 Application Form. India > Sardar Patel University web ranking & review including accreditation, study areas, degree levels, tuition range, admission policy, facilities, services and official social media.Â 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 Vallabh Vidyanagar (population range of 10,000-49,999 inhabitants), Gujarat. About Sardar Patel University. Vision and Mission. Recognition and Approvals. The Visitor His Exallancy Governor of Madhya Pradesh. Message From The Honorable Chancellor of The University. Message From Pro - Chancellor of The University.Â All Thes Students are hereby Inform that, by keeping in view of Students Safety due to COVID-19, University is Deciding to took Theory Semester Examinations by Online Mode. Schedule of Examination is Same and Time of Exam is from 11:30 pm to 01:30 pm. Sardar Patel University (SPU) - public higher education institution in India. SPUstarted accepting students in 1955. Being outside Vallabh Vidyanagar, nothing could distract the students from studying.Â SPU has affordable bachelorâ€™s programs that cost less than 1,000 USD/year. SPU students can take their studies to the next level and obtain a masterâ€™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.