Branch Code: PH21- Dual Degree (B.S & M.S) in Physics 2021 Batch

Semester 1

PH1010 Physics I

Description: Use of vectors in practical mechanics. Unit vectors in spherical and cylindrical polar coordinates. Conservative vector fields and their potential functions -gravitational and electrostatic examples. Gradient of a scalar field. Equipotentials, states of equilibrium. Work and energy, conservation of energy. Motion in a central force and conservation of angular momentum. Physics concepts in vector fields, Continuity equations and conservation principles for matter, energy and electrical characteristics

Course Content: Use of vectors in practical mechanics. Unit vectors in spherical and cylindrical polar coordinates. Conservative vector fields and their potential functions -gravitational and electrostatic examples. Gradient of a scalar field. Equipotentials, states of equilibrium. Work and energy, conservation of energy. Motion in a central force and conservation of angular momentum. Physics concepts in vector fields, Continuity equations and conservation principles for matter, energy and electrical charge. Flux, divergence of a vector. Gauss' theorem, physical applications in gravitation and electrostatics. Irrotational versus rotational vector fields. Physical significance of circulation, curl of a vector field. Stokes' theorem, physical applications. Oscillatory motion, Wave motion in one dimension. Wave equation and travelling wave solutions. Wave velocity, group velocity and dispersion. Shallow water waves. Wave equation in three dimensions, spherical waves.

Text Books :

ReferenceBooks:
1. Kittel C., Knight W.O. and Ruderman M.A., Mechanics - Berkeley Physics Course, Vol. 1, Tata McGraw-Hill
2. Purcell E.M. Electricity and Magnetism - Berkeley Physics Course, Vol.2, Tata McGraw-Hill
3. Crawford F.S. - Waves and Oscillations, Berkeley Physics Course, Vol. 3, McGraw-Hill4. Feyman R.P., Leighton R.B. and Sands M. (Narosa) The Feyman Lectures on Physics, Vol. 1 5. Feyman R.P., Leighton R.B. and Sands M. (Narosa) The Feyman Lectures on Physics, Vol. 26. Davis D. (Academic) - Classical Mechanics

PH1050 Foundation of Computational Physics

Description: Learning Objectives: To motivate the need for computational approach in Physics. To develop the skill of using numerical techniques to solve basic physics problems. To introduce programming skills using interactive platforms such as Mathematica and Python. To develop the analytical skill through visualization and data plotting.Learning Outcome: Students must be able to use interactive platforms to execute basic numerical tasks and data analysis. This will assist them to solve basic numerical physics problems.

Course Content: Overview of various interactive platforms (Mathematica, Matlab, Python and other programming languages) and their utility in PhysicsPart-A (Data Analysis and Numerical Problem Solving through Mathematica)Preface of Mathematica (What Mathematica is all about, how it works, few basic commands);Functions; Plotting of multi-variable functions; 2D and 3D visualizations; Polynomial data fitting (linear, least square, spline);

Data interpolation; Probability and Statistics; Regression analysis; Error analysis, Random number generator; Solving algebraic expressions, Numerical precision; Matrix algebra: Finding eigenvalues and eigenvectors; Calculus: Differentiation and IntegrationPart-B (Learning through Python)Introduction to Python, Basic Commands, Importing Modules (Numpy, Scipy, Matplotlib) Revisit of the problems and concepts discussed in part-A through PythonPart-C (Application of Mathematica/Python to solve problems in physics)Central Force Problem, Harmonic Oscillator, Waves & Oscillations, Electricity and Magnetism, Data Analysis

Text Books:
1. S. Wolfram, The Mathematica Book (5th Ed.), Champaign, IL: Wolfram Research (2003)
2. Alex Martelli, Phython in a Nutshell (2nd Ed.) Oâ€™ Reilly, CA, 2006

Reference Books:
1. R. L. Zimmerman, F. I. Olness, Mathematica for Physics (2nd Ed) Addison Wesley (2002)2. M. Lutz, Learning Python, (5th Ed.) Oâ€™Reilly, CA, (2013)

PH1080 Thermodynamics and Kinetic Theory

Description: To introduce to the students basic concepts like entropy, etc, kinetic theory and laws of thermodynamics to enable them to use and apply them in later courses like Statistical Physics, Condensed Matter Physics, etc. Also introduce and familiarize to the students other important formulations like thermodynamic potentials etc, and study phenomena like liquefaction of gases, phase transformations and other phenomena. This course aims to take the students from the elementary thermodynamics to the threshold of Statistical Physics.

Course Content: Overview and introduction: characteristic features of macroscopic systems, conditions of equilibrium. The basic problems of thermodynamics. Specification of the state of a system. Number of states accessible to a macroscopic system, constraints, equilibrium and irreversibility, interaction between systems and first law of thermodynamics. Thermal interaction: Approach to thermal equilibrium, temperature, systems in contact with heat reservoir, probability of occurrence of a state. Classical approximation, Maxwell Velocity distribution, the equipartition theorem, the specific heat of solids. General thermodynamic interaction between systems. Dependence of number of states on the external parameters. General thermodynamic relation at equilibrium. Thermodynamic potentials. Legendre Transformations. Second and third law of thermodynamics. Equilibrium conditions of an isolated systems and a system in contact with reservoir. Equilibrium between phases. Gibbs phase rule. Elementary kinetic theory of transport process. Viscosity, conductivity, self-diffusion, electrical conductivity. Boltzmann transport equation.

Text Books: Concepts in Thermal Physics, S.J. Blundell and K. M. Blundell, Oxford University Press, 2012

Reference Books: Course References: 1. F. Rief , Statistical Physics , Berkeley Volume 5 (Tata McGraw Hill, special Indian edition 2008)
2. H .B. Callen, Thermodynamics and an introduction to Thermostatistics (John Wiley and Sons 1985)
3. K.P.N.Murthy, Excursions in Thermodynamics and Statistical Mechanics, Universities Press 2009 4. H. Gould and J. Tobochink, Thermal and statistical Physics Princeton University Press in 2010

PH1030 Physics Laboratory I

Course Content: Experiments in Mechanics Properties Materials, Heat, Electromagnetism and Optics.

Reference Books :
1. Smith E. V. -Manual of Experiments in Applied Physics, London,'" Butterworth, 1970.
2. Workshop B.L., and Flint H.P. -Advanced Practical Physics for Students, Methuen and Co. Ltd. London.
3. Jerrad H.G. and Mc Neil D.B. -Theoretical and Experimental Physics.
4. Fretter W.B. -Introduction to Experimental Physics, Blackiee
5. M. Nelkon and J.rlJl. Ogborn -Advanced Level Practical Physics, English Language Book Society, 1955.

Semester 2

PH1020 Physics II

Description: To enable the students to: a) descrie electromagnetic phenomena using the language of vector calculus. b) determine electric and magnetic fields arising from simple configurations of static charges as well as steady currents in vacuum and in matter. c) solve problems involving propagation of electromagnetic waves in vacuum and in matter. d) apply the methodology of quantum mechanics to simple systems.

Course Content: Unit 1: Electrostatics and magnetostatics Maxwellâ€™s equation-I, work and energy in electrostatics, displacement and polarization, boundary conditions. Maxwellâ€™s equation-II, Ampereâ€™s law, magnetic vector potential, magnetism in matter.
Unit 2: Electrodynamics and electromagnetic radiation Lorentz force, Faradayâ€™s law and Lenzâ€™s law, electromagnetic induction. Displacement current, Maxwellâ€™s equations III and IV, energy stored in an electromagnetic field, electromagnetic waves in vacuum and in matter, Snellâ€™s law.
Unit 3: Introduction to quantum mechanics The quantum nature of radiation, interference experiment with radiation and particle beams. Postulates of quantum mechanics, Schrodinger wave equation. Applications to simple physical systems such as free particle, particle in a box and barrier penetration, spin, two-state systems.

Text Books :
1. Introduction to Electrodynamics David J. Griffiths, Pearson Education India Learning Private Limited; 4 Edition (2015)
2. Intro to Quantum Mechanics David J. Griffiths, Pearson Education India Learning Private Limited (2015)
3. Fundamentals of Physics II - Electromagnetism, Optics, and Quantum Mechanics: 2 (The Open Yale Courses) R. Shankar Yale University Press; 1 edition (2016)

Reference Books: 1. The Feynman Lectures on Physics Vol 2, Richard P. Feynman and R. B. Leighton Narosa Publishing House (2008)
2. The Feynman Lectures on Physics Vol 3, Richard P. Feynman and R. B. Leighton Narosa Book Distributors (2008)
3. Quantum PhysicsH C Verma, TBS, 2nd edition (2012)

PH1040 Physics Lab II

Course Content:
Experiments in Electricity, Magnetism, Optics and Atomic.

Reference Books:
1. Smith E.V. - Manual of Experiments in Applied Physics, London, Butterworth, 1970.
2. Workshop B.L., and Flint H.P. -Advanced Practical Physics for Students, Methuen and Co. Ltd. London.
3. Jerrad H.G. and Mc Neil D.B. -Theoretical and Experimental Physics.
4. Fretter W.B. -Introduction to Experimental Physics, Blackiee, 5. M. Nelkon and J.M. Ogborn - Advanced Level Practical Physics,English Language Book Society, 1955

PH2170 Basic Electronics

Description: Learning objectives This is an introductory course in electronics, the principal objective of which is to lay a convincing foundation. Essentially, this course is expected to help raise the background of the students to the level required for taking advanced-level courses in electronics. Specific topics that are proposed include, lumped circuit models for passive and active circuit elements, analysis of bipolar junction transistors, applications of transistors, concept of feedback and application, and a quick introduction to operational amplifiers. Learning outcomes Upon successful completion, the students will be in a position to i) use circuit models for discrete passive and active electronic components, ii) apply various methods of analysis, including super position principle and nodal analysis for electronic circuits, iii) design and analyze transistor based circuits using the concepts of load lines and operating points, iv) develop and fabricate bipolar junction and field effect transistor based linear and non-linear circuits for specific application, analyze their performance and explain discrepancies using circuit models, and v) use differential amplifiers and build linear circuits based on operational amplifiers.

Course Content: Passive elements and diodes Lumped circuit elements - Kirchhoffâ€™s Laws â€“ Thevenin and Norton theorems â€“ nodal and mesh analysis â€“ superposition principle. PN junction diode â€“ load line and small signal analysis â€“ types of diodes â€“ simple diode circuits. Bipolar junction transistors Transistor amplifiers and dc analysis â€“ CB, CE and CC configurations â€“ the Ebers-Moll Model. Two-port devices and hybrid model â€“ h parameters and small signal analysis of amplifiers â€“ cascading transistor amplifiers. Bias and bias stabilization â€“ operating point â€“ stability factor â€“ analysis of different biasing schemes â€“ bias compensation methods. Feedback Feedback and transfer gain â€“ negative feedback amplifiers â€“ input output characteristics. Voltage series, current series, voltage shunt and current shunt configurations. Positive feedback, stability and oscillators â€“ transistor oscillators â€“ Hartley, Colpitt and RC phase shift oscillators. Power amplifiers Class A, B, C and AB power amplifiers â€“ efficiency and power dissipation of Class B push-pull amplifier. Single tuned amplifiers. Field effect transistors JFETs and their characteristics â€“ biasing and JFET amplifiers â€“ MOSFETs and their characteristics. Opamps Differential amplifiers and opamps â€“ opamp characteristics â€“ simple linear opamp circuits.

Text Books:
1. Integrated Electronics: Analog and Digital Circuits and Systems, Jacob Millman and Christos C. Halkias, 48th reprint, 1991 edition, Tata- McGraw Hill, New Delhi, India, 2008.
2. Electronic Devices and Circuits Theory, Robert L. Boylestad and Louis Nashelsky, 10th edition, Pearson, Delhi, India, 2009.
3. Electronic Principles, Albert Malvino and David Bates, 7th edition, Tata-McGraw Hill, New Delhi, India, 2007.

Reference Books:
1. The Art of Electronics, Paul Horowitz and Winfield Hill, 2nd edition, Cambridge University Press, New York, USA, 1989. 2. 2000
Solved Problems in Electronics, J. J. Cathey, Schaumâ€™s outline series, Tata-McGraw Hill, New Delhi, India, 1991. 3. Electronic Circuits: Discrete and
Integrated, D. L. Schilling and C. Belove, Tata-McGraw Hill, New Delhi, India, 2002.

Semester 3

EP2110 Introduction to Mathematical Physics

Description: Learning Objectives: To gain a working knowledge of mathematical methods used in physics.Learning Outcomes: At the end of the course, the student (i) will know elementary ideas in linear algebra, special functions and complex analysis and (ii) will be able to apply these to solve problems in classical, statistical and quantum mechanics as well as electromagnetism

Course Content: Linear vector spaces, Basis sets. Orthogonality and completeness. Linear maps and dual space, Bra and ket notation. Inner product; Linear operators and Matrices, Hermitian and unitary operators, Normal matrices and their diagonalization, Cayley-Hamilton theorem.New vector spaces from old: Direct sum and tensor products, outer product of matrices; Examples: Vectors and Tensors in R^3, Rotation group in 2 and 3 dimensions. Spin and C^2, Pauli matrices. Generators of rotations. Multiple spins and the tensor product, Hilbert space. Dirac delta function, representation and properties.

Examples: L_2(S^1) and Fourier Series; L_2(R) and Fourier transforms; Convolution in Fourier Series and Transforms; L_2(S^2) and spherical harmonics.Families of orthogonal polynomials as basis sets in function space, Legendre, Hermite, Laguerre, Chebyshev and Gegenbauer polynomials, Generating functions. Expansion of functions, Inversion formulas.Elements of analytic function theory, Cauchy-Riemann conditions, Cauchy's integral theorem and integral formula, Singularities-poles and essential singularities, residue theorem and contour integration. Occurrence of Laplace, Poisson, Helmholtz wave and diffusion equations in physical applications, Elementary properties of these equations and their solutions.

Text Books:
1. P. Dennery and A. Krzywicki, Mathematics for physicists (Dover Publications, 1996)
2. J. Hefferon, Linear Algebra (Chapters 2 and 3), (Orthogonal Press, 2014),
Freely available at: http://joshua.smcvt.edu/linearalgebra/3. G. Arfken and H. J. Weber, Mathematical Methods for Physicists (7th Edition) (Academic Press, 2012).

Reference Books:
1. K.F.Riley, M.P.Hobson and S.J. Bence, Mathematical Methods for physics and engineering (Cambridge U. Press, 2006).
2. L.A.Pipes and L.R.Harwell, Applied Mathematics for Engineers and Physicists (McGraw-Hill).
3. B.Friedman, Principles and Techniques of Applied Mathematics (Dover, 1990).
4.D.W.Lewis, Matrix Theory (Allied Publishers, 1991).8. M.P.Boas, Mathematical Methods in the Physical Sciences (2nd Edition) (Wiley, 1983)

PH2050 Physics Lab - III

Description: The course will deal interesting phenomena that are not only relevant from a fundamental point of view, but often have important applications. The aim is to bring students laboratory experiences, in pragmatic terms, which stress the acquisition of practical skills, equipment familiarity, observational skills, interpretation of data and a critical approach to experimentation. Undergraduate students, however, have some different perceptions off laboratory aims, and rate highly those activities associated with educational processes, for example the links which they observe to exist between theoretical material and laboratory work.

Course Content: The course accommodates experiments based on the (i) mechanics, (ii) electricity and magnetism, (iii) optics, (iv) electronics and (v) thermodynamics.

Text Books: B. L. Worsnop and H. T. Flint, Advanced Practical Physics for Students, Methusen and Co. (1950).

Reference Books:
1. E. V. Smith, Manual for experiments in applied physics, Butterworths (1970).
2.R. A. Dunlap, Experimental physics: Modern methods, Oxford University Press (1988).
3.D. Malacara (ed), Methods of experimental physics: Series of volumes, Academic Press Inc. (1988).
4. Roman Kezerashvili, College physics laboratory experiments : electricity, magnetism, optics, New York : Gurami Pub., (2003).
5. S. Panigrahi & B.Mallick, Engineering Practical Physics, Cengage Learning India Pvt. Ltd., (2015).
6. Michael Nelson and Jon M. Ogborn, Advanced level Physics
Practicals, 4th Edition, reprinted, Heinemann Educational Publishers, (1985).
7. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, 11th
Edition, Kitab Mahal, New Delhi, (2011).
8. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication, (1985

Semester 4

PH2070 Introduction to Biophysics

Description: To introduce Physics students to the emerging interdisciplinary area of biological physics, and train them in using physical concepts to gain quantitative understanding of biological phenomena.

Course Content: Total lecture hours: 38 (estimated number for each unit given in brackets).1.The living cell as a physical system. (3) Thermodynamic foundations, Structure and organization of the cell, molecular forces2. Review of Thermodynamics and Probability (5) Thermodynamic potentials, Random variables, Gaussian and Poisson distributions, fluctuations 3. Entropy and Free Energy (5) Entropic forces in the cell, rectification of fluctuations, osmotic flow, self-assembly.4. Biological applications of diffusion (5) Brownian motion, Fickâ€™s law, diffusion in one and higher dimensions, biological examples of random walks5. Hydrodynamics (5) Viscosity, friction and dissipation, Reynolds number, biological applications: pumping, stirring and swimming 6. Chemical kinetics and enzymes (5) Chemical reactions, binding and dissociation, diffusion-limited association, Kramersâ€™ theory, Michaelis-Menten kinetics, molecular motors7. Structure and mechanics (5) Hookeâ€™s law, elastic models of polymers and membranes, bending and stretching of DNA8. Mathematical Biology (5) Differential equation models, instability and bifurcations, reaction-diffusion systems, pattern formation, chemotaxis.

TextBooks:1. Biological Physics: Energy, Information, Life, Philip Nelson (W. H. Freeman and Company, 2004)

Reference Books:
1. Molecular and Cellular Biophysics, Meyer B. Jackson (Cambridge University Press, 2006)
2. Physical Biology of the Cell, R. Phillips, J. Kondev and J. Theriot (Garland Science, 2009)
3. Random walks in Biology, H. Berg (Princeton University Press, 1993)
4. Molecular Biology of the Cell, B. Alberts et al. (Garland Science, 4th ed,2002)
5. Mathematical Biology: I. An Introduction, J. D. Murray (Springer, 2007)
6. Pattern Formation and Dynamics in Nonequilibrium Systems, M. Cross and H. Greenside (Cambridge University Press, 2009)

PH2080 Physics Lab IV

Description: The course will deal interesting phenomena that are not only relevant from a fundamental point of view, but often have important applications. The aim is to bring students laboratory experiences, in pragmatic terms, which stress the acquisition of practical skills, equipment familiarity, observational skills, interpretation of data and a critical approach to experimentation. Undergraduate students, however, have some different perceptions of laboratory aims, and rate highly those activities associated with educational processes, for example the links which they observe to exist between theoretical material and laboratory work.

Course Content: The course accommodates experiments based on the (i) mechanics, (ii) electricity and magnetism, (iii) optics, (iv) electronics and (v) thermodynamics.

Text Books: B. L. Worsnop and H. T. Flint, Advanced Practical Physics for Students, Methusen and Co. (1950).

Reference Books:
1. E. V. Smith, Manual for experiments in applied physics, Butterworths (1970).
2.R. A. Dunlap, Experimental physics: Modern methods, Oxford University Press (1988).
3.D. Malacara (ed), Methods of experimental physics: Series of volumes, Academic Press Inc. (1988).
4. Roman Kezerashvili, College physics laboratory experiments : electricity, magnetism, optics, New York : Gurami Pub., (2003).
5. S. Panigrahi & B.Mallick, Engineering Practical Physics, Cengage Learning India Pvt. Ltd., (2015).
6. Michael Nelson and Jon M. Ogborn, Advanced level Physics Practicals, 4th Edition, reprinted, Heinemann Educational Publishers, (1985).

7. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, 11th Edition, Kitab Mahal, New Delhi, (2011).
8. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication, (1985).

Semester 5

PH5030 Classical Mechanics:

Mechanics of a system of particles in vector form. Conservation of linear momentum, energy and angular momentum. Degrees of freedom, generalised coordinates and velocities. Lagrangian, action principle, external action, Euler-Lagrange equations. Constraints. Applications of the Lagrangian formalism. Generalised momenta, Hamiltonian, Hamilton's equations of motion. Legendre transform, relation to Lagrangian formalism. Phase space, Phase trajectories. Applications to systems with one and two degree.

Reference Books:
H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Pub. House (1989). I. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press (1987) [Chapters 4,5,6, 7 in particular. also parts of Chapter 1-3,9, 10]. D. Rindler, Special Theory of Relativity, Oxford University Press (1982).

PH5100 Quantum Mechanics I:

Description: The aim of the course is to provide a systematic introduction to the primary concepts and methods of quantum mechanics.

Course Content: Basic principles of quantum mechanics. Probabilities and probability amplitudes. Linear vector spaces. Bra and ket vectors. Completeness, orthonormality, basis sets. Change of basis. Eigenstates and eigenvalues. Position and momentum representations. Wavefunctions, probability densities, probability current. Schrodinger equation. Expectation values. Generalized uncertainty relation. One dimensional potential problem. Particle in a box. Potential barriers. Tunneling. Linear harmonic oscillator: wavefunction approach and operator approach. Motion in three dimensions. Central potential problem. Orbital angular momentum operators. Spherical harmonics. Eigenvalues of orbital angular momentum operators. The hydrogen atom and its energy eigenvalues. A charged particle in a uniform constant magnetic field, energy eigenvalues and eigenfunctions. Schrodinger and Heisenberg pictures. Heisenberg equation of motion. Interaction picture. Semiclassical approximation: The WKB method. Time- independent perturbation theory. Nondegenerate and degenerate cases. Examples. Time-dependent perturbation theory. Transition probabilities. Sudden and adiabatic approximations. Fermi golden rule. The variational method: simple examples.

Text Books:
1. P. A. M. Dirac, The Principles of Quantum Mechanics, Fourth Edition (Oxford University Press, Oxford, 1958).
2. S. Gasiorowicz,Quantum Physics, Third Edition (John Wiley and Sons, New York, 2003).
3. R. L. Liboff, Introductory Quantum Mechanics, Fourth Edition (Pearson Education, Delhi, 2003).
4. W. Greiner, Quantum Mechanics, Fourth Edition (Springer, Delhi, 2004).
5. D. J. Griffiths, Introduction to Quantum Mechanics, Second Edition (Pearson Education, Delhi,2005).
6. R. W. Robinett, Quantum Mechanics, Second Edition (Oxford University Press, Oxford, 2006).
7. R. Shankar, Principles of Quantum Mechanics, Second Edition (Springer, Delhi, 2008).

Reference Books:
1. E. Merzbacher, Quantum Mechanics, Second Edition (Wiley International Edition, 1970).
2. L. D. Landau and E. M. Lifshitz,Quantum Mechanics (Course of Theoretical Physics, Volume 3), Third Edition (Pergamon Press, New York, 1977).
3. P. M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics (Tata McGraw-Hill, 1977).
4. V. K. Thankappan, Quantum Mechanics. (Wiley Eastern,1985)
5. R. P. Feynman, R.B. Leighton and M.Sands, The Feynman Lectures on Physics, Volume 3 (Narosa Publishing House, 1992). 6. J. J. Sakurai,Modern Quantum Mechanics (Addison-Wesley, Singapore, 1994

PH5040 Electronics

Description: Gives an overview of modern integrated circuit electronics with special reference to applications in measurements and laboratory. Learn concept of operational amplifier. Design different electronics circuit using operational amplifier and learn itâ€™s application. Concept of digital electronics and its application detail. Finally, will be introduced to microprocessor and itâ€™s uses.

Course Content:
Introduction to Integrated Circuits > Differential amplifiers using Transistors > Operational amplifiersFeatures Characteristics Negative feedback configurations Mathematical operations application circuits Non-linear applications Comparator Window comparator Regenerative comparator Relaxation oscillator Log and Antilog amplifiers Multiplier, square and square-root circuits > NE555, principle of operation and applications> Introduction to Digital logic gates Combinational circuits Reduction using Karnaugh map Implementation using universal gates Arithmetic circuits Look-ahead carry implementation Binary BCD addition > Decoders and encoders > Multiplexers and demultiplexers their applications > Flip-flops, types and implementation Conversions, triggering, master/slave implementation > Registers Binary up down counters Synchronous counters Ring and Johnson counters > Random sequence generators 7-segment display devices> A to D and D to A converters > Applications of digital circuits Digital clock, stop- watch, frequency and period counter, digital voltmeter etc. > Introduction to microprocessors Brief outline of 8085 processor Instruction set Simple programming examples Pick the largest number Delay Arithmetic operation with single and multiyear Block move with overlapping memory address Ascending and descending ordering

Text Books:
Electronic Principles â€“ 5th Edition, Albert Paul MalvinoTana Mc-Graw-Hill Publishing Company Ltd., New Delhi, 1993Digital Principles and Applications â€“ 5th EditionAlbert Paul Malvino Donald P.LcachTana Mc-Graw-Hill Publishing Company Ltd., New Delhi, 1994 Microprocessor Architecture, Programming and its Applications with the 8-85/8080A latest edition, 5th edition Ramesh S.Gaonkar Wiley Eastern Ltd., New Delhi, Bangalore, Madras. , 2002 Digital Fundamentals â€“ 9th edition,Thomas L.Floyd,Prentice Hall, July 13, 2005 Digital Design â€“ 3rd edition,M.Morris ManoPrentice Hall, 2001 Digital Design â€“ 4th edition,M.Morris ManoPrentice Hall, 2006.

PH5050 Mathematical Physics II

Description: To introduce to students some advanced methods of mathematical physics to pose and solve physical problems.

Course Content: Complex Variables: Analytic functions of a complex variable. Cauchy-Riemann conditions. Power series. Cauchyâ€TMs integral theorem. Conformal mapping. Singularities: poles, essential singularities. Residue theorem. Contour integration and examples. Analytic continuation. Multiple-valued functions, branch points and branch cut integration. Partial Differential Equations: Partial differential equations in Physics: Laplace, Poisson and Helmholtz equations; diffusion and wave equations. Applications. Integral transforms: Laplace transforms and Fourier transforms. Parsevalâ€TMs theorem. Convolution theorem. Applications. Calculus of Variations: Functionals. Natural boundary conditions. Lagrange multipliers. Rayleigh-Ritz method. Group theory: Elements of group theory. Discrete groups with examples. Continuous groups (Lie groups) [rotation group in 2 and 3 dimensions, U(1) and SU(2)]. Generators. Representations, Character tables for some point groups and the orthogonality theorem.

Text Books:
1. V. Balakrishnan, Mathematical Physics with Applications, Problems and Solutions, Anne Books Pvt Ltd (2018).
2. P Dennerey and A Kryzwicki, Mathematics for Physicists, Dover (Indian Edition), (2005).
3. G Arfken and H J Weber, mathematical Methods for Physicists, Academic Press, 7th Edition, Indian Edition, (2008).
4. K F Riley, M P Hobson and S J Bence, Mathematical Methods for Physicists and Engineering, Cambridge University press (Cambridge Low-priced Edition).

Reference Books:
1. Schaumâ€TMs outline series, McGraw Hill (1964): (i) Complex Variables, (ii) Laplace Transforms, (iii) Group Theory.
2. M. Boas,Mathematical Methods in Physical Sciences, 2nd Edition, Wiley International Edition, (1983).
3.E. Kreyszig, Advanced Engineering Mathematics, Wiley Eastern, 5th Edition, (1991).
4. L.A. Pipes and L.R. Harwell, Applied Mathematics for Engineers and Physicists, McGraw-Hill, (1995).
5. M. Artin, Algebra, Prentice-Hall India, (2002).

6. I. N. Sneddon, The Use of Integral Transforms, Tata McGraw Hill, (1985).
7. D. H. Sattinger and O.L. Weaver, Lie
Groups and Algebras with Applications to Physics, Geometry and Mechanics, Springer, (1986).
8. M. Tinkham, Group Theory and Quantum Mechanics,
Dover (2003).

PH5060 Physics Lab – I (PG) (Attosecond Photonics)

Description: This course will impart theoretical knowledge and hands-on numerical simulations in attosecond photonics with a focus on current trends and state of the art in this area.

Course Content: The following topics will be covered in this course -
1) Basics of linear and nonlinear interaction between light and matter
2) Nonlinear propagation of pulses
3) Nonlinear conversion / parametric amplification
4) High-harmonic and attosecond pulse generation
5) Characterization of ultrashort laser pulses
6) Free electron lasers
7) Attosecond quantum dynamics in atomic and condense matter systems
8) Laser plasmas and relativistic photonics
9) Special topics and current trends

Text Books:
1) Fundamentals of Attosecond Optics, Author: Zenghu Chang, ISBN 9781420089370
2) Attosecond and Strong-Field Physics, C. D. Lin, Anh-Thu Le, Cheng Jin, Hui Wei, , Publisher: Cambridge University Press, Edition: May 2018, ISBN: 9781108181839,

Reference books:
1) Attosecond Physics: Attosecond Measurements and Control of Physical Systems, Authors: Luis Plaja, Ricardo Torres, Amelle ZaÃ¯r, Publisher: Springer, ISBN: 978-3-642-37623-8
2) Principles of Free Electron Lasers, Authors: Freund, H. P., Antonsen, Jr., T. M.,
ISBN 978-3-319-75106-1, Publisher: Springer

Semester 6

PH5020 Electromagnetic Theory

Description:A systematic exposition to classical electromagnetic theory.

Course Content: Electrostatics: Laplace and Poisson equations. Boundary value problems. Dirichlet and Neumann boundary conditions. Method of images. Concept of the Green function and its use in boundary value problems. Magnetostatics: Ampere's law and Biot-Savart's law. Concept of a vector otential. Maxwell equations and electromagnetic waves. Maxwell equations (both differential and integral formulations). Boundary conditions on field vectors D, E, B and H. Vector and scalar potentials. Gauge transformations: Lorentz and Coulomb gauges. Green function for the wave equation. Poynting's theorem. Conservation laws for macroscopic media. Propagation of plane waves and spherical waves in free space, dielectrics and conducting media. Reflection and refraction of electromagnetic waves. Superposition of waves. Radiation from an oscillating dipole and radiation from an accelerating charge. Electromagnetic stress tensor. Wave Guides: Modes in rectangular and cylindrical wave guides (conducting and dielectric).
Resonant cavities. Evanescent waves. Energy dissipation. Q of a cavity.

Text Books:
1. J.D. Jackson, Classical Electrodynamics, Wiley Eastern, 2nd Edition (1975).
2. David J. Griffiths, Introduction to Electrodynamics, Prentice Hall of India, 2nd Edition, (1989).

Reference Books:
1. J.R. Reitz., F.J. Milford and R. W. Christy, Foundations of Electromagnetic Theory, 3rd Edition, Narosa Pub. House (1979).
2. P. Lorrain and D. Corson, Electromagnetic Fields and Waves. CBS Publishers and Distributors (1986).
3. B.H. Chirgwin, C. Plumpton and C. W. Kilmister, Elementary Electromagnetic Theory, Vols.1, 2 and 3" Pergamon Press (1972).

PH5080 Statistical Physics

Description: An introduction to the physics of macroscopic systems, emphasizing the probabilistic nature of statistical mechanics and its relation to thermodynamics

Course Content: Systems with a very large number of degrees of freedom: the need for statistical mechanics. Macrostates, microstates and accessible microstates. Fundamental postulate of equilibrium statistical mechanics. Probability distributions. Microcanonical ensemble, Boltzmann's formula for entropy. Canonical ensemble, partition function, free energy. calculation of thermodynamic quantities. Classical ideal gas. Maxwell-Boltzmann distribution, equipartition theorem. Paramagnetism, Langevin and Brillouin functions, Curie's law. Quantum statistics: systems of identical, indistinguishable particles, spin, symmetry of wavefunctions, bosons, Pauli's exclusion principle, fermions. Grand canonical ensemble. Bose-Einstein and Fermi-Dirac distributions. Degeneracy. Free electron gas, Pauli paramagnetism. Blackbody radiation. Bose-Einstein condensation. Einstein model of lattice vibrations. phonons, Debye's theory of the specific heat of crystals. Phase diagrams, phase equilibria and phase transitions. Mean-fjeld theory of liquid-gas transition (Van der Waals model) and ferromagnet-paramagnet transition (Weiss' molecular field theory). Heisenberg exchange interaction and the origin of ferromagnetism. Elementary ideas on Ising and Heisenberg models of ferromagnetism.

Text Books:
1. D. Chandler, Introduction to Modern Statistical Mechanics, Oxford University press (1987).
2.F. Reif, Fundamentals of Statistical and Thermal Physics, International Student Edition, McGraw-Hill (1988).
3. K. Huang, Statistical Mechanics, IJ\Iiley Eastern (1988).
4. L.D.. Landau and E.M. Lifshitz, Statistical Physics (Par1I), 3rd Edition, Pergamon Press (1989).
5. F. Reif, Statistical Physics (Berkeley Physics Course, Vol.5), McGraw Hill (1967).
6. F. Mandl, Statistical Physics, 2nd edition, ELBS & Wiley (1988)

Reference Books:
1. C.J. Thompson, Equilibrium Statistical Mechanics, Clarendon Press (1988).
2. E.S.R. Gopal, Statistical Mechanics and Properties of Matter MacMillan India (1988).
3. R. Kubo. Statistical Physics -Problems and Solutions, North Holland (1965).
4. Y.K. Lim, Problems and Solutions in Thermodynamics and Statistical Mechanics, World Scientific (1990).
5. M. Kardar, Statistical Physics of particles, Cambridge University Press (2007).

PH5160 Condensed Matter Physics I

Description:
To introduce the students to basic concepts in condensed matter physics.

Course Content: Classification of condensed matter: crystalline, noncrystalline, nanophase solids, liquids. Crystalline solids: Bravais lattices, crystal planes, crystal directions, and Miller indices, point groups, space groups and typical structures. Crystal symmetry and macroscopic physical properties: tensors of various ranks: Propagation of elastic waves in crystals and measurement of elastic constants. Diffraction of waves by crystals: X-rays, neutrons, electrons. Bragg's law in direct and reciprocal lattice. Structure factor. Principles of diffraction techniques. Classification of solids. Types of binding. Cohesive energy Ionic crystals: Born Mayer potential. Thermochemical Bom-Haber cycle. Van der Waals binding: rare gas crystals and binding energies. Covalent and metallic binding: characteristic features and examples. Extended defects: dislocations, models of screw and edge dislocations. Burgers vector. Stress field around dislocation interaction between dislocations with point defects. Working hardening. Lattice dynamics: monoatomic and diatomic lattices. Born-von Karman method. Phonon frequencies and density of states. Dispersion curves, neutron scattering. The Drude and Sommerfeld theory of metals, Nearly free electron approximation, Electrical resistivity, Models of Einstein and Debye, heat capacity of conduction electrons, the Fermi surface, thermal conductivity, Thermal properties, Thermal expansion. Thermal conductivity. Normal and umklapp processes. Motion in a magnetic field: Cyclotron resonance and hall effect, AC conductivity and optical properties. Failure of free electron model, Energy bands in solids, bloch theorem, Band symmetry in k-space, Brillouin zones, The tight binding model, Metals, semiconductors and insulators, velocity of the Bloch electrons, Models for calculating band structures, Density of states, Effective mass, concept of hold, carrier concentration, intrinsic semiconductor, impurity states, semiconductor statistics. Liquid crystal: thermotropic and lyotropic. Nematics and sematics: applications. Amorphous/glassy states.

Reference Books:
1. Charles Kittel, Introduction to Solid State Physics, Wiley, 5th Edition (1976).
2. A.J. Dekker, Solid State Physics, Prentice Hall, (1957)
3. N.W. Ashcroft and N.D. Mermin, Solid State Physics, Saunders College Publishing (1976).
4. J.S. Blakemore, Solid State Physics, 2nd Edition, Cambridge University Press. (1974).
5. Mendel Sachs, Solid State Theory, McGraw-Hill (1963)
6. Harald bach and Hans Luth, Solid-State Physics, Springer International Student Edition, Narosa Pub. House, (1991).
6. Introduction to Solid State Physics, A. Omar

PH5170 Quantum Mechanics II

Description: The course provides an introduction to advanced topics in quantum mechanics, including the Dirac equation.

Course Content: Orbital and spin angular momentum. Angular momentum algebra. Eigenstates and eigenvalues of angular momentum. Addition of angular momenta, Clebsch-Gordon coefficients. Irreducible tensor operators and the Wigner-Eckart theorem. Systems of identical particles. Symmetric and antisymmetric wavefunctions. Bosons and Fermions. Pauli's exclusion principle. Second quantization, occupation number representation. Non-relativistic scattering theory. Scattering amplitude and cross- section. The integral equation for scattering. Born approximation. Partial wave analysis. The optical theorem. Elements of relativistic quantum mechanics. The Klein-Gordon equation. The Dirac equation. Dirac matrices, spinors. Positive and negative energy solutions, physical interpretation. Nonrelativistic limit of the Dirac equation.

Text Books:

1. J. Bjorken and S. Drell, Relativistic Quantum Mechanics (McGraw-Hill, New York, 1965).
2. L. D. Landau and E. M. Lifshitz, Quantum Mechanics (Course of Theoretical Physics, Volume 3), Third Edition (Pergamon Press, New York, 1977).
3. P. M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics (Tata McGraw-Hill, 1977).
4. D. J. Griffiths, Introduction to Elementary Particles (John Wiley, New York, 1987).
5. J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley, Singapore, 1994).
6. D. J. Griffiths, Introduction to Quantum Mechanics, Second Edition (Pearson Education, Delhi, 2005).

Reference Books:

1. P. A. M. Dirac, The Principles of Quantum Mechanics, Fourth Edition (Oxford University Press, Oxford, 1958).
2. A. Messiah, Quantum Mechanics, Volumes 1 and 2 (North Holland, Amsterdam, 1961).
3. J. J. Sakurai, Advanced Quantum Mechanics (Addison-Wesley, Singapore, 1967).
4. F. Halzen and A. D. Martin, Quarks and Leptons: An Introductory Course in Modern Particle Physics (John Wiley, New York, 1984).
5. R. W. Robinett, Quantum Mechanics, Second Edition (Oxford University Press, Oxford, 2006).
6. F. Dyson, Advanced Quantum Mechanics (World Scientific, Singapore, 2007).
7. R. Shankar, Principles of Quantum Mechanics, Second Edition (Springer, Delhi, 2008).

PH5120 Physics Lab II (PG)

Description:

Arc spectra: analysis of line and band spectraG.M. counterCurie temperatureMillikan's oil drop method: electron chargeVelocity of ultrasonic waves in liquids (a) by diffraction(b) by inteferometer.Twyman-Green interferometer.Fourier transform processor.Hall effect. Scintillation counter.X-ray powder photographMagnetostriction Thermal expansion: Fizeau's methodLatent heat of liquid nitrogen. Absorption spectrum of colour centersspectrophotomerter.

Reference Books:

1. Worsnop and Flint, Advanced Practical Physics for StudentsMethusen & Go. (1950).
2. E.V. Smith, Manual for Experiments in Applied Physics. Butterworths(1970).
3. R.A. Dunlap, Experimental Physics: Modern Methods, OxfordUniversity Press (1988).
4. D. Malacara (ed), Methods of Experimental Physics, Series ofVolumes, Academic Press Inc. (1988).

Summer

PH4500 Industrial Training

Semester 7

PH5410 Atomic and Molecular Physics

Description:

To provide the students an introduction to Physics at various energies, ranging from atomic to the lower limit of high energy physics.

Course Content:
NUCLEAR PHYSICS: Basic facts about nuclei: size, shape, binding energy, electric and magenetic moments; Nuclear forces: charge independence, isospin symmetry, NN, pi-pi scattering, relations between scattering cross sections; The deuteron: models of n-p potentials; nuclear models: liquid drop and shell models; elementary ideas on radioactivity; nuclear fission and fusion; elementary ideas about nuclear reactorsClassification of fundamental forces, elementary particles. Particle accelerators and detectors; Gell-Mann-Nishijima formula, quark model for mesons and baryons

ATOMIC AND MOLECULAR PHYSICS: Hydrogen atom, hydrogen-like spectra, many electron systems; Electron configurations and spectroscopic notation, equivalent and nonequivalent electrons, Hundâ€TMs rules, spin orbit coupling and lultiplet structure; Atoms in electric and magnetic fields, Zeeman effect, Stark effect; hyperfine interactions; Selection rules, transition probabilities, intensity of spectral lines, Spontaneous and stimulated emissions, Einstein coefficients, masers and lasers.Synchrotron radiation spectroscopy; Rotational and Vibrational Spectra of molecules; Anharmonicity, Bonn Oppenheimer Approximation; Franck-Condon Principle, Electronic, Infrared and Raman Spectra.

Text Books:
NUCLEAR PHYSICS: 1. K S Krane, Introductory Nuclear Physics, John Wiley (1988)
2. ATOMIC AND MOLECULAR PHYSICS: 1. B H Bransden and C J Joachain, Physics of Atoms and Molecules, Longman Inc. New York (1983)

Reference Books:
1. W S C Williams, Nuclear and Particle Physics, Clarendon Press (1991)
2. Emilio Segre, Nuclei and Particles, Benjamin Cummings Pub. (1980)
3. H A Enge, Introduction to Nuclear Physics, Addison Wesley (1979)
4. J M Blatt and V F Weisskopf, Theoretical Nuclear Physics, John Wiley (1952)

PH5270 Physics Lab – III (PG)

Description:
To familiarize the students with devices and circuit principles with special focus on applications related to instrumentations and measurements. Course contents: Phase-lock loop and its applications - Frequency multiplicationAnalog multiplier and its applications - Log and Antilog amplifiers - Instrumentation amplifiers - Sensors and transducers-temperature, magnetic field, displacement, light intensity, force, etc. Microcontroller - 8051 family - programming and Interfacing.

Text Books:
1. Linear Integrated Circuits, D.Roy Choudhury, Shail B.Jain, Revised Second Edn., New Age International pvt. Ltd., 2003
2. Electronic Devices and Circuit Theory, R.L.Boylestad and L.Nashelsky, Eighth Edn. Printice Hall, India, 2002.
3. Op.Amps and Linear Integrated Circuits, Ramakant Gaikwad, Fourth Edn. Printice Hall India, New Delhi, 2002.
4. The 8051 Microcontroller, Architecture Programming & Applications, Kenneth J.Ayala, Second Edn.
5. Microcontrollers: Theory and Applications, Ajay Deshmukh.

Reference Books:
1. Design with Micro Controller, J.B.Peatman.
2. Programming and Customizing the 8051 Microcontroller, Myke Predko.

Semester 8

Summer Project