Branch
Code: PH
M.Sc. Physics 2021 Batch

Semester 1

PH5010 Mathematical Physics I

Description:
To introduce to students various techniques of basic Mathematical Physics to enable them to learn Physics using the language of Mathematics.

Course Content:
1. Vectors and tensors Vector Calculus and tensors in index notation
2. Linear Algebra Linear vector spaces. Dirac notation. Basic sets. Inner products. Orthonormality and completeness. Gram-Schmidt ortho-normalization process. Linear operators. Matrix algebra, similarity transforms, Diagonalization. Orthogonal, Hermitian and unitary matrices. Spaces of square summable and sequences and square integrable functions, Generalized functions, Dirac delta function and its representations, Differential operation.
3. Fourier series, Fourier integral and Fourier transforms Simple examples.
4. Ordinary differential Equation Power series solutions for second-order ordinary differential equations. Singular points of ODEs. Sturm-Liouville problems. Hermite, Legendre, Laugerre and Bessel functions. Recurrence relations and generating functions. Spherical harmonics. Addition theorem, Gamma, Beta and error functions.
5. Partial Differential EquationsPartial differential Equations in Physics: laplace, poisson and Helmholtz equations; diffusion and wave equations solutions using the method of separation of variables.
6. Probability theory and random VariablesProbability distributions and probability densities. Standard discrete and continuous probability distributions. Moments and generating functions. Central Limit theorem (statement and applications).
7. Complex VariablesFunctions of a complex variable and analytic functions. Cauchy-Riemann conditions. Singularities poles and essential singularities. Residue theorem, Contour integration and examples.

Text Books:
1. G Aafken and H J Weber, Mathematical Methods for Physicists, Academic Press, 7th edition, Indian Edition, (2008).
2. P Dennerey and A Kryzwicki, Mathematics for Physicists, Dover (Indian Edition), (2005).
3. K F Riley, M P Hobson and S J Bence, Mathematical Methods for Physicists and Engineering, Cambridge University Press (Cambridge Low-priced Edition) (1999).

Reference Books:
1. Schaum TMs outline series, McGraw:(i). Vector and tensor analysis, (ii). Linear Algebra, (iii). Differential Equations, (iv). Probability, (v).Statistics
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. E Kreyszig, introductory Functional analysis and Applications John Wiley, (1978).

5. P R Halmos, Finite Dimensional Vector Spaces, prentice-Hall India, (1988).
6. W E Boyce and R C DiPrima, Elementary differential Quations and Boundary Value problems, Wiley International Edition, (1988).
7. C E Wealtherburn, A First course in Mathematical Statistics, ELBS, (Cambridge university press), (1962).

PH5030 Classical Mechanics

Description: 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:
1. H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Pub. House (1989).
2. 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].
3. 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 problems. Particle in a box. Potential barriers. Tunnelling. 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 it TMs application. Concept of digital electronics and its application detail. Finally, will be introduced to microprocessor and it TMs 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:

1. Electronic Principles 5th Edition, Albert Paul MalvinoTana Mc-Graw-Hill Publishing Company Ltd., New Delhi, 1993
2. Digital Principles and Applications 5th EditionAlbert Paul Malvino Donald P.LcachTana Mc-Graw-Hill Publishing Company Ltd., New Delhi, 1994
3. 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
4. Digital Fundamentals 9th edition,Thomas L.Floyd,Prentice Hall, July 13, 2005
5. Digital Design 3rd edition,M.Morris ManoPrentice Hall, 2001
6. Digital Design 4th edition,M.Morris ManoPrentice Hall, 2006.

PH5060 Physics Lab. I (PG)

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 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)
2. Principles of Free Electron Lasers, Authors: Freund, H. P., Antonsen, Jr., T. M., ISBN 978-3-319-75106-1, Publisher: Springer

Semester 2

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 potential. 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).

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).

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).
7. Introduction to Solid State Physics, A. Omar

PH5250 (or) PH5720 Advanced Electronics & Lab (or) Numerical Methods and Programming Lab

Description: Learn the design and application of analog electronics in the field of sensors and transducers. Introduced to design different interfaces using micro controller using Lab view and construct and demonstrate the working of the circuit. Hands on experience of simulating different types of electronic circuits. Learn how to write programs to control circuit using micro controller.

Course Content: Phase-lock loop and its applications frequency multiplication- analog 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, simple input-output, stepmotor control, DAC and ADC interfacing, 7-segment and LCD display system- digital gain control- analog multiplexers- PC based measurement system- IEEE and USB bus systems, Labview programming. Special Lectures/demos: Telemetry, Noise reduction techniques, frequency analysis, familiarising ORCAD, pSpice, VHDL etc

Text Books:
1. Linear Integrated Circuits, D. Roy Choudhury, Shail B. Jain, revised 2nd ed., New Age International Pvt Ltd (2003)
2.Electronic Devices and Circuit Theory, R. L. Boylestead and L. Nashelsky, 8th ed., Prentice Hall India (2002)
3. Op. Amps and Linear Integrated Circuits, Ramakant Gaikwad, 4th ed., Prentice Hall India (2002)
4. The 8051 Microcontroller, Architecture, Programming and Applications, Kenneth J. Ayala, 2nd ed.
5. Microcontrollers: Theory and Applications, Ajay Deshmukh

Reference Books:
1.Design with Microcontroller, J. B. Peatman 2.Programming and customizing the 8051 microcontroller, Myke Predko

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 Centers spectrophotomerter.

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

Semester 3

PH 5410 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 baryonsATOMIC 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)
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)

PH5110 (or) PH5050 Optics and Photonics (or) Mathematical Physics II

PH5110 Optics and Photonics

Description: This course will cover the basic principles o Optics and Photonics in depth and provide introduction to the upcoming frontiers.

Course Content: Fourier Optics: Diffraction integral; fourier transformation in beam propagation Fresnel and Fraunhoffer approximations; Fourier filtering, Image processing; Abbes principle of image formation; principle of phase contrast microscope; holography principles of recording and reconstruction.Optics of periodic media: multilayer dielectric interference coatings and their applications photonic crystals, Bragg reflectors.Lasers: optical amplification and lasers; characteristics of laser radiation; spatial and temporal coherence, optics of Gaussian beams.Fibre and Integrated Optics:
Guided modes; attenuation and dispersion in optical fibres; application in sensors and communication.Photonic devices based on acousto-optics, electro- optics and magneto-optics: Intensity, phase and frequency modulation; frequency shifters; optical diode and isolator; directional coupler; spatial light modulators.Introductory treatment of: nano-photonics, negative refraction and meta-materials, nonlinear optical processes, slowing of light and other contemporary topics.

Text Books:1. E. Hecht and A R Ganesan, Optics, 4th Edi., Pearson Education (2008) or earlier editions: E Hecht and A Zajac.
2. B E A Saleh and M C Teich, Fundamentals of Photonics, 2nd Ed. Wiley (2007)
3. A K Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press (1989)
Reference Books:
1. Text Books: E. Hecht and A. R. Ganesan, Optics, 5th Ed., Pearson Education (2020) or earlier ed.
2. B. E. A. Saleh and M. C. Teich Fundamentals of Photonics, 2nd Ed. Wiley (2007)
3. A. K. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press (1989).

Course References:
1. M. Born and E. Wolf, Principles of Optics, Pergamon Press (1985)
2. J. W. Goodman, Introduction to Fourier Optics, McGraw Hill (1996)
3. K.Iizuka, Engineering Optics, Springer Verlag (2008)
4. J. D. Joannopoulos, S. G. Johnson and J. N. Winn, Photonic crystals: molding the flow of light, Princeton University Press (2008)
5. L. Novotny and B. Hecht, Principles of Nano-Optics, Cambridge University Press, UK (2006)

6. P. N. Prasad, Nanophotonics, Wiley Interscience (2004)
7. S. A. Maier, Plasmonics: Fundamentals and Applications, Springer (2007)

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. Cauchy's 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€™s 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. Schaum's 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).

PH5210 (or) PH5211 Condensed Matter Physics II (or) High Energy Physics

PH5210 Condensed Matter Physics II

Description: To introduce advanced topics in condensed matter physics.

Course Content: Diamagnetic susceptibility, Quantum theory of paramagnetism. Transition metal ions and rare earth ions in solids. Crystal field effect and orbital quenching. Ferromagnetic and antiferromagnetic ordering. Furie-Weiss theory, Heisenberg theory, Curie and Neel temperatures. Exchange mechanisms, Domain walls, Spin waves and magnon dispersion. Internal electric field in a dielectric. Clausius-Mossotti and Lorentz-Lorenz equations. Point dipole, deformation dipole and shell models. Dielectric dispersion and loss. Ferroelectrics: types and models of ferroelectric transition. Nonlinear polarization and effects in response to extreme stimuli. Optical properties of solids: band to band absorption, excitons, polarons. Colour centres. Luminescence. Photoconductivity, Point defects: Thermodynamics of point defects, Frenkel and Schottky defects. Formation enthalpies. Diffusion and ionic conductivity, Superionic conductors. Superconductivity, Thermodynamics of superconducting transition, Electrodynamics of superconductors, Types of superconductors, Tunneling and Josephson effect, experimental and theoretical aspects, new materials and models.

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).
7. Introduction to Solid State Physics, A. Omar

PH5211 High Energy Physics

Description: Introduce sub-atomic physics with emphasis on experimental techniques.

Course Content: Nuclear physics: basic facts about the nuclei: size, shape, binding energy, electric and magnetic 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; elementary ideas of Effective Field Theory; elementary ideas on radioactivity: alpha, beta and gamma rays; nuclear fission and fusion; elementary ideas about nuclear reactors.Â Fundamental forces in nature; classification of particles: bosons and fermions; hadrons and leptons; spin, addition of angular momentum, helicity and chirality; quark content of hadrons; isospin, flavor, and color symmetry, particle quantum numbers, Gell-mann Nishijima formula. Â Real and virtual processes; matrix elements; relativistic kinematics of decay and interaction process (1â†’2 and 2â†’2) illustrated with examples from electromagnetic, weak and strong processes; Scattering amplitudes, differential and total cross-sections, decay rates and life-times; Breit-Wigner formula.Â Elementary introduction to accelerators including, event rates and luminosity; the interaction of particles with matter, scintillators and time-of-flight detectors, the principle of gas chambers, silicon detectors, calorimetry and detectors for particle identification. Large detector systems at electron-positron, electron-proton and hadron colliders.

Text Books:
1. D. Griffiths, Introduction to Elementary Particles, Wiley (1987)
2. D. H. Perkins, Introduction to High Energy Physics, 4th edition, Cambridge (2000).
3. Introductory Nuclear Physics, Kenneth S. Krane, Wiley India Pvt Ltd.

Reference Books:
1. The Nucleon-Nucleon Interaction, Gerald Brown and A.D. Jackson, North Holland.
2. Detectors for Particle Radiation, Konrad Kleinknecht, Cambridge.
3. Techniques for Nuclear and Particle Physics Experiments: A How-To Approach, William R. Leo, Springe

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 andL.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

PH5291 Project I

Semester 4

PH5230 Seminar
PH5240 Viva voce
PH5292 Project II