Learning Outcome-Based Curriculum Framework

for

Postgraduate education

in

Physics

under

Choice Based Credit System (CBCS)

Panskura Banamali College (Autonomous)

Panskura-721152, West Bengal

Introductions:

The learning outcomes-based curriculum framework (LOCF) for the postgraduate programs in Physics is intended to provide a broad framework which will acquaint the student with various realms of Physics at a deeper level in continuity with the basic knowledge acquired in undergraduate level. The primary focus is to grow an overall aptitude in Physics that will enable the student to understand the laws of nature, develop a keen interest in the mysteries of the Universe yet to be known and also equip the student with a firm base for future research and application with a global perspective. The curriculum has been designed and formulated for development of scientific attitudes, rational reasoning, and critical thinking, problem solving skills and initiating research which are competitive globally and are on par in excellence with the standard Higher Education Institutions (HEI) in the advanced countries of America, Asia and Europe. Panskura Banamali College (Autonomous) being a rural college, mainly the first-generation learners enroll for PG Physics course. After completion the course, students are well placed in various prestigious institutions in the areas of research, teaching, industry and management.

The learning outcome-based curriculum framework in Physics should also allow for the flexibility and innovate on in the program design of the PG education, and its syllabi development, teaching learning process and the assessment procedures of the learning outcomes. The process of learning is defined by the following steps which should form the basis of final assessment of the achievement at the end of the program.

- To develop an understanding and knowledge of the advanced Physics governing the laws of nature.
- To analyze new situations, find solutions, interpret results and make predictions for future developments using mathematics, engineering and technology.
- The ability to synthesize the acquired knowledge, understanding and experience for a better and improved comprehension of the physical problems in nature and to create new skills and tools for their possible solutions.

The conceptualization and formulation of the learning outcomes for a postgraduate program in Physics is aimed to achieve the above and could be planned for the research programs in Physics in the Higher Education Institutions in India.

Learning Outcomes based approach to Curriculum planning

Nature and extent of PG program in Physics:

The PG programs in Physics builds on the basic Physics taught at the undergraduate level in the colleges in the country. Ideally, UG Physics achieve a sound grounding in understanding the Physics with sufficient content of topics from modern Physics and contemporary areas of exciting developments in physical sciences to ignite the young minds. The curricula and syllabi should be framed and implemented in such a way that the basic connection between theory and experiment and its importance in understanding Physics. The PG program aims to give a deeper and advanced understanding of the different realms of Physics which builds the foundation on research, prepare them for various prestigious jobs.

The postgraduate programs in Physics are of two-year duration, spread over four semesters after the undergraduate Physics.

Course Structure

Semester- I					Semester- III				
Paper		**Subject**	**Credit**	**Marks**	**Paper**		**Subject**	**Credit**	**Marks**
PHS 101	A	Methods of Mathematical physics-I	2	25	**PHS 301**	A	Quantum Mechanics-III	2	25
	B	Classical Mechanics	2	25		B	Statistical Mechanics-I	2	25
PHS 102	A	Quantum Mechanics-I	2	25	**PHS 302**	A	Molecular Spectroscopy and Laser Physics	2	25
	B	Solid State Physics-I	2	25		B	Nuclear Physics-I	2	25
PHS 103	A	Electrodynamics	2	25	**PHS 303**	A	Applied electronics-Analog (Special Paper-I)	2	25
	B	Material Preparation and characterization	2	25		B	Applied electronics-Digital (Special Paper-I)	2	25
PHS 104	A	Analog Electronics-I	2	25	**PHS 304**	Science of Universe (CBCS)		4	50
	B	Digital Electronics-I	2	25					
PHS 105	Electronics Practical-I		4	50	**PHS 305**	Advance Practical - II		4	50
PHS 106	Computer Practical		4	50	**PHS 306**	Applied electronics Practical (Special Paper-I)		4	50
Semester- II					**Semester- IV**				
Paper		**Subject**	**Credit**	**Marks**	**Paper**		**Subject**	**Credit**	**Marks**
PHS 201	A	Quantum Mechanics-II	2	25	**PHS 401**	A	Particle Physics	2	25
	B	Methods of Mathematical physics-II	2	25		B	Statistical Mechanics-II	2	25
PHS 202	A	Solid State Physics-II	2	25	**PHS 402**	A	Nuclear Physics-II	2	25
	B	Semiconductor Physics	2	25		B	Quantum Field Theory	2	25
PHS 203	A	Analog Electronics-II	2	25	**PHS 403**	A	Semiconductor Devices	2	25
	B	Digital Electronics-II	2	25		B	Applied Optics	2	25
PHS 204	Concepts of Physics: Inventions and applications (CBCS)		4	50	**PHS 404**	A	Applied electronics-Analog (Special Paper-II)	2	25
						B	Applied electronics-Digital (Special Paper-II)	2	25
PHS 205	Electronics Practical-II		4	50	**PHS 405**	Applied electronics Practical (Special Paper-II)		4	50
PHS 206	Advance Practical-I		4	50	**PHS 406**	Project, Seminar and Grand viva		4	50

Matrix of Learning outcome

SEM-I

Sl. No.		PHS101	PHS102	PHS103	PHS104	PHS105	PHS106
1	Fundamental understanding of thefield	✓	✓	✓	✓	✓	✓
2	Application of basic Physics concepts	✓	✓	✓	✓	✓	✓
3	Linkages with related disciplines	✓	✓	✓	✓	✓	✓
4	Procedural knowledge for professional subject	✓	-	-	✓	✓	✓
5	Skills in related field of specialization	✓	-	-	✓	✓	✓
6	Ability to use in Physics problem	✓	✓	✓	✓	✓	✓
7	Skills in Mathematical modeling	✓	✓	✓	✓	-	_
8	Skills in performinganalysis and interpretation of data	-	-	-	-	✓	✓
9	Develop investigative Skills	✓	✓	✓	✓	✓	✓
10	Skills in problem solving in Physics and related discipline	✓	✓	✓	✓	-	-
13	Developing ICT skills	-	-	-	-	✓	✓
14	Demonstrate Professional behaviour with respectto attribute like objectivity, ethical values, self-reading,etc.	✓	✓	✓	✓	✓	✓

SEM-II

Sl. No.		PHS201	PHS202	PHS203	PHS204	PHS205	PHS206
1	Fundamental understanding of thefield	✓	✓	✓	✓	✓	✓
2	Application of basic Physics concepts	✓	✓	✓	✓	✓	✓
3	Linkages with related disciplines	✓	✓	✓	✓	✓	✓
4	Procedural knowledge for professional subject	✓	✓	✓	-	✓	✓
5	Skills in related field of specialization	✓	-	-	✓	✓	✓
6	Ability to use in Physics problem	✓	✓	✓	✓	✓	✓
7	Skills in Mathematical modeling	✓	✓	✓	✓	-	_
8	Skills in performinganalysis and interpretation of data	-	✓	-	-	✓	✓
9	Develop investigative Skills	✓	✓	✓	✓	✓	✓
10	Skills in problem solving in Physics and related discipline	✓	✓	✓	✓	-	-
13	Developing ICT skills	-	-	-	-	✓	✓
14	Demonstrate Professional behaviour with respectto attribute like objectivity, ethical values, self-reading,etc.	✓	✓	✓	✓	✓	✓

SEM-III

Sl. No.		PHS301	PHS302	PHS303	PHS304	PHS305	PHS306
1	Fundamental understanding of thefield	✓	✓	✓	✓	✓	✓
2	Application of basic Physics concepts	✓	✓	✓	✓	✓	✓
3	Linkages with related disciplines	✓	✓	✓	✓	✓	✓
4	Procedural knowledge for professional subject	✓	✓	-	✓	✓	✓
5	Skills in related field of specialization	✓	-	✓	✓	✓	✓
6	Ability to use in Physics problem	✓	✓	✓	✓	✓	✓
7	Skills in Mathematical modeling	✓	✓	-	✓	-	_
8	Skills in performinganalysis and interpretation of data	-	✓	-	-	✓	✓
9	Develop investigative Skills	✓	✓	✓	✓	✓	✓
10	Skills in problem solving in Physics and related discipline	✓	✓	✓	✓	-	-
13	Developing ICT skills	-	-	-	-	✓	✓
14	Demonstrate Professional behaviour with respectto attribute like objectivity, ethical values, self-reading,etc.	✓	✓	✓	✓	✓	✓

SEM-IV

Sl. No.		PHS401	PHS402	PHS403	PHS404	PHS405	PHS406
1	Fundamental understanding of thefield	✓	✓	✓	✓	✓	✓
2	Application of basic Physics concepts	✓	✓	✓	✓	✓	✓
3	Linkages with related disciplines	✓	✓	✓	✓	✓	✓
4	Procedural knowledge for professional subject	✓	-	-	✓	✓	✓
5	Skills in related field of specialization	✓	-	-	✓	✓	✓
6	Ability to use in Physics problem	✓	✓	✓	✓	✓	✓
7	Skills in Mathematical modeling	✓	✓	✓	✓	-	_
8	Skills in performinganalysis and interpretation of data	✓	-	-	-	✓	✓
9	Develop investigative Skills	✓	✓	✓	✓	✓	✓
10	Skills in problem solving in Physics and related discipline	✓	✓	✓	✓	-	-
13	Developing ICT skills	-	-	-	-	-	✓
14	Demonstrate Professional behaviour with respectto attribute like objectivity, ethical values, self-reading,etc.	✓	✓	✓	✓	✓	✓

First Semester

Course No: PHS 101(A)
Methods of Mathematical Physics-I
Marks: 25 Classes: 25

This course is intended to give an exposition over some special mathematical topics that will serve as essential background and knowledge on the advanced theoretical physics course in this semester.

1. Vector spaces and matrices: Vector spaces of n dimensions, inner product, Schmidt's orthogonalization, Schwarz and Bessel inequality.
2. Hermitian and unitary matrices, eigenvectors and eigenvalues, diagonalization, unitary transformation. Cayley Hamilton theorem.
3. Complex variable: Cauchy Reimann conditions, Cauchy's integral and residue theorem, singularities, poles, branch points, contour integration. Taylor & layrebt series expansion, Principle value of an integral Reimann Surface.
4. Special functions, regular and irregular singularities, series solution. Hermite & Legendre (only revision). Laguerre and Bessel functions / polynomials, Gamma, Beta and error functions.

Books Recommended

1. M. R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables.
2. G. Arfken (Academic Press) – Mathematical Methods for Physicists.
3. J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics.
4. P. Dennery and A. Krzywicki (Harper and Row) – Mathematics for Physicists.
5. Grewal-Higher Engineering Mathematics
6. Joshi – Group Theory for Physicists
7. Hamermesh- Group Theory
8. Tulsi Dass- Mathematical Methods of Physics

Course No: PHS 101(B)
Classical Mechanics
Marks: 25 Classes: 25

As the foundation of Classical Mechanics is built up through the UG courses, these special topics in this area are chosen to give a solid understanding and applications over the fields based on classical ideas.

- Recapitulation of Mechanics of System of particles, Lagrange and Hamiltonian of different systems. Lagrange & Hamiltonian for Non conservative system: Velocity – dependent potential, dissipation function, charge particle is moving in an electro-magnetic field, Gauge function for Lagrangian, Canonical Transformations, Legendre Transformation, Poisson Bracket, Lagrange Bracket, Phase Space, Liouville's Theorem, Routhian Function.

- Variational Principles, Hamilton's Principle from Newton's equation & D'Alemberts Principle, Lagrange's equation from Hamilton's Principle, Euler-Lagrange equation, Principle of least action, Modified Hamilton's Principle, Hamiltons Canonical equations.

- Hamilton – Jacobi Theory, Hamilton – Jacobi equation for Hamilton's principal function, Physical significance of Hamilton's principal function, Hamilton – Jacobi equation for Hamilton's characteristic function, Physical significance of Hamilton's characteristic function Hamilton-Jacobi equation from Schrodinger equation, Action-angle variables.

- Small Oscillations: One Dimensional Oscillator, Systems with many Degrees of Freedom: The Eigen value Equation and Normal Coordinates, Different examples.

Books Recommended:

1. Classical Mechanics, by H.Goldstein, Narosa Publishing Home, New Delhi.
2. Classical Dynamics of Particles and Systems, by Marion and Thornton, Third Edition, Horoloma Book Jovanovich College Publisher.
3. Classical Mechanics, by P.V.Panat, Narosa Publishing Home, New Delhi.
4. Classical Mechanics, by N. C. Rana and P. S. Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
5. Introduction to Classical Mechanics, by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
6. Classical Mechanics, by J. C. Upadhyaya, Himalaya Publishing House

Course No: PHS 102(A)
Quantum Mechanics-I
Marks: 25, Classes: 25

The idea of this course in Quantum Mechanics is to revisit the foundational principles and mathematical tools to treat this subject.

1. Recapitulation of:

   I. Chronological evolution of quantum mechanics, Wave particle dualism, Uncertainty principle, Wave packets in space and time.
   II. Formalism of Quantum Mechanics: Development of the wave equation, the Schrodinger wave equation, statistical interpretation of the wave function, probability density and probability current density, Ehrenfest's theorem, stationary states, energy eigen functions, one dimensional square well potential, parity.
   III. Some bound state problems: Finite square well potential, Delta function Potential, Linear harmonic oscillator, Spherically symmetric potential, the Hydrogen atom, Particle in a spherical cavity.

2. Operators and operator algebra, eigen functions and eigen values, expectation values, Dirac bra- kets, Completeness and closure property, Hilbert space of state vectors minimum uncertainty product, form of minimum packet. Coordinate and momentum representation, Unitary transformations
3. Schrodinger, Heisenberg and interaction pictures, Matrix theory of harmonic oscillator.

Books Recommended:

1. 'Quantum Physics' by Robert Eisberg and Robert Resnick (John Wiley and sons).
2. Quantum Mechanics' by L. I. Schiff (McGraw-Hill Book, New York).
3. Quantum Mechanics' by F Schwabl (Narosa).
4. 'Quantum Theory' by D. Bohm (Prentice-Hall).
5. 'Quantum Mechanics: Theory and Applications' by A. K. Ghatak and S. Lokanathan (Macmillan India Ltd.).
6. 'Quantum Mechanics' by Cohen and Tanandji

Course No: PHS 102(B)
Solid State Physics-1
Marks: 25 Classes:25

The idea of this course in Solid State Physics is to revisit the structure and properties of crystalline solids. The classical ideas of understanding the atomic picture of Solid State matters are revisited.

1. Crystal structure: Bravis Lattice, Symmetry elements, Point group, Space group, Polycrystalline, single crystalline and amorphous materials.

2. X-ray diffraction & reciprocal lattice: Scattering of X-ray by a crystal and Derivation of Laue equation, reciprocal lattice vectors, Brillouin Zone, Atomic form factor, Structure factor and experimental diffraction methods, Debye Waller effect.

3. Vibrations of monoatomic and diatomic linear lattice(qualitative), Equivalence of vibrational mode and simple harmonic oscillator, Phonons, Anharmonic crystal interactions, thermal expansion

4. Energy Bands: Physical origin of the energy gap, Bloch function, essential features of Kronig penny model, extended, reduced and periodic zone schemes, effective mass, distinction of metal, insulator and semiconductor.

Books recommended

1. Woolfson : X ray crystallography
2. Kittel: Solid State Physics
3. Dekker: Solid State Physics.
4. Christmaan-solid state physics (academic press)
5. Warren- X-ray Diffraction

Course No: PHS 103(A)
Electrodynamics
Marks: 25 Classes: 25

This course is intended to give a fair idea over matter and radiation and their interactions. The course covers some fundamentals of plasma state. The treatments are also given over relativistic ideas for high speed charged particles.

1. Radiation loss of energy by the free charges of plasma : Radiation by excited atoms and ions. Cyclotron or Betatron radiation, Bremsstrahlung, Recombination radiation, Transport of radiation.

2. Fundamental concepts about plasma: Mean free path and collision cross section. Effect of magnetic field on mobility of ions and electrons, Diffusion of ions and electrons; Ambipolar diffusion, Electron and ion temperature. Plasma parameters

3. Elements of Plasma Kinetic theory : Phase space, Distribution function, the Boltzman equation, The Vlasov Equation

4. Field of moving charges and radiations: Retarded potentials, Lienard Wichert potentials, Field produced by arbitrarily moving charged particle & uniformly moving charged particle, radiation from an accelerated charged particle at low velocity and at high velocity, angular distribution of radiated power. Radiation from an oscillating dipole, radiation from a linear antenna

5. Radiation in material media: Cherenkov effect, Thomson and Rayleigh Scattering, dispersion and absorption, Kramer Kronig dispersion relation.

6. Relativistic electrodynamics: Transformation equations for field vectors and. Covariance of Maxwell equations in 4 vector form, Covariance of Maxwell equations in 4-tensor forms; Covariance and transformation law of Lorentz force. Self-energy of electron

Books Recommended:

1. Marion- Classical Electrodynamics
2. Jackson- Classical Electrodynamics
3. Panofsky & Phillips- Classical Electrodynamics
4. Griffith-Electrodynamics Chakraborty- Plasma Physics
5. Von Engle- Partially ionized gas

Course No: PHS 103(B)
Materials Preparation and Characterization
Marks: 25 Classes: 25

The techniques involving the preparations of various forms of solid materials and the measurements to characterize the samples are essential parts of experimental Condensed matter physics. This course deals with the ideas behind all those aspects.

1. Materials Preparation Techniques: Various methods of crystal growth, Preparation of Amorphous Materials, Thin films preparation (Poly-Crystalline & Amorphous), Glass and Glass Transition. Synthesis of low dimensional

materials. Lithography, Arc Discharge, Thermal Evaporation, Sputtering, Chemical Vapour Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy, Electrodeposition and Sol-Gel Technique;

2. Material Characterization : X-ray Diffraction (XRD), XPS, Introduction to Microscopy: Advantages and disadvantages of optical microscopy over electron microscopy, Scanning electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Electron Spectroscopy for Chemical Analysis (ESCA), Optical Absorption & Transmission study by UV-VIS Spectro-Photometer, Photo Luminescence (PL), Introduction to thermal analysis: Phase changes, crystalline and amorphous fractions – DSC Thermo-gravimetric methods – TGA, DTA
   Energy Dispersive Analysis by X-ray (EDX). Neutron scattering and neutron diffraction, NMR

3. Different optical measurements: UV-VIS, PL, FTIR, Raman. Electrical measurements; Studies on various Conduction Mechanisms in 2D (thin films) and Low-dimensional Systems: Arrhenius type Thermally Activated Conduction, Variable Range Hopping Conduction and Polaron Conduction.

4. Concept of Vacuum techniques, production and measurement of low pressure, Pirani and Penning gauges, rotary and oil diffusion, Turbo, Ion, cryo-pumps; Elements of instruments, sensor materials.

Books recommended:

1. James F Shackelford, “Introduction to Materials Science for Engineers”, 7th Edition, Pearson Prentice Hall, 2009
2. Callister W D, "Materials Science and Engineering: An Introduction", 7th Edition, John Wiley & Sons, Inc., 2007
3. Kenji Uchino,” Ferroelectric Devices”, Marcel Dekker, INC, 2000.
4. Rao V V, Ghosh T B and Chopra K L, "Vacuum Science and Technology', Allied publishers Ltd., 1998.
5. Leon I Maissel and Reinard Glang, "Hand Book of Thin Film Technology", McGraw Hill, 1970.
6. Kelsall Robert W, Ian Hamley and Mark Geoghegan, “Nanoscale Science and Technology”, Wiley Eastern, 2004.
7. Bharat Bhushan, “Springer Handbook of Nanotechnology”, 2004.
8. Michael Kohler, Wolfgang and Fritzsche, “Nanotechnology: Introduction to Nano structuring Techniques”, Wiley –VcH, 2004.
9. Charles P Poole, Frank J Owens, “Introduction to Nanotechnology”, John Wiley and Sons, 2003.
10. Gregory Timp, “Nanotechnology”, Springer-Verlag, 1999.

Course No.: PHS 104 (A)
Analog Electronics-I
Marks: 25, Classes: 25

This course serves as the basis of physical principles of electronic circuits, wave propagation and communication through wave signals.

1. Operational Amplifiers: Revision of Op-amp circuits, Differential amplifier, OP-AMP architecture, Constant current sources, Input stage of an Op-Amp, OP-AMP characteristics and parameters.

2. Elements of Communication: Principle of amplitude modulation (AM) and frequency modulation (FM), AM spectrum and FM spectrum, channel band width and signal band width, side band frequency, Generation of

transmitted carrier and suppressed carrier type AM signals with necessary circuits, Principles of detection of different types of modulated signals (TC and SC types), principle of generation of F.M. wave with necessary circuits, Detection of F.M. wave- Discriminators.
Modulation techniques in some practical communication systems: AM and FM radio, FM stereo receiver, VSB AM and QAM technique in TV broadcasting.

3. Radio wave propagation: Ground wave, Ionospheric wave and space wave and their characteristics, reflection and refraction of radio waves in ionosphere, critical frequency, skip distance, Maximum usable frequency, fading, Secant law, duet propagation.
4. Antenna: Dipole antenna, half wave antenna, antenna with two half elements, N elements array, induction field and retardation field.

5. Radar: Radar range equation, Basic pulsed radar system-Modulators, duplexers, indicators, radar antenna, CW radar, MTI radar, FM radar, Doppler radar.

6. Amplifiers: MOSFET Characteristics and applications, FET and MOSFET Amplifiers.

Books Recommended:

1. J.D.Ryder, Electronics fundamental and application(PHI).
2. Gaykwad, Operational Amplifier.
3. Roddy and Coolen, Electronic Communication systems. (PHI)
4. Chattopadhyay and Rakshit, Electronics circuit analysis.
5. Millman and Grable, Microelectronics. Tata mcGraw Hill.
6. Frazier- Telecommunications.
7. Electronic and Radio Engineering – F. E Terman.

Course No: PHS 104 (B)
Digital Electronics-I
Marks: 25 Classes:25

This course serves the fundamental principles of various digital circuits, electronic processors and logical operations.

1. Combinational logic gates: Karnaugh mapping : Methods of minimization (reduction) of Product of Sum (POS) and Sum of Products (SOP) expressions of 2, 3 and 4 variables Boolean expression, Logical implementations, Revision of Flip-Flops, Conversion of Flip-Flops.

2. Registers: Shift Register, Serial in Serial out, Parallel in Serial out, Parallel in parallel out registers, Bi-directional and Universal registers.

3. Counter: Synchronous and Asynchronous counter, modulo-Counter, decade counter, ring counter and twisted ring counter, Up/Down Counter.

4. Multivibrators: Astable and monostable (principles, Circuits and operation) using Transistors, Internal circuit of IC 555, Timer circuit with 555.

5. Digital display: Seven segment display system, developing of display system for decimal, octal number system.

Books Recommended:

1. R P Jain, Modern digital electronics, Tata McGraw Hill.
2. Anand Kumar, Fundamentals of Digital Circuits, PHI
3. Millman and Halkias- Microelectronics. Tata McGraw Hill.
4. M. Senthil Sivakumar- Fundamental of Digital Design, S. Chan

Course No: PHS105
Electronics Practical-I
Marks: 50

These laboratory experiments are set up to supplement the fundamental knowledge behind the digital electronic circuits and principles.

1. To develop a LC filter circuit having different cut-off frequencies and to find out frequency response characteristics.
2. To study the drain characteristics & transfer characteristics ($I_{D\,sat}$ vs V_{gs} with V_{DS} as parameter) of a FET/MOSFET and to find out the drain resistance, mutual conductance and amplification factor.
3. To study a transformer and to find its various parameters.
4. To construct and design a regulated power supply using Op-Amp as comparator and power transistor as pass element and to find out its ripple factor and percentage of regulation.
5. To obtain the frequency response characteristic of an inverting operational amplifier and to find out its band width.
6. To obtain the frequency response characteristic of a non-inverting operational amplifier and to find out its band width.
7. To design a J-K master – slave flip-flop and to verify its truth table.

Course No: PHS 106
Computer Practical
Marks: 50

This course serves as the foundation of scientific computation with Python. Fundamentals of Python programming will be taught to write algorithm-based codes. Emphasis will be given on Numerical Methods and Special applications in Physics with Python.

Computer Programming in PYTHON and Scientific packages developed for Python.

Basics of scientific computing
Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Working on PYTHON interpreter and Python Scripts, Python language syntaxes
Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, Data formatting, handling, List, String, Dictionary, Tuple, Set. Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D & 2D*), user defined functions, Idea of classes and objects
Basic Programming in Python

Iterative programs, Series sums, Matrix operations, Fibonacci number, Conversion of number systems etc.
Numerical Methods
Root finding, Interpolations, Differentiation, Integration, Solutions of ordinary differential equations (ODE), Monte Carlo Integration, Special functions, FFT, Specific applications to Physics: Quantum Mechanics, Statistical Mechanics.
NumPy, SciPy, Matplotlib softwares to do scientific calculations.
Numerical Methods, Array managements Advanced Course on Data Analysis

Second Semester

Course No: PHS 201(A)
Quantum Mechanics-II
Marks: 25 Classes: 25

This part deals with some advanced topics in Quantum Mechanics such as perturbation theory and Relativistic applications.

1. Symmetry and Conservation laws, Space and time displacement, rotations, angular momentum matrices, Addition of angular momentum, CG coefficients. Spin matrices and eigen functions

2. Approximation methods for bound states: Stationary perturbation theory- non degenerate and degenerate cases, Stark effect, Zeeman effect; Variation method, ground state of Helium atom, WKB approximation,

3. Relativistic wave mechanics: Klein-Gordon equation for a free particle, solution of the KG equation, A spin zero particle in EM field, Coulomb field. fine structure, Dirac's equation for a free particle, Dirac equation in covariant form, Anti commutation relations of the Dirac matrices, Spin of Dirac particle, Magnetic moment of the electron, spin orbit interaction in the Dirac equation Dirac equation in EM field and Coulomb field.

Course No: PHS 201(B)
Methods of Mathematical Physics - II
Marks: 25 Classes:25

This course includes some advanced topics in Mathematical Methods. The applications of these topics will serve as the advanced theoretical topics that are planned to be taught.

1. Partial differential equations: Elliptic, parabolic and hyperbolic type equations, Lagranges formula for 2nd order partial differential equation, Dirchlet Neumann and cauchy Boundary value problem. Greens function with applications.

2. Integral transforms: Fourier series, Fourier transforms, laplace transformation inverse laplace transform. Solution of differential equation using LT and FT. Dirac delta function and its FT.

3. Definition and nomenclature ; Examples ; Rearrangement theorem ; Cyclicgroups, Subgroups and Cosets; Conjugate elements and class structure; Factor groups; Isomorphy and Homomorphy; Direct product groups ; Symmetric groups, Cayley's theorem ; Representation of finite groups- Definition , Unitary representation, Schur's Lemma , Orthogonality theorem , Reducible and irreducible representations, Characters ; Regular representation ; Product representation , Character table , Examples of S_3 and C_4v ; Introduction to Lie groups and Lie algebra; Clebsch-Gordon coefficients.

4. Integral equations. Fredholm and volterra equations of the first and second kinds. Fredholm's theory for non-singular kernel.

Course No: PHS 202(A)
Solid State physics-II
Marks: 25 Classes:25

This is an advanced course on Solid State Physics. The theoretical understanding of Superconductivity and the dielectric properties will be taught in this.

1. Superconductivity: Basic phenomenology, Thermodynamics of Superconducting transition, Resistance less circuit, Consequence of zero resistance, Meissner effect, Type I and II superconductors, Magnetic Levitation, London equation, Quantum Mechanical Current, Supercurrent Equation, Two-Fluid Model, Josephson Tunneling: D. C. Josephson Tunneling & A.C. Josephson Tunneling, Application of super conductivity.

2. Dielectrics: Review of Dielectric in DC, Local field in liquids and Solids, Clausius-Mosotti Relation, Complex dielectric constant and dielectric losses, dielectric losses and relaxation time,

Books Recommended:

1. Introduction to Solid State Physics, by C. Kittel Wiley Publishers.
2. Introduction to Superconductivity, by A. C. Rose-Innes and E. H. Rhoderick, Peragom Press.
3. Introduction to Solid State Physics, by C. Kittel, Wiley Publishers.
4. Solid State Physics, by A. J. Dekker, Macmillan India Limited.
5. Elementary Solid-State Physics- Principles & Applications, by M. Ali Omar, Pearson.
6. Solid State Physics, by N. W. Ashcroft and N. D. Mermin, Cengage Learning
7. Solid State Physics, by S. O. Pillai, New Age International Publishers.
8. Solid State Physics, by R. L. Singhal, Kedar Nath Ram Nath Publishers.

Course No: PHS 202(B)
Semiconductor Physics
Marks: 25 Classes: 25

This course on the basic principles of Semiconductor physics serves as the foundation of Electronics and Solid state matters.

1. Electron & Hole statistics in a semiconductor: Non degenerate & degenerate semiconductor, Intrinsic semiconductor, Ionization energy calculation, Distribution function over an impurity state, N type & P type semiconductor,

2. PN junction in equilibrium, Einstein Relation, Diffusion length, Derivation of diode equation, Junction capacitance, Metal Semiconductor junction

3. Equilibrium & Non-equilibrium carriers, Photoconductivity & related device, Recombination via trap, Solar cell, Semiconductor laser, Hetero junction

Books recommended:

1. Kireev: Semiconductor Physics
2. Streatman & Banerjee: Introduction to Solid State Electronics
3. Smith: Semiconductor
4. Dekker: Solid State Physics

Course No: PHS 203(A)
Analog Electronics-II
Marks: 25, Classes: 25

This course is on the applications of Analog electronics. The principles of Network analysis and Transmission lines are taught in this.

1. (i) Network analysis: Network theorems, equivalent circuits, two-port parameters hybrid parameters, Topological descriptions of different commonly used networks, Π to T and T to Π conversions, reduction of a complicated network into its equivalent T and Π form.
   (ii) Filter Circuit: L filter, Π filter, iterative impedance, image impedance of a network, symmetrical network, characteristic impedance and propagation constant of a network. Methods of development of different constant-k filters like high pass, low pass, band pass and band stop filter circuits.

2. Transmission Lines: Line parameters, characteristic impedance and propagation constant of a transmission line, voltage and current equations of transmission line : Telegraphers' equation, attenuation constant, phase constant, line of finite length behaving as a line of infinite length, reflection co-efficient in a line, velocity of signal in a line, voltage standing wave ratio, Input impedance of Lossless line, line at radio frequency, distortion less line, cable fault location telephone cable.

3. Thyristors: SCR, Triac, Diac, characteristics parameters, Thyristor rectifirer & control circuits., DC Power control by SCR and AC power control by Triac.

4. Transducer & sensors : Photo-transducer, thermistor, photo-electric transducer, photo- conductors, Photo diodes, photo-transistors.

Books Recommended:

1. J D Ryder, Networks line and fields.
2. Van Valkenburg - Network Analysis 3rd Edition.
3. Frazier, Telecommunications.
4. Zee, Physics of semiconductor devices.

Course No: PHS 203(B)
Digital electronics-II
Marks: 25, Classes: 25

This part of digital electronics serves the foundations and workings of digital processors, computer chips and the modern computer organizations.

1. Combinational circuits: MUX, DeMUX, Encoder, Decoder, comparator. A to D and D to A Conversion.
2. The ALU: ALU organization, Integer representation, Serial and Parallel Adders, 1's and 2's complement arithmetic, Multiplication of signed binary numbers, Floating point representation, Overflow detection, Status flags.
3. Memory Unit: Memory classification, Bipolar and MOS storage cells. Organization of RAM, address decoding, Registers and stack, ROM, PROM, EPROM, EEPROM, SRAM, DRAM, and FPLA. Organization and erasing schemes, Magnetic memories, Optical Memories, Semiconductor Memories.
4. Review of 8085 Microprocessor, Internal structure, organization and assembly language. Microprocessor Programming.
5. Basic ideas of Digital Communication: Sampling theorem, Pulse amplitude modulation, Quantization, Pulse Coded Communication System.

Books Recommended:

1. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A* (2nd Ed.).
2. R P Jain, Modern digital electronics, Tata McGraw Hill.
3. Anand Kumar, Fundamentals of Digital Circuits, PHI
4. Taub & Schilling, Principals of Communication Systems, Tata McGraw Hill.
5. G.K. Kharate, Digital Electronics, Oxford

Course No: PHS 204
Concepts of Physics: Inventions and applications (CBCS)
Marks: 50 Classes: 50

The idea of this course is to give an idea of History of science and Practical applications of physics in daily life from Kitchen to Health Industry. The syllabus traces some important inventions, entertains the common and fundamental questions on the world around us.

1. **Important Developments of Physical Science before 20th century: (12L)**
   Archimedes' principle, Inertia: Galileo Galilei, Laws of motion and law of gravity: Newton, Concept of Classical Mechanics, Wave theory of light: young, atomic theory of matter: Dalton, Electrical resistance, etc.: Ohm, Electromagnetic induction: Michael Faraday, Electromagnetic waves: Hertz, Electron: Thomson.
2. **Progress of Physics in 20th century: (18L)**
   Introduction, Photoelectric effect: Einstein, Discovery of the atomic nucleus: Rutherford, Superconductivity: Kamerlingh Onnes, Concept of Quantum Mechanics, Radioactivity, Introduction to electronics, Crystal, Nano materials, Glass, Advancement of technology in 20th century

3. **Physics in daily life: (10L)**

Working principle of: Optical camera, Valve radio, Transistor radio, AM and FM radio, Television, Digital Camera, Mobile, Smart Phone, Electric heater, Microwave oven, Induction oven, Fan, electric generator, Refrigerator.

Development of different light sources: Incandescent bulb, Vapour lamp, Arc Lamp, Fluorescence Lamp (Tube light, CFL), Light Emitting Diode (LED), LASER, Field emission.

4. **Medical Instrumentation:(5L)**

X-ray, Electrocardiograph (ECG), Ultrasonography(USG), Magneto Resonance Imaging (MRI), Photodynamical Therapy (PDT), Spectrophotometry, Chromatology, Electrophoresis.

5. **Physics of Nature: (5L)**

Blue sky, Scattering of light, Colour of Sun, Rainbow, Halo, Refraction and reflection of light, Mirage.

Books recommended:

1. Bowler, Peter J. and Iwan Rhys Morus (2005), Making Modern Science: a Historical Survey. Chicago: University of Chicago Press
2. History of Science, Samarendra Nath Sen, Saibya Prakasan Bibhag, (in Bengali)
3. Itihase Bijnan, J.D. Barnal, Ananda Publishers. (in Bengali)
4. Medical Instrumentation Application and Design, John G. Webster(Editor). Wiley 4th Edition.
5. Handbook of Biomedical Instrumentation, Dr R.S. Khandpur, McGraw Hill Education (India) Private Limited, Third Edition.
6. Introduction to Light: The Physics of Light, Vision, and Color, Gary Waldman, Dover Publications.

Course No: PHS 205
Electronics Practical-II
Marks: 50

The lab experiments are to deal with microprocessors and other electronic circuitry based on various chips.

1. To design a 4 bit ripple counter and to develop different modulo counters from it.
2. Study of differential amplifier circuit using transistors and find out its differential mode gain.
3. Design of a window comparator and study its characteristics
4. Monostable multivibrator and timer circuit with IC 555.
5. Determination of the slew rate of an Op-amp.
6. To design an LC oscillator using transistor.
7. To design and develop cascaded FET amplifier and to find out its linearity and frequency response characteristics.
8. Band gap measurement of a Semiconductor using P-N junction.
9. Simple microprocessor programming.

Course No: PHS 206
Advance Practical-I
Marks: 50

Some advanced level experiments are set up based on the ideas of Modern Physics, Solid state and Nuclear Physics.

Group-A

1. Determination of electron temperature by single probe method.
2. Study of the characteristics of a GM tube.
3. Obtain X-ray Debye-Scherrer photograph and determination of Unit Cell dimensions of a crystal.
4. To Study experimentally the variation of resistivity of semiconductor with temperature and hence to find out the band gap energy.
5. Linearisation LED Characterestics and finding out the quantum efficiency.
6. Measurement of dielectric constant of solid and liquid.
7. Determination of Plank's constant (using photo electric effect).
8. Determination of refractive index using Michelson Interferometer.
9. To determine the resolving time of the G-M counting system.

Group-B

1. Determination of Electron / Ion temperature by Double probe method.
2. Determination of the gamma and beta ray absorption coefficients by using a G.M. counter.
3. Measurement of the Hall coefficient of a given sample and calculation of its concentration.
4. Frank Hertz experiment.
5. Measurement of e/m by magnetron valve
6. Determination of Curie temperature.
7. Study of nuclear counting statistics.
8. To estimate the separation between the two plates of a Febry-Perot interferometer.
9. Determination of Numerical aperture of a given optical fibre, bending loss and slice in a multimode optical fibre.

Third Semester

Course No: PHS 301(A)
Quantum Mechanics-III
Marks: 25 Classes: 25

This course deals with some advanced topics in the theory and applications of Quantum Mechanics.

1. System of identical particles, permutation symmetry, symmetric and anti-symmetric wave function, Pauli exclusion principle. Spin functions for two and three electron atoms. Helium atom (ground state and first excited state)

2. Atoms, Molecules: Central field approximation, Hartree and Hartree-Fock approximation, Koopman's theorem, Thomas-Fermi statistical model, LS coupling, JJ coupling, Hund's rule, spectral terms; Zeeman effect (weak field, strong field, quadratic). Molecules, Classification of energy levels, rotation and vibration of diatomic molecules, Hydrogen molecule.

3. Time dependent perturbation; ionization of a Hydrogen atom, sudden approximation. , Fermi's golden rule, transition probabilities, constant and harmonic perturbations, semi-classical treatment of radiation. Intensity ratio of transitions in alkali atoms.

4. Quantum theory of scattering -cross sections , partial wave analysis , phase shifts , optical theorem. Schrodinger's equation as an integral equation , Green's function , Lippman-Schwinger equation, Born's approximation, Coulomb scattering.

Course No: PHS 301(B)
Statistical Mechanics-I
Marks: 25 Classes: 25

This course first introduces the essential ideas of Classical Statistical Mechanics. Then the last module deals with the foundations of Quantum Statistical Mechanics, density matrix approach and its applications.

1. Recapitulation: Connection between statistical mechanics and thermodynamics, Macroscopic and microscopic states, classical ideal gas, Gibbs paradox. Elements of ensamble theory: Phase space and density function, Liouville's theorem, microcasnonical ensamble, Canonical ensamble, mean-square fluctuation of an observable, energy fluctuation in the canonical ensamble: correspondence with the micro canonical ensamble, a system of harmonic oscillator, thermodynamics of magnetic systems: negative temperature problems.

2. Grand canonical ensamble: density and energy fluctuation in the grand canonical ensamble: correspondence with the other ensambles.

3. Quantum mechanical ensamble theory: Postulates of Quantum Statiatical mechanics, Density matrix, statistics of various ensambles Ideal gas in Quantum mechanical miro canonical ensamble , determination of entropy in Boltzman Gas, Bose gas, Fermi gas, Ideal gas in other quantum mechanical ensambles

Books Recommended:

1. R. K. Pathria : Statistical Mechanics
2. K. Huang : Introduction to Statistical Mechanics
3. Silvio R. A. Salinas : Introduction to Statistical Mechanics.
4. F. Reif : Fundamentals of Statistical and Thermal Physics.
5. Kadanoff : Statistical Mechanics. World Scientific.
6. R. Kubo : Statistical Mechanics. (Collection of problems)

Course No: PHS 302(A)
Molecular Spectroscopy & Laser Physics
Marks: 25 Classes: 25

This course is intended to provide the fundamental ideas behind various spectroscopy. The origins and physical aspects of Microwave, Infra-red, Visible and Ultraviolet spectroscopy will be well explained. The last part deals with principles and techniques of Laser.

1. Microwave spectroscopy: Classification of molecules, Diatomic molecular rotational spectroscopy of rigid and non-rigid diatomic molecules, triatomic molecules and polyatomic molecule, microwave spectroscopy of symmetric type of molecules, Stark effect.

2. Infra-red spectroscopy: Diatomic molecular vibrational spectroscopy with harmonic and anharmonic vibration, vibrational and rotational spectroscopy, anharmonic oscillation constant, rotational constant, Dissociation energy.

3. Visible and ultraviolet spectroscopy: Molecular electronic spectroscopy, Frank Condon principle, Molecular electronic vibrational-rotational spectroscopy, Born-Oppenheimer approximation, Fortrat diagram, Band head.

4. Laser: Laser resonator, population inversion, active and passive laser resonator, Threshold condition, saturation condition, Quality factor, classification of laser Three level laser and four level laser system, equation of population inversion and threshold power calculation for the laser systems, Rubby laser, He - Ne laser, CO_2 laser, Dye laser (tunable laser), Q swatching, mode locking, Application of laser.

Books Recommended:

1. Fundamentals of Molecular Spectroscopy, by C. N. Banwell and E. M. McCah, Tata McGraw- Hill Publishing Company Limited, New Delhi.
2. Molecular Structure and Spectroscopy, by G. Aruldhas, PHI Learning Private Limited, New Delhi.
3. Molecular Structure and Molecular Spectra: vol. 1, Spectra of Diatomic Molecules, 2nd ed., by G. Herzberg, Van Nostrand.
4. Molecular Structure and Molecular Spectra: vol. 2, Infrared and Raman Spectra of Polyatomic Molecules, by G. Herzberg, Van Nostrand.
5. Molecular Spectroscopy, by G. M. Barrow, Mc-Graw Hill.
6. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
7. Fundamentals of Light Sources and Lasers, by Mark Csele, John Wiley & Sons, Inc.

Course No: PHS 302(B)
Nuclear Physics-I
Marks : 25 Classes:25

This course deals with fundamental aspects of Nuclear Physics. Stability and Nuclear decay will be discussed through the modules.

1. Properties of Nuclei: Double focusing mass Spectrometer (Nier and others), Nuclear Spin, magnetic moment Rabi method; nuclear shape-electric quadruple moment; parity; statistics.

2. Stable nuclides: Regularities, the odd-even classification, stable isotopes, isotones and isobars, isomers, mass and energy of nuclides, the mass parabolas for isobars.

3. Recapitulation of α–decay spectra, systematics of α- decay energies, Gamow theory of α-decay.

4. β-decay: Continuous nature of Spectrum; neutrino detection; Fermi's theory of beta decay; Kurie plot, Simple ideas of parity violation in beta - decay.

5. γ-decay: The modes of gamma transition, theory of multiple radiation's, selection rules, internal conversions; nuclear isomerism; recoil free gamma-ray spectroscopy.

Books Recommended :

1. Introductory Nuclear Physics- Kenneths Kiane
2. Atomic and Nuclear Physics- S.N. Ghosal
3. Introduction to High Energy Physics-P.H. Berkins
4. Nuclear Physics- Kaplan
5. Concepts of Nuclear Physics- B.L. Cohen
6. Nuclear Theory- R.R. Roy and B.P. Nigam
7. The Atomic Nucleus- R.D. Evans
8. Basic Nuclear Physics- B.N. Srivastava
9. Introductory Nuclear Physics- L.R. B. Elton
10. Nuclei and Particles- E. Segre
11. Theoretical Nuclear reactions: Blatt and Weisskopf

Course No: PHS 303(A)
Applied Electronics-Analog (Special Paper-I)
Marks:25 Classes: 25

This course deals with some special applications of Analog Electronics and devices.

1. Special OP- AMP Circuits & applications: Bridge amplifier, instrumentation amplifiers, logarithmic amplifiers, anti-log amplifier, analog multiplier, summing integrator, chopper modulator, chopper stabilized amplifier, pulse width modulator, Regenerative comparators and their uses, pulse generator, ramp generator, square and triangular wave generator, crystal oscillator, voltage controlled oscillator (VCO), active filters, Butterworth characteristics, first, second and higher order low pass and high pass active filters, band pass and band stop active filters.
2. Voltage regulators : Series Op-amp regulator, IC regulator, precision current and voltage sources, Switching Regulators.

3. Phase Lock Loop (PLL) & applications: PLL operational characteristics and parameters, Frequency multiplication, tracking, FM demodulation, Order of PLL.

4. Detectors: Peak detectors, zero-crossing detectors, phase-sensitive detectors.

Course No: PHS 303(B)
Applied Electronics-Digital (Special Paper-I)
Marks:25, Classes: 25

This course deals with some special applications of Digital Electronics and devices, converters and communications.

1. Digital Logic families: DTL, TTL, ECL, MOS, CMOS logic circuits, their advantages and disadvantages, Speed of operation, Power dissipation, Figure of merit, Fan-out.

2. Different memory systems : Memory organization and addressing, Sequential Memory : Static and Dynamic (Ratioed and Ratio-less) shift registers, Development of Read only Memory memories, RAM, MRAM, RRAM, PAL, FPLA. Charge coupled devices (CCD).

3. Revision of different types of Multiplexing, Encoders and Decoders, Code conversions: BCD to Binary converter, Binary to BCD converter.

4. Specialised Communication Systems: Mobile Communication – Concepts of cell and frequency reuse description of cellular communication standards; Pagers. Computer communication – Types of networks; Circuit message and packet switched networks; Features of network, design and examples of ARPANET, LAN, ISDN, Medium access techniques – TDMA, FDMA, ALOHA, Slotted ALOHA, CSMA/CD; Basics of protocol.

Books Recommended:

1. Gaykwad, Operational Amplifier, PHI
2. Millman and Halkias, Microelectronics. Tata mcGraw Hill.
3. Geiger, Allen and Strader – VLSI – Design Techniques for Analog and Digital Circuits.
4. Gray and Meyer – Analysis and Design of Analog Integrated Circuits.
5. S Soelof – Applications of Analog Integrated Circuits.
6. R P Jain, Modern digital electronics, Tata McGraw Hill.
7. A B Carlson – Communication Systems.
8. D Roddy and J Coolen – Electronic Communications.

Course No: PHS 304
Science of Universe (CBCS)
Marks : 50, Classes: 50

This special course is designed to give a fair idea about the fundamental ideas of Astrophysics. The question of the existence of the Universe that we observe, from planets and stars to galaxies, are well addressed through the modules.

1. Our Planet, our Universe: (12L)
   Our motion in the Universe. The night sky, basic concepts in astronomy such as distances, constellations and the celestial sphere, Asteroids & Comets, Formation of our solar system, Sun- Moon-Earth configurations that result in Moon phases and Solar and Lunar eclipses.

2. Astronomical Tools: (13L)
   Light as a tool to probe the Universe. Properties of light. The wave particle nature of light. Atoms and spectroscopy. The thermal spectrum. Stellar classification: Hertzsprung-Russell diagram. Composition of a star's outer layers and its surface temperature, The Inverse square law. Telescopes to learn about astrophysical phenomena.

3. The Sun: (5L)
   Origin of solar energy, Nuclear fusion, Solar cycle, Solar activity, Solar wind. Solar missions. Main-Sequence lifetime.

4. Evolution of Stars: (10L)
   Post-main-sequence evolution of a Sun-like star. Planetary nebulae. White dwarfs. Neutron Stars, Difference between stars, brown dwarfs and giant planets. Supernova explosions. Neutron stars and black holes. Color-magnitude diagrams, Binary star systems.

5. Galaxy and Cosmos: (10L)

Populations of stars and star clusters. Galaxy types and the formation and interaction of galaxies. The Milky Way, Active galactic nuclei, The rotation of our galaxy. Dark matter. The expansion of the Universe and the Big Bang Theory.

Books Recommended:

1. Schneider and Arny: Pathways to Astronomy, McGraw-Hill, 2007
2. M. Schwarzschild: Stellar Evolution
3. S. Chandrasekhar: Stellar Structure
4. K.D.Abhyankar: Astrophysics: Stars and Galaxies
5. Menzel, Bhatnagar and Sen: Stellar Interiors.
6. Cox and Guili : Principles of Stellar Interiors – Vol.I and II.
7. Shapiro and Tevkolsky: White Dwarfs, Neutron Stars and Black Holes.
8. R.Bowers and T.Deeming: Astrophysics (John and Barlett. Boston).
9. General Relativity, Astrophysics, and Cosmology, A. K. Raychaudhuri, Sriranjan Banerji, Asit Banerjee, Springer-Verlag, 1992

Course No: PHS 305
Advance Practical-II
Marks: 50

Some advanced level experimental settings are designed in the areas of Condensed Matter and Nuclear Physics.

Group-A

1. Determination of Electron / Ion temperature by Double probe method.
2. Determination of the gamma and beta ray absorption coefficients by using a G.M. counter.
3. Measurement of the Hall coefficient of a given sample and calculation of its concentration.
4. Frank Hertz experiment
5. Measurment of e/m by magnetron valve
6. Determination of Curie Temperature.
7. Study of nuclear counting statistics.
8. To estimate the separation between the two plates of a Febry-Perot interferometer.

Group-B

1. Determination of electron temperature by single probe method.
2. Study of the characteristics of a GM tube.
3. Obtain X-ray Debye-Scherrer photograph and determination of Unit Cell dimensions of a crystal.
4. To Study experimentally the variation of resistivity of semiconductor with temperature and hence to find out the band gap energy.
5. Linearisation LED Characterestics and finding out the quantum efficiency.
6. Determination of Plank's constant (using photo electric effect).
7. Determination of refractive index using Michelson Interferometer.
8. To determine the resolving time of the G-M counting system.

Course No: PHS 306

Applied Electronics Practical (Special Paper-I)

Marks: 50

This course is on the design and construction of various electronic circuits and applications.

1. Design, Construction and performance testing of a Logarithmic amplifier using μA 741, diode and matched transistors.
2. Design, Construction and performance testing of an antilog amplifier using μA 741 and matched transistors.
3. Design of an IC Power Amplifier and its linearity, frequency response, efficiency, and distortion calculation.
4. Design of a Precision adjustable voltage regulator using μA 741 and series pass transistor and a transistor as current limiter and its performance comparison with LM78XX series fixed regulators.
5. Design of an Active high pass/Low pass second order Butterworth filter.
6. Design an active band pass filter using single stage μA 741 Op-amp.
7. Frequency to Voltage converter circuit design.
8. 8086 Microprocessor programming.
9. Design and study of an ECL OR-NOR circuit.
10. Design and study of a Voltage Controlled Oscillator (VCO).
11. Experiments on Microprocessor interfacing.
12. Study of Time Division Multiplexing.
13. Study of Pulse Code Modulation.
14. Design of BCD adder

Fourth Semester

Course no – PHS 401(A)
Particle Physics
Marks : 25 Classes: 25

This course is introduced to give fundamental ideas of Particle physics and phenomenology.

Review of the fundamental classification of elementary particles and study of their different properties and decay scheme (Mesons, Muons), Conservation Laws, Gell-mann and K. Nishijima model, +Su(3) model, Quark model, charm and other flavors, color, properties of strange particles, improper symmetry, parity, charge conjugation, time reversal, CPT theorem, spontaneous symmetry breaking, parity non conservation, K-meson, complex and time reversal invariance.

Books Recommended:

1. Griffith, Introduction to Particle Physics
2. Perkins, High Energy Physics
3. Halgen & Martin, Quarks & Leptons
4. M.P. Khanna- Introduction to Particle Physics

Course No: PHS 401(B)
Statistical Mechanics-II
Marks: 25
Classes – 25

This advanced course deals with the foundation of Quantum Statistical Mechanics and applications. Emphasis is given on the theory of Phase transition and critical phenomena.

1. Ideal Bose system: Thermodynamical behaviour, BE condensation, blackbody radiation
2. Ideal Fermi System: Thermodynamical behaviour; Magnetic behaviour of an ideal Fermi gas: Pauli paramagnetism, Landau diamagnetism and DeHaas-van Alphen affect, electron gas in metal, thermo ionic emission, photoelectric emission
   Theory of phase transition: Theory of Yang and Lee ,Ising model (one and Two dimensional)

Books Recommended:

1. R. K. Pathria, Statistical Mechanics
2. K. Huang, Introduction to Statistical Mechanics
3. Silvio R. A. Salinas, Introduction to Statistical Mechanics.
4. F. Reif, Fundamentals of Statistical and Thermal Physics.
5. Kadanoff, Statistical Mechanics. World Scientific.
6. R. Kubo, Statistical Mechanics. (Collection of problems)
7. S.K. Ma, Statistical Physics(World Scintific, Singapore)
8. Ishihara, Statistical Physics

Course No: PHS 402(A)
Nuclear Physics-II
Marks: 25

Classes: 25

One part of this advanced course on Nuclear Physics deals with the nuclear models and nuclear reactions. The other part is on the practical applications on Neutron physics and Reactor Physics. Some fundamentals of High energy particle physics will also be discussed.

1. Nuclear interactions and reactions: Nucleon-Nucleon interaction, exchange forces and tensor forces. The deuteron - Square well potential; neutron-proton and proton-proton scattering at low energies. Classifications of nuclear reactions, Conservation laws; reaction channels; the mass & energy balance in nuclear reactions, direct and compound nuclear reaction mechanisms, compound nuclear model; basic ideas on continuum theory; nuclear resonance.
2. Nuclear models: liquid drop model, Bohr Wheeler theory of fission, experimental evidence for shell effect, shell model, spin orbit coupling , magic numbers, angular momenta and parity of nuclear ground state; collective model of Bohr and Mottelson.
3. Neutron Physics: Classification of neutrons, Source of neutrons, Thermal neutrons; Velocity selection and time of flight methods, elements of neutron optics.
4. Reactor physics: Slowing down of neutrons in a moderator, average log decrement of energy per collision, moderatingratio.
5. High energy physics: Types of interaction –typical strength and time scale, Conservation loss, Parity & time reversal, CPT theorem

Course No: PHS 402(B)
Quantum Field Theory
Marks: 25
Classes:25

This course is intended to give an idea of Field theoretic approach to understand High energy physics and deals with some essential theorems and aspects of Standard model.

Elements of field theory ; Symmetries and Noether's theorem ; Canonical Quantization ; Creation-Annihilation operators ; Quantization of Klien-Gordan field, Dirac field, quantization of electromagnetic field ; Discrete symmetries of the Dirac theory ; Interacting fields - Perturbation theory , Wick's theorem, Feynman diagrams , cross sections and S-matrix., Non-perturbative methods - Field and Mass renormalization ; LSZ reduction formula ; Renormalized charge and Ward Identities. , brief idea on Gauge theory, weak and strong interactions, brief discussion on Weinberg - Salem model, Grand unified theories

Books Recommended:

1. Ryder, Quantum Field Theory
2. Barger & Phillips, Collider Physics
3. Peskin & Schroeder, Quantum Field Theory
4. Palash Pal and A Lahiri, Quantum Field Theory, Narosa
5. Mandle, Quantum Field Theory

Course No: PHS 403(A)
Semiconductor Devices
Marks: 25 Classes:25

This course deals with the principles of semiconductor devices that are essential part of modern-day experiments and measurements.

1. Transistor, FET, MOSFET, Tunnel Diode, Gunn effect oscillator, Single electron Transistor.

2. Boltzman transport equation applied to a non-degenerate semiconductor, Electrical conductivity, Hall effect & Thermoelectric effect in semiconductor, Quantum Hall effect.

3. Phototransistors, UJT, Four- layer pnpn device, Diac, Triac.

Books Recommended:

1. Kireev: Semiconductor Physics
2. S.M. Zee: Physics of semiconductor devices
3. Streatman & Banerjee: Introduction to solid state electronics

Course No: PHS 403(B)

Applied Optics

Marks: 25 Classes: 25

Ideas behind some advanced areas and applications like Fibre optics, Holography techniques, Non-linear Optics and Photonics will be dealt in this course.

1. Fiber optics: Different types (single and multi mode) of step index and graded index optical fiber, ray path in graded index optical fiber, Multipath broadening, Modal analysis of Electromagnetic waves in planer waveguide. Application of fiber in digital communication.

2. Holography: Coherent light and application of coherent light in holography. Recording and reconstruction of wave front.

3. Non-linear Optics: Non-linearity of medium, second and higher harmonic generation, phase matching condition, frequency addition and frequency subtraction, self focusing and self defocusing, Pokels & Kerr type of nonlinear materials, Examples of Organic and inorganic nonlinear materials.

4. Photonics Information Processing: Optical logic operations, Optical arithmetic operation with binary, optoelectronic logic gates, all optical logic gates, tristate logic system and tristate AND & OR gate.

Books Recommended:

1. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
2. Semiconductor optoelectronic devices, by P. Bhattacharya, Prentice Hall publication
3. Optical Electronics, by A. Yariv, Holt McDougal
4. Laser Physics and Applications by L. Tarasov, Mir Publishers, Moscow.
5. optical computation and parallel processing, S. Mukhopadhyay, Classique Books Publisher
6. Some digital approaches in optical computation, by P. Ghosh and S. Mukhopadhyay, Premier Books publication, India

Course No: PHS 404(A)
Applied Electronics-Analog (Special Paper-II)
Marks:25 Classes: 25

Advanced electronics on Practical applications in devices and instruments and in modern technology.

1. Television: Working principle, TV camera- Image Orthicon, Vidicon, Plumbicon; Picture tube- B/W and Colour, scanning and deflection, synchronization, Details of composite video signal, Transmitting and Receiving systems, Vestigial Side band transmission, Television standards, Advantages of Negative modulation, TV antenna, BW TV receiver.
   Colour TV standards : NTSC, PAL SECAM, colour television principles, Colour subcarrier, transmission format of intensity and colour signal.

2. Wave Guides : Wave guides coaxial, rectangular and cylindrical; Different modes of propagation of em signal through wave guides, resonators.

3. Instrumentations: Digital voltmeter : different types, Digital ammeter and ohmmeters, Ultrasonic techniques and instrumentations.

Course No: PHS 404(B)
Applied Electronics-Digital (Special Paper-II)
Marks:25 Classes: 25

Modulation, demodulation, communication through signals, Signal and Data processing - all these are part of this special course in Electronics. Also, the usage of Microprocessors and the logical programming are part of this course.

1. Signal processing & data conversion: Signal sampling, aliasing effect, sample and hold systems, anti-aliasing filter, analog-multiplexer, Digital image processing (ideas only). Successive approximation A/D converter.

2. Pulse modulation and demodulation techniques: Sampling the rein PAM, PWM, PPM, Pulse code modulation-Coding technique modulation and demodulation, DPCM, Delta Modulation.

3. Digital modulation techniques: ASK, FSK, PSK, DPSK, QPSK, MSK principle, modulation and demodulation.

4. Microprocessor and their applications: Architecture of 8-bit (8085) and 16-bit (8086) microprocessors; addressing modes and assembly language programming of 8085 and 8086. Interfacing concepts memory and I/O interfacing; Interrupts and interrupt controllers; microprocessor-based data acquisition (DAS) system, comparison of different microprocessors. Microprocessor programming.

Books Recommended

1. R.R. Gulati – Monochrome and Color TV.
2. A M Dhake – Television and Video Engineering.
3. D Roddy and J Coolen – Electronic Communications.
4. Helfrick & Cooper- Modern Electronic Instrumentation-PHI
5. A B Carlson – Communication Systems
6. Kennedy and Davis – Electronic Communication Systems.

7. Taub and Schilling – Principle of Communication Systems., McGraw Hill
8. A P Mathur – *Microprocessors.*
9. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A (2nd ed.)*
10. D V Hall – *Microprocessor and Interfacing*.
11. Lin and Gibson – *Microprocessor*.

Course No: PHS 405
Applied Electronics Practical (Special paper-II)
Marks: 50

This course is on the design and construction of various electronic circuits which have various applications.

1. Design of a Schmitt trigger circuit using μA 741.
2. DSB-TC and DSB-SC generation using analog multiplier IC MC 1495 or MC1496.
3. Design and performance study of a VCO IC (NE 566).
4. Design and performance study of a PLL IC (NE 565).
5. Digital adder, subtractor and comparator Shift registers and shift counter, PISO, SISO, PIPO, SISO.
6. Digital multiplexing.
7. Study of Pulse Amplitude Modulation.
8. Study of Pulse Width Modulation.
9. Pattern waveform generator for analog multiplexing.
10. To study the input stage of an Op-amp using discrete components and fine out the differential mode gain.
11. PSIPCE study the input stage of an Op-amp using discrete components and fine out the differential mode gain.

Paper 406
Project, Seminar and Grand Viva
Marks-50

Students learn to formulate problems, design a framework to solve it in laboratory and to analyse the outputs. They will gain exposure on seminar presentation, will interact with the subject experts through viva vocation. This course will help the students to prepare them in future research.