UG Physics (Major) Course Structure, Tripura University
(As per NEP-2020 guideline)

Year	Semester	Course Code	Paper Title	Theory/ Practical	Credits
1st	I	PH-101C	Mathematical Physics-1 (Th)	Theory	4 Cr
		PH-102C	Mechanics (Th+Pr)	Theory + Practical	2 Cr+ 2 Cr
	II	PH-201C	Thermodynamics& Transport Phenomena (Th)	Theory	4 Cr
		PH-202C	Fluid Mechanics &Acoustics (Th+Pr)	Theory + Practical	2 Cr+ 2 Cr
2nd	III	PH-301C	Electricity and Magnetism-1 (Th)	Theory	4 Cr
		PH-302C	Electricity and Magnetism -2 (Th+Pr)	Theory + Practical	2 Cr+ 2 Cr
	IV	PH-401C	Optics (Th)	Theory	4 Cr
		PH-402C	Electromagnetic Wave & Application of Optics (Th+Pr)	Theory + Practical	2 Cr+ 2 Cr
3rd	V	PH-501C	Classical Mechanics &Special Theory of Relativity (Th)	Theory	4 Cr
		PH-502C	Statistical Mechanics (Th), Programming in Python-1 (Pr)	Theory + Practical	2 Cr+ 2 Cr
		PH-503C	Quantum Mechanics -1 (Th)	Theory	4 Cr
		PH-504C	Analog Electronics (Th+ Pr)	Theory + Practical	2 Cr+ 2 Cr
	VI	PH-601C	Solid state Physics (Th)	Theory	4 Cr
		PH-602C	Atomic & Molecular Physics (Th) + Project -2 (Pr)	Theory + Practical	2 Cr+ 2 Cr
		PH-603C	Nuclear Physics (Th)	Theory	4 Cr
		PH-604C	Digital Electronics (Th+Pr)	Theory + Practical	2 Cr+ 2 Cr

First Semester: Physics Major
Paper Code:PH101C
(Theory): [Mathematical Physics-I]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60 hours

Unit-I NLP-15

Vector: Scalars and vectors, laws of vector algebra, scalar and vector product, triple scalar product and their interpretation in relation to application in Physics, triple cross product, product of four vectors. Scaler and vector fields. [**NLP: 4 hours]**

Vector differentiation: Gradient, divergence and curl, their physical meaning and application in Physics problems. Vector identities. [**NLP: 5 hours]**

Vector integration: Line, surface and volume integration, problems related to line, surface and volume integral. Gauss divergence theorem, Stoke's theorem, and Green's theorem and their application to problems. **[NLP: 6 hours]**

Unit-II NLP-15

Matrices: definition, different types of matrices, Unitary Matrix, Hermitian matrices. Eigen value and eigen vector of matrix, Cayley-Hamilton theorem, diagonalization of a matrix, Jacobian [**NLP: 7 hours]**

Beta and gamma functions, Gamma function beta function, their properties and interrelationship, their application to simple problem. [**NLP: 6 hours]**

Taylor's Series: Taylor's series expansion for elementary functions, Maclaurin series formula. [**NLP: 2 hours]**

Unit-III NLP-15

Differential Equation: Definition, Order, degree, Linearity, Homogeneous and inhomogeneous differential equation, Example of differential equation in Physics, First order equations and linear second order differential equations with constant coefficients

[NLP: 3 hours]

Series Solution: Ordinary point, regular Singular point, irregular singular point, Solution of second order homogeneous differential equation by Frobenius method, **[NLP: 4 hours]**

Special function: Legendre differential equation, series solution method to obtain the solution: Legendre Polynomial, its generating function, Recurrence relation**,** examples of applications of Legendre polynomial.

Hermite differential equation and Hermite Polynomials (solution derivation not required), generating function and recurrence relations for Hermite polynomials.

Laguerre differential equation and Laguerre Polynomials (solution derivation not required), generating function and recurrence relations for Laguerre polynomials.

[NLP: 8 hours]

Unit-IV NLP-15

Orthogonal curvilinear co-ordinate system: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian, and applications in Cartesian, Spherical and Cylindrical Coordinate Systems. **[NLP: 6 hours]**

Fourier series and application: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Fourier Co-efficient, Analysis of different simple waveform such as square wave, half wave rectifier, full wave rectifier, saw tooth wave, triangular waveusing Fourier series methods. **[NLP: 6 hours]**

Probability Distributions: Elementary probability theory Discrete and continuous random variables, Probability distribution functions, Binomial, Poisson and Gaussian distributions, **[NLP: 3 Hours]**

Suggested readings:

(1) Vector Analysis: Murray R Spiegel, Seymour Lipschutz, Dennis Spellman, Schaum's Outline, McGraw Hill.

(2) Mathematical Physics, B. D. Gupta, S. CHAND

(3) Mathematical Physics, H. K. Dass, and Rama Verma S. CHAND

(4) Mathematical Methods for Physicists by Arfken, Weber and Harris, Elsevier

(5) Mathematical Physics by A.K. Ghatak, I.C. Goyal, S.J. Chua, Laxmi Publication Private Ltd

First Semester: Physics Major
Paper Code: PH102C
Group:-A (Theory): Mechanics
Total Marks- 60 (IA-24+ EXE-36)
Total Credit-02
Total Number of lecture periods: 30hours

Unit-1 NLP-15

Plane curvilinear motion: velocity and acceleration of a particle in plane polar coordinate system (*radial and transverse component of velocity and acceleration*), tangential and normal components of velocity and acceleration **[NLP: 5 Hour]**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of inertia, Radius of gyration, Parallel and perpendicular axes theorems (2D) and application, Calculation of moments of inertia for plane lamina, rectangular solid body, circular disc, sphere (thin, thick, solid), cylinder (thin, thick, solid), solid cone, hollow cone, andproblems related to moment of inertia, Kinetic energy of rotation. Motion along an inclined plane and identification of types of bodies using inclined planes **[NLP: 10 Hour]**

Unit-II NLP-15

Elasticity: Stress-strain graph, Elastic moduli (including axial modulus) and their inter-relations, torsion of a cylinder, torsional oscillations, Bending Moment, Cantilever in different cases (neglecting own mass), strain energy in all cases. **[NLP: 4 Hour]**

Gravitation: Gravitational field and Potential and their relation,conservative property of gravitational field,Gravitational field and potential due to solid sphere, Thick and thin Spherical shell, Gauss's theorem in gravitation and its application to spherical and cylindrical mass distribution, Basic idea of Hohmann Transfer Orbits. **[NLP: 5 Hour]**

Central motion: Central force, conservative force and related theorems, central orbit, law of force, differential equation of motion of a particle moving under central force in plane polar co-ordinate system, nature of orbits in an inverse square attractive force field,areal velocity, Kepler's laws of planetary motion and their applications, proofs of Kepler's laws considering the inverse square law. **[NLP: 6 Hour]**

Paper Code: PH102C

Group:-B (Practical, Credit 2)

Total Number of laboratory periods: 60 hours

Total Marks- 40 (IA-16 + ESE-24)

Introductory Instruments Concepts and related activities:

• **Use of Basic Instruments**: Determination of least count and use of instruments likevernier callipers, spherometer, screw gauge,travelling microscope, spectrometer for measuring lengths, diameter, height, angleetcof given sample.

• **Errors Analysis**: Estimation of errors- Proportional error, systematic error, standard deviation from sample data, significant figures

• **Graph Plotting**: Pictorial visualisation of relation between two given physical quantities, Plotting of graphs with sample data set, calculation of slope from graph.

List of Experiment through virtual lab:

1. Torque and angular acceleration of a fly wheel
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=1517&cnt=1
2. Moment of inertia of flywheel
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=1517&cnt=1
3. Ballistic pendulum.
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=202&cnt=1
4. Elastic and inelastic collision
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=189&cnt=1
5. Projectile motion
   Projectile Motion (Theory) : Mechanics Virtual Lab (Pilot) : Physical Sciences : Amrita Vishwa Vidyapeetham Virtual Lab
6. Finding Viscosity of Liquid by Rotating Cylinder Method

https://bop-iitk.vlabs.ac.in/exp/liquid-viscosity/

Suggested readings:

1) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency
2) Advanced Practical Physics Vol-I & Vol-II, B. Ghosh and K.G. Mazumder, Sreedhar Publishers

Second Semester: Physics Major
Paper Code: PH201C
(Theory): [Thermodynamics & Transport Phenomenon -I]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60hours

Unit-I (NLP-15 hours)

Introduction to Thermodynamics

Zeroth Law & First law of Thermodynamics, differential form, Thermodynamic Processes, Expression for work done in isothermal and adiabatic processes. Application of first law to specific heat and latent heat. Carnot engine, its efficiency, Principle of refrigerator, co-efficient of performance, Reversible and irreversible processes. Second law of thermodynamics, Equivalence of Clausius and Kelvin-Planck Statements, Carnot's theorem, Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

[NLP: 8Hour]

Entropy

Concept of Entropy, Clausius Theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of Increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Universe, Principle of Increase of Entropy, Entropy and available energy, Entropy, probability and disorder, Temperature–Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics, Un-attainability of Absolute Zero. **[NLP: 7 Hour]**

Unit-II (NLP-15 hours)

Thermodynamic Potentials

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, their Definitions, Properties and Applications. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest equations **[NLP: 7 Hour]**

Maxwell's Thermodynamic Relations

Derivation of Maxwell's thermodynamic Relations and their applications, Maxwell's Relations use in: (1) Clausius- Clapeyron equation, (2) Value of Cp - Cv, (3) Tds Equations, ,(4)Joule-Kelvin coefficient for Ideal and Van der Waal Gases (5) Energy equations (6) Change of Temperature during Adiabatic Process. **[NLP: 8 Hour]**

Unit-III (NLP-15 hours)

Kinetic Theory of Gases

Basic assumptions of kinetic theory, Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (derivation not required), Specific heats of Gases. **[NLP: 8 Hour]**

Molecular Collisions

Mean Free Path. Collision Probability, derivation of survival equation due to the collision as $N(x) = N_0 e^{-x/\lambda}$. Experimental determination of Mean Free Path, Expression for pressure using the concepts of mean free path, Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion: Characteristic features, Distribution of Brownian particles in vertical column under gravity and determination of Avogadro's Number. **[NLP: 7Hour]**

Unit-IV (NLP-15 hours)

Real Gases

Behavior of Real Gases: Deviations from the Ideal Gas Equation. Andrew"s Experiments on CO_2 Gas, Virial Equation, Critical Constants, Continuity of Liquid and Gaseous State, Vapour and Gas, Boyle Temperature, van der Waal's Equation of State for Real Gases and its derivation, Values of Critical Constants, Law of Corresponding States. Comparison with Experimental Curves, p-V Diagrams, Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment, Joule-Thomson Effect for Real and van der Waal's Gases, Temperature of Inversion, Joule-Thomson Cooling. **[NLP: 8Hour]**

Transference of heat

Totalemissive power and spectral emissive power, absorptive power and spectral absorptive power, black body, black body radiation spectrum, Kirchoff's law and its rigorous derivation, pressure and energy density of diffused radiation. Stefan's law, determination of Stefan's constant, solar constant, determination of solar temperature, Wien's law, Rayleigh-Jeans law, basic assumptions and statement of Planck's law. **[NLP: 7 Hour]**

Reference Books:

1) Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
2) Heat Thermodynamics & Statistical Physics, Brij Lal and Subramaniam, 1st Edn., 2008, S. Chand.
3) Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
4) A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press
5) Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

Second Semester: Physics Major
Paper Code: PH202C
Group: A (theory): [Fluid Dynamics & Acoustics]
Total Credit-2
Total Marks- 60 (IA-24+ EXE-36)
Total Number of lecture periods: 30 hours

Unit-I NLP-15

Motion of various fluids

Newton's formula for viscosity, Streamline and turbulent flow, Critical Velocity, Reynold's number, Poiseuille's equation for the flow of an incompressible fluid with necessary corrections, statement of Stokes' law, equation of motion of a body through viscous medium under gravity and its solution, terminal velocity. **[NLP: 4Hour]**

Fluid dynamics

Derivation of equation of continuity in differential form, Conception of pressure energy of fluid motion under gravity, Euler's equation, derivation of Bernoulli's theorem using Euler's equation, Application of Bernoulli's theorem to venture meter, Pitot tubes, Torricelli's theorem, Bernoulli's theorem as applied to gases **[NLP: 4Hour]**

Oscillations

Idea of Simple Harmonic Motion, Composition of SHM using Vector method, Kinetic energy, potential energy, total energy and their time-average and position-average values, Graphical Variation of energy of particle executing SHM with time and position, Lissajous figures with equal and unequal frequency and their uses, Detailed analytical treatment of damped and forced vibrations, Resonance and sharpness of resonance, Amplitude and velocity resonance, Power dissipation and Quality Factor. **[NLP: 7 hour]**

Unit-II NLP-15

Wave

Idea of plane progressive wave, Ideal plane wave and its equation and complex representation, Particle and wave velocity and relation between them, Phase velocity and group velocity, reflection of waves and phase change, amplitude of reflected and transmitted wave (Rigid and non-rigid reflector), Differential equation of wave motion, wave pressure and energy distribution, Derivation of expression of intensity of wave, expression for intensity of Spherical and cylindrical wave (No derivation), Intensity and loudness of sound – Decibels, Bel **,** Differential equation of wave produced in a stretched string, Solution of

differential equation of wave in a stretched string, longitudinal waves in rods and in gases, Detailed analytical study on the theory of Plucked string and struck string, Young's law, Principle of superposition of waves: Interference, Silent zone, stationary waves, Beats, Acoustics of building, Growth and decay of sound, Expression for the Reverberation time, Sabine's formula, live room and dead room, Characteristics of a good auditorium

[NLP: 15 hour]

Paper Code: PH202C

Group: B (Practical, Credit 2)

Total Number of laboratory periods: 60 hours

Total Marks- 40 (IA-16 + ESE-24)

1) To determine the moment of inertia of a body about an axis passing through its centre of gravity & To determine the modulus of rigidity of the material of the given wire by dynamical method.
2) To determine the Young's modulus of the material of a beam by the method of flexure.
3) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
4) Determination of surface tension of liquid by Capillary rise method and to verify Jurin's law.
5) To determine the coefficient of thermal Conductivity of the material of a bad conductor by Lee and Charlton's method.
6) To determine the acceleration due to gravity (g) using Kater's reversible Pendulum.
7) To determine the frequency of a tuning fork by Melde's experiment and to verify $\lambda^2 - T$ law.
8) Determination of the velocity of sound in a solid rod by Kundt's tube method and hence to determine the ratio of two SHCs of air

Third Semester: Physics Major
Paper Code: PH301C
(Theory): [Electricity & Magnetism-1]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60hours

Unit-I (NLP-15)

Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge. Divergence of electric field using Dirac Delta function, Curl of electric field, electric field vector as negative gradient of scalar potential, Ambiguities of Electric potential, Differential and integral forms of Gauss Law, Applications of Gauss's Law to various charge distributions with spherical, cylindrical and planar symmetries. **[NLP-8Hour]**

Boundary Value Problems in Electrostatics: Formulation of Laplace's and Poissonequations. The first and second uniqueness theoremsSolutions of Laplace's equation: in one dimension, spherically symmetric cases, azimuthally symmetric cases with special mentioning of (i) uncharged conducting grounded sphere in uniform electric field, (ii) point charge in front of conducting grounded sphere, (iii) dielectric sphere in uniform electric field and (iv) point charge in front of dielectric sphere. **[NLP-7 Hour]**

Unit-II (NLP-15)

Special techniques (Method of Electrical image): The Method of Images isapplied to a system of a point charge and finite continuous charge distribution (line charge andsurface charge) in the presence of (i) a Plane infinite sheet maintained at constant potential, and (ii) a Sphere maintained at constant potential. **[NLP- 6Hour]**

Electric Field in Matter: Polarization in matter, Bound charges and their physicalinterpretation. Field inside a dielectric, Displacement vector D, Gauss' Law in the presence of dielectrics, Boundary conditions for D and E, Linear dielectrics, Electric Susceptibility and Dielectric Constant, idea of complex dielectric constant due to varying electric field. Boundary value problems with linear dielectrics. **[NLP-6 hours]**

Capacitor: Capacitance of spherical capacitors and cylindrical capacitors. **[NLP-3Hour]**

Unit-III (NLP-15)

Thermoelectricity: Thermoemf, laws of thermoelectricity, Peltier and Thomson's coefficient, total emf developed in a thermocouple, thermoelectric diagram and its uses, and the concept of neutral temperature and temperature of inversion of a thermocouple, thermoelectric power, uses of thermocouple, law of intermediate temperature and law of intermediate metal, Derivation of i) $\frac{de}{dT} = \frac{d\pi}{dT} - (\sigma_A - \sigma_B)$ $ii)$ $\pi = T\ (de/dT)$ $iii)$ $\sigma_A - \sigma_B = T\ (d^2e/\ dt^2)$**[NLP-6Hour]**

Magnetic Field: Divergence and curl of magnetic field B, Biot-Savart law, Magnetic field due to arbitrary current distribution using BiotSavrt law, use of Biot-Savart law for the (i) magnetic field at a point on the axis of circular current carrying coil, (ii) magnetic field due to Helmholtz double coil (iii) Magnetic field at a point on the axis of finite and infinite solenoid. Ampere's law, Integral and differential forms of Ampere's Law, use of Ampere's circuital law and application to (i) infinitely long cylindrical current, (ii) infinite current carrying solenoid (iii) Toroidal current. Vector potential and its ambiguities, Coulomb gauge and possibility of making vector potential divergenceless, Vector potential due to line, surface and volume currents using Poisson equation. **[NLP-9Hour]**

Unit-IV (NLP-15)

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and charge Sensitivity. Electromagnetic damping. Logarithmic damping. **[NLP-3 Hour]**

Magnetic Properties of Matter: Magnetic permeability, Intensity of magnetic field (H), magnetization vector. Bound currents, Differential and integral form of Ampere's Law in the presence of magnetised materials. Magnetic susceptibility, retentivity, coercivity,dia-, para- and Ferromagnetic material, Curie's law, Curie-Wiess law, Curie point, Hysteresis property using B-H loop, Calculation of hysteresis loss, Selection of magnetic material in various applications. **[NLP-6Hour]**

Electrodynamics: Self and mutual inductance and relation between them, combination of inductances, self-inductance of a circular coil and solenoid, mutual inductance between two circular coils and co-axial solenoids. Reciprocity Theorem, coefficient of coupling.Eddy current and its explanation. Energy stored in an inductor.principle of ideal transformer and energy losses. **[NLP-6Hour]**

Third Semester: Physics Major
Paper Code: PH302C
Group: A (Theory): [Electricity and Magnetism-2]
Total Credit -2
Total Marks- 60 (IA-24+ EXE-36)
Total Number of lecture periods: 30 hours

Unit-I (NLP-15)

Circuit Analysis: Ideal voltage source, real voltage source, current source, comparison between ideal and real current and voltage sources. Kirchhoff's current law, Kirchhoff's voltage law, node analysis, mesh analysis, Star and Delta conversion. **[NLP- 5Hour]**

Potentiometer: Basic principle, measurement of current in a circuit, measurement of internal resistance, comparison of emf of two cells. **[NLP- 3Hour]**

Bridges: Callender and Griffith bridge , Carey-Foster Bridge, Kelvin double bridge **[NLP- 3Hour]**

DC Transient Analysis: Charging and discharging with initial charge in RC circuit, RLcircuit with initial current, time constant, RL and RC Circuits with source. **[NLP- 4 Hour]**

Unit-II (NLP-15)

AC Circuit Analysis: Sinusoidal voltage and current, Definitions of instantaneous, peak topeak, root mean square and average values, form factor and peak factor (for half-rectified andfull-rectified sinusoidal wave, rectangular wave and triangular wave), voltage-currentrelationship in resistor, inductor and capacitor, phasor, complex impedance, power in ACcircuits, sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series and parallel RLC Circuits (Frequency Response, Bandwidth, Quality Factor), selectivity, application of resonant circuits, Parallel resonant circuit and its use as rejecter circuit. **[NLP- 8 Hour]**

Network Theorems: Principal of duality, Superposition theorem, Thevenin theorem, Norton theorem. Their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits, Reciprocity Theorem, Millman's Theorem, Tellegen's theorem. **[NLP- 7 Hour]**

Paper Code: PH302C

Group: B (Practical)

Credit 2

Total Marks- 40 (IA-16 + ESE-24)

Total Number of laboratory periods: 60 hours

List of Experiment in Laboratory:

1. Determination of Horizontal component of earth magnetic field (H) and magnetic moment of bar magnet (M) by deflection magnetometer and vibration magnetometer.

2. Determination of the end correction of a meter-bridge wire and to find the specific resistance of the material of the given wire.
3. Determination of resistance per unit length of the meter bridge wire by Carey-Foster's method and determination of unknown resistance.
4. To determine the resistance of a suspended coil galvanometer by half deflection method and hence to find its figure of merit.
5. To determine the current flowing in a circuit by using a potentiometer
6. Comparison of the values of two resistances by their fall of potential method with the help of Carey Foster's bridge.
7. Determination of mutual inductance between two coils.
8. To study the variation of thermos emf across two junctions of a thermocouple with temperature.
9. Determination of temperature coefficient of resistance
10. Study of resonance in series LCR circuit.
11. Verification of Thevenin theorem and Norton theorem (dc circuit).

Suggested readings:

3) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency
4) Advanced Practical Physics Vol-I & Vol-II, B. Ghosh and K.G. Mazumder, Sreedhar Publishers

List of Experiment in virtual lab:

1) To find the temperature coefficient of resistance of a given coil.

(https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=346&cnt=1)

2) To determine the self inductance of the coil (L) using Anderson's bridge.

https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=859&cnt=1

3) To determine the magnetic dipole moment (m) of a bar magnet and horizontal intensity (B_H) of earth's magnetic field using a deflection magnetometer.

https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=847&cnt=1

4) To determine the reduction factor of the given tangent galvanometer (K).

https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=1049&cnt=1

5. Measurement of high resistance by the method of leakage of a condenser

https://bop-iitk.vlabs.ac.in/exp/condenser-leakage-method/index.html

6. Carey Foster's Bridge to Measure Specific Resistance of Material

https://bop-iitk.vlabs.ac.in/exp/carey-foster-bridge/

Fourth Semester: Physics Major

Paper Code: PH401C

(Theory): [Optics]

Total Credit 4

Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60hours

Unit-I (NLP: 15 Hours)

Lens System: Cardinal points of optical systems, Combination of two thin lenses(locations to bederived) and equivalentlens, Idea about thick lens and position of cardinal points of a thick lens (no derivation. **[NLP: 4Hour]**

Aberrations: Qualitative discussions of aberrations, spherical aberration and chromatic aberration, qualitative study of their remedies and expression for achromation and conditionforremedy of sphericalaberration.**[NLP: 4Hour]**

Optical Instruments: Construction and working of Ramsden and Huygen's eyepieces andderivationof expression for locationcardinalpoint. **[NLP: 4Hour]**

Huygen'sprinciple: Conceptofwavefront,Huygen'sprinciple,derivationoflawsof reflectionand refraction using Huygen's principle. **[NLP:3Hour]**

Unit-II (NLP: 15 Hours)

Interference: Analytical treatment of interference, coherent sources, Interference of lightwaves by division of wavefront-Young's double slit experiment, derivation of expression forfringe width, Interference by Lloyd's mirror, Fresnel Biprism-Interference with white light,Determinationof wavelengthoflightusingFresnelBi-prism.

[NLP: 8 Hour]

Interference by division of amplitude, interference by a plane parallel film illuminated by aplane wave, interference by a film with two non-parallel refracting surfaces, colour of thinfilms,Newton'srings (reflected light):theory and experiment.

[NLP: 7Hour]

Unit-III (NLP: 15 Hours)

Coherence : Temporal Coherence and Spatial Coherence, Line width and Coherence Time.

[NLP: 4 hours]

Fresnel Diffraction: Fresnel diffraction: Fresnel's assumptions, Fresnel's Half period Zones for plane wave, explanation of rectilinear propagation of light, theory of Zone plate, multiplefociofa Zone plate, behavior of Zone plate as convergent lens, Diffraction at a straight edge,Diffraction at a circular aperture.

[NLP: 6 hours]

Fraunhofer Diffraction: Single slit, doubleslit, diffraction grating, Dispersive power of grating, Resolving power, Rayleigh criterion for resolution, Resolving power of telescope, microscope, prism and grating. **[NLP: 5 hours]**

Unit-IV (NLP: 15 Hours)

Polarization of Light: Brewster's law, Concept of plane polarized, circularly polarized and elliptically polarized light. Nicol prism, polaroids and their uses, Huygen's theory of double refraction, productionand analysis of plane, circularly and elliptically polarized light, retardation plates and Babinet's compensator, analysis of polarized light, optical activity, Specific rotation, half shade and Biquartz polarimeters. **[NLP:15 hours]**

SuggestedBooks:

1. OPTICS,A.K.Ghatak,TataMcgrawHill.
2. A TEXTBOOK ONOPTICS,N.Subrahmanyam,Brijlal,S CHAND.
3. MODERNOPTICS,A.B.Gupta,BooksandAllied.
4. ATEXTBOOKONLIGHT,B.Ghosh&K.G.Majumder,SreedharPublishers.
5. INTRODUCTIONTOOPTICS,PedrottiandFrankL,Pearson.
6. FUNDAMENTALSOFOPTICS,FrancisJenkinsHarveyWhite,McGrawHill.
7. OPTICS,EugeneHecht,Pearson.
8. INTRODUCTIONTOOPTICS,AnchalSrivastava,R.K.Shukla,T.P.Pandya,NewAgeInternationa l(P) Ltd.
9. WAVEOPTICS,SureshGarg,SanjayGupta,CKGhosh,PrenticeHallofIndia

Fourth Semester: Physics Major
Paper Code: PH402C
Group: A (Theory): [Electromagnetic Waves & Application of Optics]
Total Credit -2
Total Marks- 60 (IA-24+ EXE-36)
Total Number of lecture periods: 30 hours

Unit-I (NLP-15)

Maxwell's equation and their significance**,** Propagation of plan electromagnetic waves in free space, transverse character and polarized electromagnetic wave,Hertz's experiment, Poynting vector and Poynting theorem, **radiation pressure and momentum**,electromagnetic energy density, Propagation of plane electromagnetic waves in isotropic dielectric and conducting media –skin effect and skin depth. **[NLP: 7 Hour]**

S- and P-polarization, Boundary conditions of Electric field and magnetic field using Maxwell's equation, Derivations of laws of Reflection and Refraction of plane Electromagnetic Waves at the interface of two di-electric media, Fresnel Formulae for S-polarised and P-polarised EM waves, Explanation of total Internal Reflection. Brewster's Angle. Dispersion Theory: Normal and anomalous dispersion, Cauchy Equation and Sellmier equation, Lorentz theory of normal and anomalous dispersion. **[NLP: 8Hours]**

Unit-II (NLP-15)

Introduction to Fiber Optics: Basics of Optical fibre, step index fiber, graded index fibre, light propagation through an optical fibre, acceptance angle and numerical aperture, qualitative discussion of fibre losses-**attenuation & dispersion**, **splicing**, **fiber optic communication system (schematic)**, applications of optical fibres. **[NLP: 7Hour]**

Lasers: Idea of spontaneous emission, spontaneous absorption and stimulated emission, Metastable states, Optical Pumping and Population Inversion,Einstein's A and B coefficients, components of laser, characteristic of laser beam, lasing action,3-level and 4-level systems, Ruby, Helium-Neon and semiconductor lasers, Laser applications, holography (Basic principle). [**NLP: 8Hour]**

Paper Code: PH402C
Group: B (Practical)
Credit 2
Total Marks- 40 (IA-16 + ESE-24)
Total Number of laboratory periods: 60 hours

List of Experiment in Laboratory:

1. To determine the refractive index of the given liquid with the help of a plane mirror and a convex lens (radius of curvature is to be determined with the help of spherometer).
2. To determine the focal length of a concave lens by the combination of concave and convex lens using optical bench.

3. To determine the refractive index of the material of the given convex lens with the help of lens and plane mirror.
4. To determine the refractive index of a given liquid using travelling microscope.
5. To determine refractive index of material of given prism by using spectrometer for a given wavelength.
6. To determine the dispersive power of material of prism by using spectrometer.
7. To draw $(\delta - \lambda)$ curve and to determine unknown wavelength by prism.
8. To determine unknown concentration of an optically active substance by a polarimeter.
9. Determination of wavelength of spectral line by plane transmission grating.
10. Determination of wavelength of unknown light by using Fresnel's biprism.
11. To determine the power of a convex lens by displacement method.

List of Experiment in virtual lab:

1. To find the resolving power of the prism.
   https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=1524&cnt=1
2. To determine the refractive index of the material of a prism.
   https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=1513&cnt=1
3. To determine the dispersive power of prism.
   https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=851&cnt=1

4. Angle of the prism using Spectrometer
https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=1508&cnt=1

5. To determine the number of lines per millimeter of the grating
https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=334&cnt=1

6. To determine the Cauchy's constant of the given prism.
https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=1514&cnt=1

7. To determine the wavelength of a laser using the Michelson interferometer.
https://vlab.amrita.edu/?sub=1&brch=189&sim=1106&cnt=1

8. To find the numerical aperture of a given optic fibre and hence to find its acceptance angle.
https://vlab.amrita.edu/?sub=1&brch=189&sim=343&cnt=1

9. To verify the Brewster's law and to find the Brewster's angle.
https://vlab.amrita.edu/?sub=1&brch=189&sim=333&cnt=1
https://vlab.amrita.edu/index.php?sub=1&brch=189&sim=333&cnt=1

10. Measurement of focal length of the combination of the two lenses separated by a distance
https://bop-iitk.vlabs.ac.in/exp/focal-length-measurement/

11. Measurement of the wavelength of monochromatic source of light with the help of Fresnel's Bi prism
https://bop-iitk.vlabs.ac.in/exp/fresnel-biprism/

12. To measure the specific rotation of cane sugar using Polarimeter
https://bop-iitk.vlabs.ac.in/exp/cane-sugar-rotation/

Suggested readings:

1. An advanced course in practical Physics by D. Chattopadhyay & P.C. Rakshit
2. Advanced Practical Physics by B. Ghosh & K.G. Mazumdar

Fifth Semester: Physics Major
Paper Code: PH501C
(Theory): [Classical Mechanics &Special Theory of Relativity]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60 hours

Unit-I (NLP-15 hours)

Constrained Motion: Constraints - Definition, Classification and Examples. concept of constraints in different cases, Constrained system, Forces of constraint and Constrained motion, Degrees of Freedom, Generalised coordinates, Principle of Virtual work and D'Alembert's principle. **[NLP: 7Hour]**

Lagrangian Formalism: Lagrangian for conservative system, Lagrange's equations for conservative systems (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates and its applications, Simple examples based on Lagrangian formulation. **[NLP: 8 Hour]**

Unit-II (NLP-15 hours)

Hamiltonian Formalism: Phase space, Hamiltonian for conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (derivation not required), Comparison of Lagrangian & Hamiltonian formulations, Construction of Hamiltonian from Lagrangian, Simple examples based on Hamiltonian formulation. **[NLP: 15 Hour]**

Unit-III (NLP-15 hours)

Rigid Body dynamics: Rigid body, angular momentum of a rigid body, moment and product of inertia, kinetic energy of rotation of a rigid body, ellipsoid of inertia, inertia tensor, principle axis in simple symmetric cases, Euler's angles. **[NLP: 15Hour]**

Unit-IV (NLP-15 hours)

Special Theory of Relativity: Gallilean transformation and Gallilean invariance, inertial and non-inertial frames, pseudo forces, apparent weight in accelerated frame. Concept of space, time and mass according to Newtonian mechanics. Michelson-Morley experiment and its apparent negative result. Postulates of special theory of relativity, simple derivation of Lorentz transformation formula, Lorentz transformation matrix and its commutation property, length contraction, time dilation, addition/transformation of velocities (velocites along the one direction), velocity addition formula using Lorentz transformation matrix. Definition of

four-vector, velocity and momentum four vector and their Lorentz invariance. Variation of mass with velocity (deduction on the basis of head on collision), equivalence of mass and energy. Energy-momentum relation, Doppler effect in light and comparison with that in sound **[NLP: 15Hour]**

Suggested readings:

1) Classical Mechanics by H Goldstein, C.P. Poole, J. Safko, Pearson
2) Classical Mechanics by J. C. Upadhyaya, Himalaya Pub. House
3) Classical Mechanics by N C Rana & P C Joag, McGraw Hill
4) Classical Mechanics and General Properties of Mater by S N Maiti, New Age Int. Private Ltd.
5) Classical Mechanics by G Aruldhas, PHI
6) Introduction Classical Mechanics, R Takwale and P Puranik, McGraw Hill
7) Introduction to Special Relativity, Robert Resnick, 2007, Wiley

Fifth Semester: Physics Major

Paper Code: PH502C

Group: A (Theory): [Statistical Mechanics]

Total Credit 2

Total Marks- 60 (IA-24+ EXE-36)

Total Number of lecture periods: 30 hours

Unit-I (NLP-15)

Systems and ensembles, microstates and macro-states, calculations of microstates and macro-states in different cases, postulate of equal apriori probability, concept of chemical potential, Micro-canonical, canonical and grand canonical ensembles, few examples of different ensembles from the physical world. **[NLP-10 Hour]**

Phase space and its features, dimension of elementary phase cell, thermodynamic probability and its calculation in various cases, partition function and its significance, calculations of partition functions in different cases.**[NLP-5 Hour]**

Unit-II (NLP-15)

Most probable distribution, derivation of distribution function for Maxwell-Boltzmann for a system of non-interacting particles, equipartition of energy.

Spin angular momentum of identical and indistinguishable particles and their symmetry requirements, calculations of macrostates, microstates and wave functions in case of assemblies of identical and indistinguishable particles, Bose-Einstein and Fermi-Dirac statistics for a system of non-interacting particle.

[NLP-15 Hour]

Paper Code: PH502C

Group: B (Practical): Python programming-1

Credit 2

Total Marks- 40 (IA-16 + ESE-24)

Total Number of laboratory periods: 60 hours

Basic Elements of Python: The Python interpreter, the print statement, comments, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability, Formatting in the print statement.

Control Structures: Conditional operations, if, if-else, if-elif-else, while and for loops, indentation, break and continue, List comprehension.

Functions: Inbuilt functions, user-defined functions, Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers, etc.,

Recommended List of Programs

1. Sum of a list of numbers
2. Average of a list of Numbers
2. largest of a given list of numbers and its location in the list,
3. Sorting of numbers in ascending and descending order,
4. Write a program to display the result of one number raised to the power of another
5. Area of circle, area of square, volume of sphere etc.
6. value of pi (π)
7. Random number generation
8. Evaluation of trigonometric functions e.g. sin θ, cos θ, tan θ, etc
9. Write a program to find out whether the given number is even or odd.
10. Write a program to find out whether the given number is a prime number
11. Write a program to display the square root of a number
12. Write a program to find the roots of the quadratic equation
13. Write a program to find the average of marks obtained by a student in three subjects
14. Program to reads your age and prints a message whether you are eligible to vote or not.
15. Write a program to find the sum of digits of an integer.
16. Write a program to find out whether a given number is positive or negative.
17. Program to check if a given year is a leap year

18. Program to find the factorial of a number.
19. Program to find the sum of all odd and even numbers up to a number specified by the user.
20. Program to display the Fibonacci Sequences up to nth term where n is provided by the user.
21. Program to find the sum of first n natural numbers using a while loop/ for loop
22. Write a program to print multiplication table of a given number (Using for loop/ while loop)
23. Write a program to print a multiplication table of n using for loop in reversed order.
24. LCM and HCF of two numbers
25. To print all numbers except few numbers from a series
26. Distance between two points (x_1,y_1,z_1) & (x_2,y_2,z_2)
27. Addition of two matrices
28. Multiplication of two matrices
29. Transpose of a matrices
30. Write a program to calculate the grade of a student from his marks from the following scheme

    90 - 100 → Ex
    80 – 90→ A
    70 – 80→ B
    60 – 70→ C
    50 - 60 → D
    < 50 → F

31. Write a program to find out whether a student is pass or fail, if it requires total 40% and at least 33% in each subject to pass. Assume three subjects and take marks as an input from the user.
32. Write a program that finds outs whether a given name or number is present in a list or not
33. Write a program using the function to find the greatest of three numbers.
34. Write a program using the function to convert Celsius to Fahrenheit.
35. Factors of a number.

Fifth Semester: Physics Major
Paper Code: PH503C
(Theory): [Quantum Mechanics – I]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60hours

Unit-I (NLP-15 hours)

Foundation of quantum mechanics: Black body radiation and discussion of the failure of classical theory with special mentioning of Wien's law, Rayleigh-Jeans law.Basic assumptions and statement of Planck's law, Planck's energy distribution law (Deduction required). Derivation of Wien's law,Wien's displacement law, Rayleigh-Jeans law, Stefan-Boltzmann law from Planck's law,Photoelectric effect, Compton Effect **[NLP: 15hour]**

Unit-II (NLP-15 hours)

Wave-Particle Duality: de Broglie's hypothesis and matter wave**,** Wave packet and its manifestation as particle, group velocity and phase velocity, Davisson-Germer's experiment, G. P. Thomson Experiment. **[NLP: 6 hours]**

The Uncertainty Principle and its Consequences: Heisenberg's Uncertainty Principle. Some Thought Experiments: The Single-Slit Diffraction Experiment,Double-Slit Experiment. *Consequences of the Uncertainty Principle :-* Zero-Point Energy, The Size of an Atom, Non-existence of the Electron inside the Nucleus, Bohr's principle of Complementarity.

[NLP: 9 hour]

Unit-III (NLP-15 hours)

Schrodinger Equation and related concept: Wave function and its physical significance. Schrodinger time dependent and time independent equation in one dimension, Solution of Schrodinger time dependent equation using separation of variable method. Probability Current Density and the Continuity Equation, Normalization of the wave function,

[NLP: 10 hour]

Quantum Mechanical Operators: Eigenfunctions and Eigenvalues, Energy and momentum operator,Hamiltonian operator.Properties of Operators, Hermitian Operators, Commuting and Non-Commuting Operators, Angular Momentum operators, expression and their commutation relations **[NLP: 5 hour]**

Unit-IV (NLP-15 hours)

Application of Quantum mechanics:

Expectation Values, Ehrenfest theorem, Degeneracy, Orthonormal Eigenfunctions.
Infinite potential well, wave functions and energy values, Free particle in a box (1D & 3 D), Potential step and Barrier potential, Transmission and reflection coefficient in one dimension, tunnelling effect, Solution of Schrödinger equation for the one dimensional harmonic oscillator,

[NLP-15 hour]

Suggested readings:

1. Quantum Mechanics: Theory and applications by Ajoy Ghatak and S Loknathan, Macmillan.
2. Introduction to Quantum Mechanics by David J Griffith, Pearson
3. Quantum Mechanics by G.Aruldas, PHI learning P Ltd
4. Quantum Mechanics by Gupta, Kumar, Sharma, JaiprakashNath Publication
5. Concept of Modern Physics by Arthur Beisar, Tata McGrow Hill
6. Quantum Mechanics by E Merzbacher

Fifth Semester: Physics Major
Paper Code: PH504C
Group: A (Theory): [Analog Electronics]
Total Credit -2
Total Marks- 60 (IA-24+ EXE-36)
Total Number of lecture periods: 30 hours

Unit: I (NLP: 15 hours)

Applications of PN junction diode: Half wave and full wave rectifiers: calculation of ripple factor and efficiency, load regulation and line regulation of power supply, , their significance and mathematical definition , comparison of Centre-tapped and Bridge Rectifiers, Basic RC filter, T and π filters and their working, Zener breakdown and avalanche break down, Zener Diode , I-V characteristics of zener diode, break down region DC and AC resistance of zener diode and use of zener diode as voltage regulator.

[NLP: 7 hours]

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Physical Mechanism of Current flow , Input, output and transfer characteristics of CB, CE and CC Configurations and their comparison , Current gains α and β, Working of CE amplifier and calculation of AC voltage gain, DC Load line and Q-point.**Transistor biasing:** Faithful amplification, Variation of transistor parameters due to various reasons, instability of bias, definitions of stability factors, significance of stability factor, Calculations of stability factors in the case of fixed biasing, potential divider bias and self biasing and their comparisons

[NLP: 8 hours]

Unit: II (NLP: 15 hours)

Field effect transistor (FET): FET – structure and operation p-channel and n-channel FETs, Definitions of Gate (G), Source (S) and Drain (D) symbols of FETs, Comparison with BJT, Static output and transfer Characteristics , FET parameters and their relation, Dynamic output characteristics of FET, FET as a voltage amplifier and calculation of voltage gain. Introduction to MOSFET: Structures and Basic operations of enhancement and depletion MOSFET, MOSFET symbols and characteristics, comparison of MOSFET and FET.

[NLP: 5 hours]

Feedback in Amplifiers: Principle of feedback, different components of feedback amplifier, different feedback protocols of voltage feedback and current feedback with diagrams, Positive and Negative Feedback. Gain with Feedback, Effect of negative feedback on input impedance , output conductance, noise, bandwidth (qualitative explanations only). Simple

idea about sinusoidal oscillators, Barkhausen's Criterion for self-sustained oscillations, tuned collector oscillator and its working using characteristic graph of CE configuration.

[NLP: 3 hour]

Operational Amplifiers (Black Box approach): Features of an Ideal and Practical OP-AMP. (IC 741), concept of virtual ground. Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate, Use of OP-AMP as inverting amplifier, non-inverting amplifier, inverter, phase shifter, adder, differentiator, integrator

[NLP: 7 hour]

Reference Books:

1. Principle of Electronics by V.K. Meheta and RohitMeheta, S. CHAND
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
5. Electronics Fundamentals and Applications, P.C. Chattopadhyay and D. Rakshit, New Age International Private Ltd
6. Fundamental Principle of Electronics by Basudev Ghosh, Books and Allied Ltd.

Paper Code:PH504C

Group: B (Practical)
Credit 2
Total Marks- 40 (IA-16 + ESE-24)
Total Number of laboratory periods: 60 hours

List of Experiment in Laboratory:

1. To study V-I characteristics of a PN junction diode and calculation of dc & ac resistance.
2. To study the forward and reverse characteristics curves of a Zener diode and calculation of dc and ac resistance.
3. To study the line and load regulation characteristic of Zener diode.
4. To draw the input characteristics of a Bipolar Junction Transistor (BJT) amplifier in CE configuration.
5. To draw the output characteristics of a Bipolar Junction Transistor in (BJT) amplifier in CE configuration.
6. To draw the static characteristics of a JFET and hence determine the FET parameters.

7. To study the operational amplifier (OPAMP-741) as an adder and subtractor.
8. To study the operational amplifier (OPAMP-741) as an integrator and differentiator.
9. To study the operational amplifier (OPAMP-741) as an inverting and non-inverting amplifier.

Suggested Readings:

5) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency
6) Advanced Practical Physics Vol-I & Vol-II, B. Ghosh and K.G. Mazumder, Sreedhar Publishers
7) Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
8) OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.

List of Experiment based in Virtual Lab

1. Explain the function of Bridge Full Wave Rectification.

http://vlabs.iitkgp.ac.in/be/exp7/index.html

2. Explain the forward and reverse biased characteristics of a Silicon diode.http://vlabs.iitkgp.ac.in/be/exp5/index.html
3. Explain the operation of bipolar junction transistor and Common Emitter characteristics of a BJT.

http://vlabs.iitkgp.ac.in/be/exp11/index.html

4. Explain the function of a Zener diode and Zener Diode as Voltage Regulator.

http://vlabs.iitkgp.ac.in/be/exp10/index.html

5. Experiment with OPAMP in virtual lab
   A. Study of basic properties of Operational Amplifier: Inverting Amplifiers
   B. Study of Differentiator using Operational Amplifier.
   C. Study of Integrator using Operational Amplifier.
   D. Study the Half Wave Rectification using P-N diode.

http://vlabs.iitkgp.ac.in/be/#

6. To Determine Energy Band Gap of Semiconductor

1. https://bop-iitk.vlabs.ac.in/exp/energy-band-gap/

Sixth Semester: Physics Major
Paper Code: PH601C
(Theory): [Solid state Physics]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60 hours

Unit-I (NLP: 15 hours)

Crystal Structure: Solids: Amorphous and Crystalline Materials. Discussion on different types of crystal: namely ionic crystal, metallic crystal, covalent crystal, molecular crystal. Mention different forces responsible for the formation of crystal. **[NLP: 4 hour]**

Different crystal parameters: Crystallographic axis, Translation Lattice parameters and Lattice Translation vectors, Angular Lattice parameters.Lattice, Basis,Unit Cell, Primitive cell, **[NLP: 2hour]**

Types of Cubic Lattices: Different types of Cubic Lattice system namely Simple Cubic (Primitive), F.C.C., B.C.C. Discuss their unit cells, Lattice point density in the unit cell. Positions of Lattice points in Unit cell of SC, BCC and FCC lattices. Packing fractions. Number of nearest neighbour and nearest neighbour distance. **[NLP: 5hour]**

Miller Indices: Step by Step explanation of the construction of Miller Index. Draw a set of two Miller planes of the following Miller Indices [100], [010], [200], [111], [020]. Importance of Miller Index. **[NLP: 2hour]**

Reciprocal Lattice: Importance of Reciprocal Lattice, Construction of Reciprocal Lattice Parameters for simple cubic lattice, properties of Reciprocal Lattice, simple conception of Brillouin zone. **[NLP: 2 hour]**

Unit-II (NLP: 15 hours)

X-ray Diffraction: Diffraction of X-rays by Crystals. Bragg‟s Law.Laue Condition,Powder diffraction method. **[NLP: 4 hour]**

Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons.Qualitative Description of the Phonon Spectrum in Solids. **[NLP: 6hour]**

Lattice Specific heat: Dulong and Petit‟s Law, Einstein and Debye theories of specific heat of solids. T^3 law. **[NLP: 5hour]**

Unit-III (NLP: 15 hours)

Classical Free Electron Theory: Electrons in metals- Drude model, Calculation of electrical conductivity and thermal conductivity following classical Free Electron Theory. Wiedemann-Franz law. **[NLP: 3hour]**

Band Theory of Solids: Elementary band theory:Kronig Penny model. Band Gap., Effective mass, mobility, Hall Effect (Metal and Semiconductor). **[NLP: 3hour]**

Magnetic Properties of Matter: Discussions of important parameters of magnetism namely Magnetisation, Susceptibility, Permeability. Discussion of permanent atomic magnetic dipole moment and induced atomic magnetic dipole moment. Origin of atomic magnetic dipole moments – Orbital Magnetic Moment, Spin Magnetic Moment, Total Magnetic Moment.

Arrangement of magnetic dipole moments in Dia-, Para-, Ferro-, Antiferro- and Ferri-magnetic materials (qualitative discussions with picture).

Paramagnetic materials as paramagnetic gas: an analogy with ideal gaseous system (qualitative discussion).

Classical Langevin Theory of Paramagnetism, Quantum Mechanical Treatment of Paramagnetism., Curie's law of Paramagnetism. Qualitative discussion of Weiss Theory of Ferromagnetism and write the mathematical expression for Curie-Weiss law (no derivation). Qualitative discussion on Curie temperature or Ferromagnetismphase Transition temperature.Domain theory of Ferromagnetism, Hysteresis curve of Ferromagnetism.

[NLP: 9hour]

Unit-IV (NLP: 15 hours)

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius-Mosotti Equation.Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. **[NLP: 10hour]**

Superconductivity: Experimental Results. Critical Temperature, Critical Magnetic Field. Critical Current Density, Meissner effect. Type I and type II Superconductors. London's Equation and Penetration Depth. **[NLP: 5 hour]**

Reference Books:

· Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
· Solid State Physics, A.J.Dekker, Macmillan India Pvt. Ltd.
· Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice-Hall of India.
· Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
· Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
· Solid-state Physics, H.Ibach and H. Luth, 2009, Springer.
· Solid State Physics, Rita John, 2014, McGraw Hill
· Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

Sixth Semester: Physics Major
Paper Code: PH602C
Group: A (Theory): [Atomic and Molecular Physics]
Total Credit -2
Total Marks- 60 (IA-24+ EXE-36)
Total Number of lecture periods: 30 hours

Unit-I (NLP: 15 hours)

Vector Atom Model

Stern and Gerlach experiment, Vector atom model, Various quantum numbers associated with vector atom model, L-S and J-J couplings, application of spatial quantization, Pauli's exclusion principle - magnetic dipole moment of electron due to orbital and spin motion - Spin-Orbit coupling.

[NLP: 7hrs]

Atomic Spectra

Optical spectra, Spectral terms and notations, selection rules, fine structure of sodium D lines, hyperfine structure of alkali spectra, Zeeman effect, Larmor's theorem, quantum mechanical explanation of normal Zeeman effect. Anomalous Zeeman effect, Paschen-Back effect, Stark effect. **[NLP: 8 hrs]**

Unit-II (NLP: 15 hours)

X-rays

Soft and Hard X-rays, X-ray Spectra: continuous , Origin of continuous Spectrum and characteristics X- ray spectrum, , Origin of characteristic X-ray spectra, Moseley's law and its explanations, X-ray energy level diagram. Absorption of X-rays-Applications of X-rays

[NLP: 3hrs]

Molecular Spectra

Cause and occurrence of different spectrum. Regions of Spectrum, Homonuclear and heteronuclear diatomic molecule, Permanent and induced dipole moment, Production of Spectra from periodic change in dipole moment. Representation of Spectra, Born Oppenheimer approximation (general idea), Pure rotational spectra, rigid rotator (quantum mechanical solution not required), Concept of reduced mass and moment of inertia, energy levels, frequency of spectral line, selection rule (derivation not required) and the spectrum,

non-rigid rotator (qualitative idea only),Vibrating diatomic molecule as a harmonic oscillator, frequency, energy levels, selection rules (derivation not required), applications of vibrational spectroscopy.

Raman effect and its quantum mechanical explanation, Rotational and vibrational Raman spectra, comparison of infrared and microwave spectra with Raman spectra, Rule of mutual exclusion. **[NLP: 12hrs]**

Paper Code: PH602C

Group: B (Practical): Project Work
Credit 2
Total Marks- 40 (IA-16 + ESE-24)

General Guidelines for Project Writing

1. Total marks for project would be 40 including internal assessment/viva/seminar and main project content writing etc.

2. The project title can be chosen on specific topics as per students' choice in discussion with Project Guide/Supervisor & Department Faculty. The allotted titles should be unique for each student and should not be identical for any two students.

3. The project should be around **3000-4000 words** and may contains images, tables, dataset, diagrams etc. for better presentation.

4. The project may have following **major headings** (as per suitability of the project topics selected)
   i) Introduction ii) Theory/Concepts iv) Experimental results (if any) iv) Discussion/ Details in-depth analysis v) Conclusion vi) References etc.

5. The project should be typed in English language.

6. **Design Format** : Project should be **computer typed** in English in A4 page size (single side printed) with 1 inch margin on all sides. There should be table of contents, cover page, page number on each page etc. The tables, figures etc. should be sequentially numbered with captions.

7. **Reference format**: All references and citation should be in Elsevier Journals Numbered Style
   - **In-text citations**: Indicate references by number(s) in square brackets in line with the text. Example: "..... as demonstrated [1, 2]. Barnaby and Jones [3] obtained a different result [4-6] ...."

- **Reference list**: Number the references (numbers in square brackets) in the list in the order in which they appear in the text.

  [1] A. Paivio, B. Jansen, L.J. Becker, Comparisons through the mind's eye, Cognition 37 (2) (1975) 635–647

  [2] W. Strunk, E.B. White, The Elements of Style, third ed., MacMillan, New York, 1979 (Chapter 4) 6th Ed.

  [3] Cancer Research UK, Cancer statistics reports for the UK.

  <http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/>, 2003.

[For details can check - Numbered style (Style 1):

https://booksite.elsevier.com/9780081019375/content/Elsevier%20Standard%20Reference%20Styles.pdf]

8. There should be firm deadline on the project submission and internal assessment etc. and preferably should be completed before the start of the 6th semester final examination.

Sixth Semester: Physics Major
Paper Code: PH603C
(Theory): [Nuclear Physics]
Total Credit 4
Total Marks-100 (IA-40 + ESE-60)
Total Number of lecture periods: 60 hours

Unit-I (NLP: 15 hours)

General Properties of Nuclei: Constituents of Nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density, binding energy, average binding energy and its variation with mass number, features of binding energy curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments. **[NLP: 7hour]**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, evidence for nuclear shell structure and the basic assumptions of shell model. **[NLP: 8hour]**

Unit-II (NLP: 15 hours)

Radioactivity: Fundamental laws, decay rate and equilibrium, Radioactive Series, Radioactive branchingAlpha decay: basics of α-decay processes,Gamowtheory, Gamow factor, Geiger Nuttall law. β- decay: β-spectrum, positron emission, electron capture, neutrino hypothesis. Gamma decay: Gamma ray emission, excited states of nucleus, Concept of internal conversion, internal pair production and nuclear Isomerism**[NLP: 10 hour]**

Nuclear Reactions: Types of Reactions, Conservation Laws, Q-value, Concept of compound and direct reaction, resonance reaction.:, **[NLP: 5 hour]**

Unit-III (NLP: 15 hours)

Interaction of Nuclear Radiation with matter: Interaction of Nuclear Radiation with matterEnergy loss of charged particle, ionization loss, relation between range and energy, Cerenkov radiation. Gamma ray interaction with matter, pair production, attenuation of gamma rays in matter [**NLP: 8hour**]

Detector for Nuclear Radiations: Gas filled ionization detectors: proportional counter and GM Counter. Basic principle of Scintillation Detectors. **[NLP :7hour]**

Unit-IV (NLP: 15 hours)

Particle Accelerators: Van-de Graaff generator (Tandem accelerator),Linear accelerator, Cyclotron (including variable energy cyclotron),Betatron, Synchrotron**[NLP:10hour]**

Particle physics: Concept of different types of forces, types of elementary particles and its families (Leptons, Mesons and Baryons). Basic concept of quark model **[NLP: 5 hour]**.

Suggested readings:

1. Nuclear Physics by S. N. Ghosal, S.Chand
2. Nuclear Physics by Irving Kaplan, Narosa Publisher
3. Nuclear Physics by Satya Prakash, PragatiPrakashan
4. Nuclear Physics by D. C. Tayal, Himalaya Publishing House
5. Introductory Nuclear Physics by K. S. Krane, Wiley
6. Modern Atomic and Nuclear Physics by A.B. Gupta, Books and Allied Ltd.
7. Fundamental of Nuclear Physics, Varma, Bhandhari and Somayajulu, CBS Publisher and Distributer
8. Fundamental of Nuclear Physics, Jahan singh, Pragati Publications

Sixth Semester: Physics Major
Paper Code: PH604C
Group: A: [Digital Electronics]
Total Credit -2
Total Marks- 60 (IA-24+ EXE-36)
Total Number of lecture periods: 30 hours

Unit-I (NLP: 15 hours)

Arithmetic Circuits: Difference between Analog and Digital circuits, concept of logic levels,digital ICs and theirclassification, Binary number system, Counting in Binary, Binary to decimal conversion and vice versa, binary addition and subtraction, 1's and 2's complement methods.

NLP: 7hour]

Logic gates: Positive and negative logic systems, truth table, realization of basic logic gates - AND, OR and NOT gates using discrete components, NAND and NOR Gates as Universal Gates. XOR and XNOR Gates, pulsed operation of logic gates

[NLP: 8hour]

Unit-II (NLP: 15 hours)

Boolean algebra: Logic operations, Postulates and laws of Boolean Algebra, De Morgan's Theorems. Reducing Boolean expressions, Converting Boolean expressions to logic diagrams and vice versa.

[NLP: 5hour]

Combinational circuits: Logic diagram of half adder, full adder, half subtractor and Full subtractor and their realization, 4-bit parallel binary adder, multiplexer (4:1).

[NLP: 6 hour]

Sequential circuits: Difference between combinational and sequential circuits, working of non-clocked SR flipflop using NOR/ NAND gates, D flipflop.

[NLP: 4hour]

Suggested readings:

1. Digital Principles and Applications by A.P.Malvino, D.P.Leach and G. Saha,, Tata McGraw
2. Fundamentals of Digital Circuits by Anand Kumar, PHI Learning Pvt. Ltd.
3. Digital Electronics by G K Kharate ,2010, Oxford University Press
4. Modern Digital Electronics by R. P. Jain, McGraw Hill Education.
5. Digital Logic and Computer Design by Morris Mano, Pearson Education India

Paper Code: PH604C

Group: B (Practical)
Credit 2
Total Marks- 40 (IA-16 + ESE-24)
Total Number of laboratory periods: 60 hours

List of Experiment in Laboratory:

1. Design a three input OR gate using discrete components and verification of truth table.
2. Design a three input AND gate using discrete components and verification of truth table.
3. Design a NOT gate using discrete components and verification of truth table.
4. Design a circuit to verify the Boolean expressionsusing IC 74 ** series.
5. Design a NOR gate and NAND gate using IC 74** series and verification of truth table.
6. Design a XOR gate and XNOR gate using IC 74** series and verification of truth table.
7. Design a half adder circuit using IC 74** series and verification of truth table
8. Design a half subtractor circuit using IC 74** series and verification of truth table

Suggested Readings:

9) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency

10) Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

11) OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.

12)

List of Experiment based in Virtual LabLink:

http://vlabs.iitkgp.ac.in/dec/exp3/index.html

Study of simple Boolean expressions with basic gates using IC 74 series

Verify the Boolean expression $AB + \overline{A}\,C + BC = AB + \overline{A}\,C$

Verify the Boolean expression $AB + \overline{A}\,C = (A + C)(\overline{A} + B)$

Verify equivalence of AND-OR and NAND-NAND structure

Verify equivalence of OR-AND and NOR-NOR structure

UG Physics (Minor Course Structure, Tripura University
(As per NEP-2020 guideline)

Year	Semester	Course Code	Paper Title	Credits
1st	I	PH-101M	**Mathematical Physics and Mechanics (Theory + Practical)**	Theo-3 Prac-1
	II	PH-201M	**Thermal & Physical Properties and Oscillation & waves (Theory +Practical)**	Theo-3 Prac-1
2nd	III	PH-301M	**Electricity and Magnetism (Theory+Practical)**	Theo-3 Prac-1
	IV	PH-401M	**Optics and Electromagnetic Theory (Theory+Practical)**	Theo-3 Prac-1
3rd	V	PH-501M	**Modern Physics-I and Analog Electronics (Theory+Practical)**	Theo-3 Prac-1
	VI	PH-601M	**Modern Physics-II and Digital Electronics (Theory+Practical)**	Theo-3 Prac-1

MINOR

Semester-I: Physics Minor
Paper Code: 101M
Group: A (Theoretical):Mathematical Physics and Mechanics
Full marks-60 (Internal assessment-24 + End Sem. Exam.-36) Credit = 3
Total Number of lecture periods: 45 hours

Unit-I (NLP: 15 hours)

Vector Algebra and Vector Calculus

Scalars and vectors: Recapitulations: laws of vector algebra, scalar and vector product, Vector triple products.Scalar and vector fields:Definitions and expressions or Gradient of a scalar, divergence and curl vectors, their physical meanings and applications in Physic, Vector identities, Line, surface and volume integration, Gauss's divergence theorem(statement only), Stoke's theorem(statement only)and their simple applications. [**NLP: 08 hours]**

Matrices

Definition, different types of matrices, Unitary Matrix, Hermitian matrices, Eigen values and eigen vector of a matrix [**NLP:05 hours]**

Beta and gamma functions

Beta function, Gamma function, their properties. [**NLP:02hours]**

Unit-II (NLP: 15 hours)

***Ordinary Differential Equation*:**

Definition, Order, degree, Linearity, Homogeneous and inhomogeneous differential equation, Examples of ordinary differential electric circuit, [**NLP: 4 hours]**

Rotational Dynamics

Velocity and acceleration of a particle in plane polar coordinate system (*radial and transverse component of velocity and acceleration*), **[NLP: 3 hours]**

System of particles and rigid body: Kinetic energy of rotation, Angular momentum ,Torque, Principle of conservation of angular momentum with examples., Moment of inertia and radius of gyration, Parallel and perpendicular axes theorems, Calculation of moments of inertia for disc, sphere, cylinder and cone. Kinetic energy of rolling bodies:acceleration of rolling body along inclined surface. **[NLP:08 hours]**

Unit-3

Fluid Dynamics

Streamline and turbulent motion: Equation of continuity in differential form **(Statement only**), statement of Bernoulli's theorem (simple derivation using work-energy principle): Application of

Bernoulli's theorem to Venturimeter, Pitot tubes, Torricelli's theorem and different phenomenon.

[NLP -07 hours]

Gravitation& Central Force

Gravitational field and potential due to homogeneous solid sphere, Thick and thin Spherical shell, Central force, conservative force, central orbit, differential equation of motion of a particle moving under central force in plane polar co-ordinate system (**simple derivation**), areal velocity, Kepler's laws of planetary motion and their applications, **[NLP:08 hours]**

Paper Code: 101M

Group: B (Practical)
Full marks-40 (Internal assessment-16 + End Sem. Exam.-24) Credit = 1

Laboratory periods: 30 hours

Part-1: Introductory Instruments Concepts and related activities:

• **Use of Basic Instruments**: Determination of least count/vernier constant and use of instruments like slide calliper, screw gauge for measuring lengths, diameter, height ofa given sample.

• **Errors Analysis**: Estimation of errors- Proportional error, systematic error, standard deviation from given set of sample data, significant figures representation of data

• **Graph Plotting**: Pictorial visualisation of relation between two given physical quantities, Plotting of graphs with sample data set, calculation of slope and other parameters from graph.

Part-2: List of Experiment through virtual lab/Assignment/Task:

1. Torque and angular acceleration of a fly wheel
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=1517&cnt=1
2. Moment of inertia of flywheel
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=1517&cnt=1
3. To find the acceleration of the cart in the simulator. To find the distance covered by the cart in the simulator in the given time interval.
   https://vlab.amrita.edu/?sub=1&brch=74&sim=207&cnt=1
4. Elastic and inelastic collision
   https://vlab.amrita.edu/index.php?sub=1&brch=74&sim=189&cnt=1
5. To verify the momentum and kinetic energy conservation using collision balls.
   https://vlab.amrita.edu/?sub=1&brch=74&sim=197&cnt=1
6. Projectile motion
   https://vlab.amrita.edu/?sub=1&brch=74&sim=191&cnt=1

7. To determine the rigidity modulus of the suspension wire using torsion pendulum.
https://vlab.amrita.edu/?sub=1&brch=280&sim=1518&cnt=1

MINOR

Semester-II: Physics Minor
Paper Code: PH201M
Group: A (Theory): Thermal & Physical Properties and Oscillation & waves
Full marks-60 (Internal assessment-24 + End Sem. Exam.-36) Credit = 3
Total Number of lecture periods: 45 hours

Unit: I (NLP: 15 hours)

Introduction to Thermodynamics

Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, Internal Energy, State Functions, First Law of Thermodynamics and its differential form, First Law & various processes, General Relation between $C_P$and C_V, Work Done during Isothermal and Adiabatic Processes, ***[NLP: 05 Lectures]***

Reversible and Irreversible process and*Second Law of Thermodynamics:*

Reversible and Irreversible process with examples, Carnot's Cycle, Carnot engine &its efficiency, Second Law of Thermodynamics Kelvin-Planck and Clausius Statements, Carnot's Theorem, Significance of Second Law of Thermodynamics,.***[NLP: 05 Lectures]***

Entropy

Concept of Entropy, Clausius Theorem, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of Increase of Entropy, Entropy Changes in Reversible and Irreversible processes, Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics ***[NLP:05 Lectures]***

Unit: II (NLP: 15 hours)

Kinetic Theory of Gases

Basic assumptions of kinetic theory, Distribution of Velocities, Mean, R. M. S. and Most Probable Speeds,Degrees of Freedom. Law of Equipartition of Energy (Derivation is not required), application to Cp and Cv. [NLP:04 hours]

Elasticity

Elastic moduli and their inter-relations, torsion of a cylinder, torsional oscillations, Determination of rigidity modulus, Bending Moment, Cantilever in case of loading at the middle only (neglecting mass of cantilever), calculation of strain energy.

[NLP:04 hours]

Surface Tension

Surface Tension & Surface Energy, Calculation of excess pressure in a spherical drop and bubble, Capillarity and derivation of height of Capillary rise, application to determination of surface tension. , Jurin's law ***[NLP -04 hours]***

Viscosity:

Poiseuille's equation for the flow of an incompressible fluid, statement of Stokes' law, terminal velocity. ***[NLP -03hours]***

Unit: III (NLP: 15 hours)

Oscillations::

Idea of Simple harmonic motion, Kinetic energy, potential energy, total energy and their time-averageand position-average values,Graphical Variation of energy of particlein SHM with time and position,Lissajous figures with equal frequency, Damped and Forced vibrations (***Qualitative discussion only***), Resonance and sharpness of resonance. ***[NLP -08 hours]***

Waves:

Ideal plane wave and its equation presentation, Differential equation of wave motion, wave pressure and energy distribution, Derivation of expression of intensity of wave, Velocity of transverse wave in a stretched string, Differential wave equation in stretch string, Solution of differential equation of wave in stretched string, Principle of superposition of waves, interference, stationary waves, Beats.

[NLP:07 hours]

Paper Code: PH201M
Group: B (Practical)
Full marks-40 (Internal assessment-16 + End Sem. Exam.-24) Credit = 1 Total Number of Laboratory periods: 30 hours

General Properties of Matter (Practical)

1) To determine the modulus of rigidity of the material of the given wire by dynamical method.
2) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
3) Determination of surface tension of liquid by Capillary rise method and to verify Jurin's law.

4) To determine the acceleration due to gravity (g) using Kater's reversible Pendulum.
5) Time period and spring constant of a spring mass oscillation system
6) Moment of Inertia of a body about an axis passing through its centre of gravity.

Virtual Lab Experiment

1. Heat transfer by radiation
https://vlab.amrita.edu/?sub=1&brch=194&sim=802&cnt=1
2. Heat transfer by conduction
https://vlab.amrita.edu/?sub=1&brch=194&sim=801&cnt=1
3. Heat transfer by natural convection
https://vlab.amrita.edu/?sub=1&brch=194&sim=791&cnt=1
4. The study of phase change
https://vlab.amrita.edu/?sub=1&brch=194&sim=709&cnt=1

Reference Books:

1) Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
2) Heat Thermodynamics & Statistical Physics, Brij Lal and Subramaniam, 1st Edn., 2008, S. Chand.

Semester-III: Physics-Minor

Paper Code: PH-301M

Group: A (Theory): Electricity and Magnetism

Full marks-60 (Internal assessment-24 + End Sem. Exam.-36) Credit = 3

Total Number of lecture periods: 45 hours

Unit: I (NLP: 15 hours)

Electric Field and : Potential

Divergence of electric field, Curl of electric field, electric field vector as negative gradient of scalar potential, Integral forms of Gauss Law, Applications of Gauss's Law to cylindrical, spherical and planar symmetries of charge distributions,Coulomb's theorem, Mechanical stress on charged surface. ***[NLP:05 hours]***

Thermoelectricity

Seebeck-effect, thermo-emf graph, neutral temperature and temperature of inversion of a thermocouple, parabolic relation between thermoemf and temperature, laws of thermoelectricity, Peltier effect and its comparison with Joule's effect, Peltier coefficient, Thomson effect, positive

and negative metals, Thomson coefficient, expression for total emf developed in a thermocouple, thermoelectric power thermoelectric diagram, ***[NLP: 05 hours]***

Magnetic Field

Use of Biot-Savart's law (i) magnetic fieldat a point on the axis of circular current carrying coil, (ii) Magnetic field at a point on the axis of infinite solenoid, Ampere's circuital law, application of Ampere's circuital law(i) cylindrical current, (ii) infinite solenoid (iii) Toroidal current.

[NLP: 05 hours]

Unit: II (NLP: 15 hours)

Magnetic Properties of Matter;

Magnetic intensity (intensity of magnetic field) (H),Magnetic permeability(μ), relative permeability (μ_r), Intensity if magnetization (I or M), Magnetic susceptibility(χ,)relations among different magnetic physical quantities, Dia-, para- and Ferromagnetic material*,magnetic saturation, retentivity, coercivity,,* , Curie's law, Curie-Wies law, Hysteresis using B-H loop, Idea of hysteresis loss (no calculation), Selection of magnetic material in various applications, Magnetic intensity. ***[NLP:07 hours]***

Electromagnetic induction

Self-inductance of a circular coil and solenoid, mutual inductance between two circular coils and co-axial solenoids. Eddy current and its use. . ***[NLP :05hours]***

Circuit Analysis

Ideal voltage source, real voltage source, current source, comparison between ideal and real current and voltage sources. Kirchhoff's current law, Kirchhoff's voltage law.

[NLP 3 hours]

Unit: III (NLP: 15 hours)

Potentiometer

Basic principle, comparison of emfs, measurement of current,, measurement of internal resistance, ***[NLP 3 hours]***

DC Transient Analysis

Charging and discharging with initial charge in RC circuit, R-Lcircuit with initial current, time constant. ***[NLP3 hours]***

AC Circuit Analysis

Idea of root mean square and average values of current &emf, form factor and peak factor, voltage-currentrelationship in resistor, inductor and capacitor,power in ACcircuits, sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series (Frequency Response, Bandwidth, Quality Factor), Parallel resonant circuit and its use as rejecter circuit.

MINOR

[NLP: 09 hours]

Paper Code: PH-301M

Group: B (Practical)

Full marks-40 (Internal assessment-16 + End Sem. Exam.-24) Credit = 1

Total Number of Laboratory periods: 30 hours

List of Experiment in Laboratory:

1. Determination of Horizontal component of earth magnetic field (H) of a bar magnet by deflection magnetometer and vibration magnetometer.
2. Determination of magnetic moment of bar magnet (M) by deflection magnetometer and vibration magnetometer.
3. Determination of resistance per unit length of the meter bridge wire by Carey-Foster's method and determination of unknown resistance.
4. To determine the current flowing in a circuit by using a potentiometer
5. Determination of temperature coefficient of resistance of a wire by meter bridge

List of Experiment in virtual lab:

1) To find the temperature coefficient of resistance of a given coil.
(https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=346&cnt=1)
2) Magnetic Field Along The Axis of A Circular Coil Carrying Current
https://vlab.amrita.edu/?sub=1&brch=192&sim=972&cnt=1
3) To determine the magnetic dipole moment (m) of a bar magnet and horizontal intensity (B_H) of earth's magnetic field using a deflection magnetometer.
https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=847&cnt=1
4) To determine the reduction factor of the given tangent galvanometer (K).
https://vlab.amrita.edu/index.php?sub=1&brch=192&sim=1049&cnt=1
5) To find the resonant frequency of series LCR circuit,
https://vlab.amrita.edu/?sub=1&brch=75&sim=330&cnt=1

Suggested readings:

1) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency
2) Advanced Practical Physics Vol-I & Vol-II, B. Ghosh and K.G. Mazumder, Sreedhar Publishers

MINOR

Semester-IV: Physics-Minor
Paper Code: PH401M
Group: A (Theory): Optics and Electromagnetic Theory
Full marks-60 (Internal assessment-24 + End Sem. Exam.-36) Credit = 3
Total Number of lecture periods: 45 hours

Unit: I (NLP: 15 hours)

Ray Optics

Cardinal points of optical systems, Derivations of Positions of cardinal points for a combination of two lenses, Qualitative discussions of aberrations, spherical aberration and chromatic aberration, qualitative study of their remedies and expression for achromatism and condition for remedy of spherical aberration. Construction and working of Ramsden and Huygen's eyepieces,

[NLP: 09 hours]

Wave Optics

Huygen's principle and Interference

Concept of wave front, Huygen's principle, Laws of reflection and refraction using Huygen's principle.

Theory of interference, coherent sources, Conditions for sustained interference pattern ,Young's double slit experiment, derivation of expression for fringe width, Interference by Fresnel Biprism-, Determination of wavelength of light using Fresnel Bi-prism.Interference by division of amplitude, interference by a plane parallel film illuminated by a plane wave, Newton's rings (reflected light): theory and experiment. ***[NLP: 06 hours]***

Unit: II (NLP: 15 hours)

Diffraction,

Diffraction of light, difference between diffraction and interference,

Fresnel diffraction, Fresnel's Half period Zones for plane wave, explanation of rectilinear propagation of light, theory of Zone plate, behavior of Zone plate as convergent lens. Difference between zone plate and convergent lens. ***[NLP:05 hours]***

Fraunhofer Diffraction: Simple theory: single slit, circular aperture, transmission grating

[NLP:05 hours]

Polarization

Idea of polarization, various kinds of polarized light, Polariser and analyser, Law of Malus, Polarisation by scattering and reflection, Brewster's law, Double refraction, ordinary ray and

extra ordinary ray, Nichol Prism and action of Nichol prism as polariser, optical activity, laws of optical activity, Idea about circular and elliptical polarization.

[NLP:05 hours]

Unit: III (NLP: 15 hours)

Electromagnetic Waves

Maxwell's equation, differential equation of electromagnetic wave in free space,

Propagation of plan electromagnetic waves in free space, transverse character, E/B ratio, relative phase of electric and magnetic oscillation, Poynting vector and Poynting theorem (statement only), Electromagnetic energy density, Hertz's experiment. ***[NLP:06 hours]***

Introduction to Fiber Optics

Basics of Optical Fibre, step index fiber, graded index fiber, light propagation through an optical fiber, idea about single mode and multimode propagation, conception of acceptance angle (derivation not required) and numerical aperture, qualitative discussion of fiber losses and applications of optical fibers. ***[NLP: 04 hours]***

Lasers

Idea of spontaneous emission, spontaneous absorption and stimulated emission, Einstein's A- and B- coefficients and their relations, Population inversion, Principle of Laser action in three level system, Ruby Laser, Helium-Neon laser. ***[NLP:05 hours]***

Paper Code: PH401M

Group: B (Practical)

Full marks-40 (Internal assessment-16 + End Sem. Exam.-24) Credit = 1
Total Number of Laboratory periods: 30 hours

List of Experiment in Laboratory:

1. To determine the refractive index of the given liquid with the help of a plane mirror and a convex lens (radius of curvature is to be determined with the help of Spherometer).
2. Determination of the refractive index of a liquid using traveling microscope
3. To determine the focal length of a concave lens by the combination of concave and convex lens using optical bench.
4. To determine angle of prism and angle of deviation by using spectrometer for a given wavelength.
5. To determine the power of a convex lens by displacement method.

6. To determine the refractive index of the material of a convex lens by using the lens and plane mirror.

List of Experiment in virtual lab:

1. To find the resolving power of the prism.
   https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=1524&cnt=1
2. To determine the refractive index of the material of a prism.
   https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=1513&cnt=1
3. To determine the dispersive power of prism.
   https://vlab.amrita.edu/index.php?sub=1&brch=281&sim=851&cnt=1
4. To determine the angle of the given prism
   https://vlab.amrita.edu/?sub=1&brch=281&sim=1508&cnt=1

Suggested readings:

1. An advanced course in practical Physics by D. Chattopadhyay & P.C. Rakshit
2. Advanced Practical Physics by B. Ghosh & K.G. Majumder

Suggested Books:

1. OPTICS, A. K. Ghatak, Tata McGraw Hill.

2. A TEXT BOOK ON OPTICS, N. Subramaniam, Brijlal, S CHAND.

3. MODERN OPTICS, A. B. Gupta, Books and Allied.

4. A TEXTBOOK ON LIGHT, B. Ghosh & K. G. Majumder, Sreedhar Publishers.

Semester-V: Physics-Minor
Paper Code: PH501M
Group: A (Theory): Modern Physics-I and Analog Electronics
Full marks-60 (Internal assessment-24 + End Sem. Exam.-36) Credit = 3
Total Number of lecture periods: 45 hours

Unit: I (NLP: 15 hours)

Special Theory of Relativity

Michelson-Morley experiment (results only, no derivation required) and Discussion of the result, Postulates of special theory of relativity, simple derivation of Lorentz transformation formula, length contraction, time dilation, addition of velocities, variation of mass with velocity, equivalence of mass and energy. ***[NLP: 10 hours]***

Foundation of Quantum Mechanics

Spectral distribution of energy density of Black body radiation and discussion of the failure of classical theory with special mentioning of Wien's distribution law, Wien's displacement law and Rayleigh-Jeans distribution law, Planck's energy distribution law(derivation not required) and explanation of black body radiation characteristics. [NLP:05 hours]

Unit: II (NLP: 15 hours)

Wave-Particle Duality

Dual charater of ligt, de Broglie's hypothesis**,** Expression for de Broglie wavelength**,** Davisson-Germer's experiment, Heisenberg's Uncertainty Principle and simple applications.

[NLP:03 hours]

Schrodinger Equation

Wave function, its properties and its physical significance, Probability density and normalization wave function, Probability current density, equation of continuity (Mathematical statement only), Schrodinger's time dependent equation, Solution of Schrodinger time dependent equation and separation of time independent part using separation of variable method., Normalization of the Wave Function. ***[NLP: 6 hours]***

Quantum Mechanical Operators

Linear operator, Eigen functions and Eigenvalues, Energy and momentum operator, Hamiltonian operator or total Energy operator. The expectation values of position and momentum.

[NLP: 3 hours]

Application of Quantum Mechanics

Particle in one dimensional box with rigid walls, Energy eigenvalues, Normalization and configuration of wave functions, Potential barrier and Quantum Mechanical tunnelling (qualitative discussions). ***[NLP: 3 hours]***

Unit: III (NLP: 15 hours)

Semiconductor Diodes

Half wave and full wave rectifiers,Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor, and Efficiency for rectifiers, Idea about voltage regulation, load regulation, and line regulation, Zener Diode and its use as voltage Regulator. ***[NLP:05 hours]***

Bipolar Junction transistors

Transistors, comparison of three regions, CB and CE Configurations and features of their output and input characteristics (no explanations) , Current gains α, β and their relation, Working of CE amplifier, DC Load line and Q-point, Active, Cut-off and Saturation Regions.

[NLP:06 hours]

Field Effect transistor

FET – structure and operation, Comparison with BJT, Static Characteristics, FET parameters and their relations, FET as a voltage amplifier. ***[NLP: 4 hours]***

Suggested readings:

1. Introduction to Quantum Mechanics by David J Griffith, Pearson
2. Quantum Mechanics by G Aruldhas, PHI learning Pvt. Ltd
3. Quantum Mechanics by Gupta, Kumar, Sharma, Jaiprakash Nath Publication
4. Concept of Modern Physics by Arthur Beisar, Tata McGraw Hill
5. Quantum Mechanics by E Merzbacher

Reference Books:

1. Principle of Electronics by V.K. Mehta and Rohit Mehta, S. CHAND
2. Electronics Fundamentals and Applications, P.C. Chattopadhyay and D. Rakshit, New Age International Private Ltd
3. Fundamental Principle of Electronics by Basudev Ghosh, Books and Allied Ltd.

Paper Code: PH501M
Group: B (Practical)
Full marks-40 (Internal assessment-16 + End Sem. Exam.-24) Credit = 1
Total Number of Laboratory periods: 30 hours

List of Experiment in Laboratory:

1. To study V-I characteristics of a PN junction diode.
2. To study the forward and reverse characteristics curves of a Zener diode and find breakdown voltage in reverse bias.
3. To study the line and load regulation characteristic of a Zener diode.
4. To draw the input characteristics of a Bipolar Junction Transistor (BJT) amplifier in CE configuration.
5. To draw the output characteristics of a Bipolar Junction Transistor in (BJT) amplifier in CE configuration.

6. To draw the common source drain characteristics of a JFET and hence determine the FET parameters.

List of Experiment based in Virtual Lab

1. Explain the function of Bridge Full Wave Rectification.
   http://vlabs.iitkgp.ac.in/be/exp7/index.html
2. Explain the forward and reverse biased characteristics of a Silicon diode.http://vlabs.iitkgp.ac.in/be/exp5/index.html
3. Explain the operation of bipolar junction transistor and Common Emitter characteristics of a BJT.
   http://vlabs.iitkgp.ac.in/be/exp11/index.html
4. Explain the function of a Zener diode and Zener Diode as Voltage Regulator.
   http://vlabs.iitkgp.ac.in/be/exp10/index.html

Suggested Readings:

3) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency
4) Advanced Practical Physics Vol-I & Vol-II, B. Ghosh and K.G. Mazumder, Sreedhar Publishers
5) Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

Semester-VI: Physics-Minor
Paper Code: PH601M
Group: A (Theory): Modern Physics-II and Digital Electronics
Full marks-60 (Internal assessment-24 + End Sem. Exam.-36) Credit = 3
Total Number of lecture periods: 45 hours

Unit: I (NLP: 15 hours)

SOLID STATE PHYSICS
Crystal Structure

Amorphous and Crystalline Materials. Unit Cell, Miller Indices. Draw a set of two Miller planes of the following Miller Indices [100], [010], [200], [111], [020], Importance of Miller Indices, Types of Lattices (Different types of Cubic Lattice system namely Simple Cubic (Primitive), F.C.C., B.C.C., Lattice point density in the unit cell. Positions of Lattice in Unit cell of SC, BCC

and FCC lattices. Packing fraction, Number of nearest neighbour and nearest neighbour distance, Bragg's Law. [***NLP: 10 hours***]

Lattice Specific heat: Dulong and Petit‟s Law, Einstein and Debye theories of specific heat of solids. T^3 law. **[NLP: 5 hour]**

Unit: II (NLP: 15 hours)

NUCLEAR PHYSICS

General Properties of Nuclei

Quantitative facts about mass, radii, charge density, binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve.

[NLP: 03 hours]

Radioactivity Decay

Decay rate and equilibrium (Secular and Transient)

(a) Alpha decay: basics of α-decay processes,theory of α-emission (Qualitative only), Geiger Nuttall law,

(b) β- decay: β-spectrum, positron emission, electron capture, neutrino hypothesis.

(c) Gamma decay: Gamma rays emission from the excited state of the nucleus,

[NLP:04 hours]

Nuclear Reactions

Types of Reactions, Conservation Laws, Q-value, Concept of compound and direct reaction,. Interaction of Nuclear Radiation with matter: energy loss of electrons.

[NLP: 4 hours]

Detector &Accelerators

Ionization chamber and GM Counter, Basic principle of Scintillation Detectors, Van-de Graff generator, Linear accelerator, Cyclotron, ***[NLP: 4 hours]***

Unit: III (NLP: 15 hours)

DIGITAL ELECTRONICS

Arithmetic Circuits

Difference between Analog and Digital Circuits, Binary number system, Counting in Binary, Binary to decimal conversion and vice versa, binary addition and subtraction, 1's and 2's complement methods. ***[NLP:03 hours]***

Logic Gates

Logic gates: positive and negative logic systems, truth table, realization of AND, OR and NOT Gates using discrete components, NAND and NOR Gates as Universal Gates. XOR and XNOR gates. ***[NLP: 04 hours]***

Boolean Algebra

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. ***[NLP:03 hours]***

Combinational &Sequential circuits

Logic diagram of half adder, full adder, half subtractor and Full subtractor and their realization, Difference between combinational and sequential circuits, Working of non-clocked SR flip-flop using NOR or NAND gates. ***[NLP: 5 hours]***

Paper Code: PH601M

Group: B (Practical)
Full marks-40 (Internal assessment-16 + End Sem. Exam.-24) Credit = 1
Total Number of Laboratory periods: 30 hours

List of Experiment in Laboratory:

1. Design of three input OR gate using discrete components and verification of truth table.
2. Design of three input AND gate using discrete components and verification of truth table.
3. Design of NOT gate using discrete components and verification of truth table.
4. Design of NAND gate using discrete components and verification of truth table.
5. Design of NOR gate using discrete components and verification of truth table.
6. Design a circuit to verify the given Boolean expression using IC 74** series
7. Design of XOR gate using IC 74** series.
8. Design of XNOR gate using IC 74** series.

List of Experiment based in Virtual LabLink:

http://vlabs.iitkgp.ac.in/dec/exp3/index.html

1. Study of simple Boolean expressions with basic gates using IC 74** series

2. Verify the Boolean expression $AB + \bar{A}C + BC = AB + \bar{A}C$
3. Verify the Boolean expression $AB + \bar{A}C = (A + C)(\bar{A} + B)$
4. Verify equivalence of AND-OR and NAND-NAND structure
5. Verify equivalence of OR-AND and NOR-NOR structure

Suggested Readings:

6) An Advanced Course in Practical Physics by D. Chattopadhyay, and P.C. Rakshit. New Central Book Agency
7) Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
8) OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.

Suggested readings:

1. Fundamentals of Digital Circuits by Anand Kumar, PHI Learning Pvt. Ltd.
2. Digital Electronics by G K Kharate ,2010, Oxford University Press
3. Modern Digital Electronics by R. P. Jain, McGraw Hill Education.
4. Digital Logic and Computer Design by Morris Mano, Pearson Education India

Suggested readings:

1. Nuclear Physics by Satya Prakash Pragati Prakashani
2. Nuclear Physics by D. C. Tayal Himalaya Publishing House
3. Introductory Nuclear Physics by K. S. Krane, Wiley
4. Modern Atomic and Nuclear Physics by A.B. Gupta, Books and Allied Ltd.
5. Solid State Physics – S P Kuila
6. Solid State Physics – Puri, Babbar (S Chand)