Netaji Subhas Open University
Honours in Physics
Programme Code - HPH

Programme Objectives

In recent years, there are ample scope of higher studies as well as research in Physics, thus the students opt this subject by choice. In Netaji Subhas Open University the target group of learners are mainly from the rural areas, particularly where the Universities are too far from their local residence; but the students from urban areas are also enrolling themselves. In West Bengal, a lot of students are passed higher secondary with science background, but due to limitation of seats in the conventional Universities/ PG colleges, all of them could not get enrolled themselves in the Physics subject of their choice. NSOU caters and tries to offer the best of the opportunity by offering this subject at the BDP level to the students. The main objectives for offering this programme are: –

a. To focus within the curriculum for understanding the subject and gather practical knowledge. It is a important basic course for further study in higher education and could enhanced their knowledge by research.

b. To develop a logical analysing power of natural events and experimental facts.

c. The University is well prepared to offer Physics in BDP and the cooperation from study centres/colleges under different University shall be sought to keep the parity between regular as well distance mode of BDPin Physics. It is thus spreading the diverse real world knowledge base to the learners.

d. To educate and train individuals to be effective for gathering further knowledge.

e. To equip individuals with the necessary scientific skills and competencies to enable them to seek jobs and progress in their career by the hands-on computer based practical and the practical experience.

f. To give chances to the willing students those who could not enter into the convention Universities due to their age, job and limitation of the seat in the respective subject and make them capable at per the students of other university.

Expected Programme Outcome

After successful completion of the course, the learners are able to increase their knowledge base in the domain of Physics which enhances their employability in various fields. The greatest strength of Physics, as a discipline is its ability to integrate and apply knowledge across the Globe. The students completing this programme has following outcome:

i) A large number of student avail this opportunity of this course and start fulfilling their dreams of higher education.

ii) It educates and trained individuals to be an effective managers and decision-makers.

iii) It increases understanding that scientific knowledge is the product of a process engaged in by a community of scientists.

iv) It equips individuals with the necessary scientific skills and competencies to enable them to seek jobs and progress in their career.

v) It enhances the capabilities of the existing workforce in the country and thus contribute to economic as well as scientific development.

vi) It gives chances to the willing students those who could not entered into the conventional Universities due to their job and limitation of the seat in the respective subjects.

vii) It helps to understand and apply theoretical and practical knowledge in the appropriate areas and enhance their living condition as well as to save the nature and its surroundings.

viii) It helps student to work collaboratively with others (within different sections of the society) in cross-functional teams, and to motivate, lead, and mentor others.

ix) The learners can able to enhance their capabilities in the workforce by contributing a lot by their skills.

x) Their learnings from the discourse make them capable with the necessary scientific skills and competenciesenriched and enabled them to become a good educator, teacher, employer and researcher.

Programme Structure

	SEM	CODE	Course Name	Theory/ Prac.	Credit	Study Hours	TEE Full Marks	Assignment Full Marks	Total Marks	Pass Marks 30%
1st Year	I	**CC-PH-01**	Lab -I	Practical	6	180	70	00	70	21
		CC-PH-02	Lab -II	Practical	6	180	70	00	70	21
		AE-BG-11 /AE-EG-12	Bengali / English*	Theory	2	60	50	20	70	21
		#GEC-01	Refer Table Below	Theory	6	180	50	20	70	21
	II	**CC-PH-03**	Mechanics and General Physics	Theory	6	180	50	20	70	21
		CC-PH-04	Mathematical Methods in Physics-I	Theory	6	180	50	20	70	21
		AE-ES-21	Environmental Studies	Theory	2	60	50	20	70	21
		#GEC - 02	Refer Table Below	Theory	6	180	50	20	70	21
2nd Year	III	**CC-PH-05**	Lab -III	Practical	6	180	70	00	70	21
		CC-PH-06	Lab -IV	Practical	6	180	70	00	70	21
		CC-PH-07	Mathematical Methods in Physics-II	Theory	6	180	50	20	70	21
		SE-PH-11	Electrical Circuits and Network Skills	Theory	2	60	50	10	60	18
		#GEC- 03	Refer Table Below	Theory	6	180	50	20	70	21
	IV	**CC-PH-08**	Electricity and Magnetism	Theory	6	180	50	20	70	21
		CC-PH-09	Waves and Optics	Theory	6	180	50	20	70	21
		CC-PH-10	Mathematical Methods in Physics-III	Theory	6	180	50	20	70	21
		SE-PH-21	Renewable Energy and Energy Harvesting	Theory	2	60	50	10	60	18
		#GEC- 04	Refer Table Below	Theory	6	180	50	20	70	18

3rd Year	V	**CC-PH-11**	Lab-V	Practical	6	180	70	00	70	21
		CC-PH-12	Thermodynamics and Statistical Mechanics	Theory	6	180	50	20	70	21
		DS-PH-11	Physics of Devices and Communication	Theory	6	180	50	20	70	21
		DS-PH-21	DSE Lab-I	Practical	6	180	70	00	70	21
		CC-PH-13	Quantum Physics	Theory	6	180	50	20	70	21
	VI	**CC-PH-14**	Electronics	Theory	6	180	50	20	70	21
		DS-PH-31	Solid State Physics	Theory	6	180	50	20	70	21
		DS-PH-41	Nuclear and Particle Physics	Theory	6	180	50	20	70	21
	TOTAL				**140**				**1800**	

* Learners will choose any one from AE-BG-11: Bengali or AE-EG-12: English as Ability Enhancement Compulsory Course 1

#Any one from each group (column) to be selected from the following

Option of GE courses for HPH

Subject	SEM-I: GE-01	SEM-II: GE-02	SEM-III: GE-03	SEM-IV: GE-04
Mathematics	**GE-MT-11**: Statistical Techniques	**GE-MT-21**: Dynamical Systems	**GE-MT-31**: Applications of Algebra	**GE-MT-41**: Modelling and Simulation
Chemistry	**GE-CH-11**: Basic Physical Chemistry	**GE-CH-21**: Basic Inorganic Chemistry	**GE-CH-31**: Basic Organic Chemistry	**GE-CH-41:** Application Oriented Chemistry
				GE-CH-42: Approved MOOCs'

Examination System Per Semester

Term-End Examination Dec (Odd Sem July-Dec)

Semester I	Semester III	Semester V
CC1 CC2 AECC1 (Beng/ Eng) GE1 Total credit: 20	CC5 CC6 CC7 SEC1 GE3 Total credit: 26	CC11 CC12 DSEC1 DSEC2 Total credit: 24

Term-End Examination June (Even Sem Jan-June)

Semester II	Semester IV	Semester VI
CC3 CC4 AECC2 (ENVS) GEC2 Total credit: 20	CC8 CC9 CC10 SEC2 GEC4 Total credit: 26	CC13 CC14 DSEC3 DSEC4 Total credit: 24

Assignment will be conducted through digital platform on MCQ

Objective and Expected Outcome for Each Course

Course Code	Course Objectives	Expected Outcomes
Core Courses		
CC-PH-01 Lab -I	• To enhance the instrumental handling and measuring ability of the learner. • To get an idea about measuring technique in mechanics. • To learn how to plot the graph and get the result of any physical quantity. • To learn how to write basic programming in c.	• Learner will able to understand the different process of measurement and application of different theory of Physics. • And also they will be able to represent physical quantity in graph and able to explain its nature. • Learners ability of calculating any measured quantity will also increase.

		• They will be able to write, execute and take an output in C programming. • They will be able to solve simple problem using c programming. • They can design the experimental setup and able to find possible faults in the set up.
CC-PH-02 Lab -II	1. To enhance the instrumental handling and measuring ability of the learner. 2. To get an idea about measuring technique in mechanics. 3. To learn how to plot the graph and get the result of any physical quantity. 4. To learn how to handle electrical and magnetic instruments.	1. Learner will be able to understand the different process of measurement and application of different theory of Physics. 2. And they will be able to represent physical quantity in graph and able to explain its nature. 3. Learners' ability of calculating any measured quantity will also increase. 4. They will be able to understand different electrical circuits and their operation 5. They can design the experimental setup and able to find possible faults in the set up
CC-PH-03 Mechanics and General Physics	1. To enhance the basic knowledge of the learner in mechanics and general properties of matter. 2. To get an advance idea about different kind of motion in central force. 3. To learn about relative motion and its actual and apparent consequence.	1. Learner will be able to understand the different process of mechanics. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically. 3. Learners' ability of calculating different theory will also increase. 4. They will be able to understand different relative motion. 5. They can explain time dilation, length contraction and other outcome of special theory of relativity.

CC-PH-04 Mathematical Methods in Physics-I	• To enhance the basic knowledge of the learner in mathematical methods used in Physics. • To get an advance idea about vector and metrics analysis of different kind of problem in physics. • To learn about computer programming in C and using it in problem solving of Physics	1. Learner will be able to understand the different process of mathematical methods. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically with using this mathematical tool. 3. They will be able to calculate physical problem using this vector and metrics. 4. They will be able to write, execute and take an output in C programming. 5. They will be able to solve simple problem using c programming.
CC-PH-05 Lab -III	1. To enhance the instrumental handling and measuring ability of the learner. 2. To get an idea about measuring technique in mechanics. 3. To learn how to plot the graph and get the result of any physical quantity. 4. To learn how to handle electrical, optical, and magnetic instruments.	1. Learner will be able to understand the different process of measurement and application of different theory of Physics. 2. And they will be able to represent physical quantity in graph and able to explain its nature. 3. Learners' ability of calculating any measured quantity will also increase. 4. They will be able to understand different electrical circuits and their operation 5. They can design the experimental setup and able to find possible faults in the set up.
CC-PH-06 Lab -IV	1. To enhance the instrumental handling and measuring ability of the learner. 2. To get an idea about measuring technique in mechanics. 3. To learn how to plot the graph and get the result of any physical quantity.	1. Learner will be able to understand the different process of measurement and application of different theory of Physics. 2. And they will be able to represent physical quantity in graph and able to explain its nature.

	4. To learn how to handle electrical and electronics related instruments. 5. To enhance the idea of digital circuit elements.	3. Learners' ability of calculating any measured quantity will also increase. 4. They will be able to understand different electrical circuits and their operation. 5. They can design the experimental setup and able to find possible faults in the set up.
CC-PH-07 Mathematical Methods in Physics-II	1. To enhance the basic knowledge of the learner in mathematical methods used in Physics. 2. To get an advance idea about Fourier series, special function, special integrals, and partial differential equation in order to solve problem in physics. 3. To learn about advance mechanics and its application.	1. Learner will be able to understand the different process of mathematical methods. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically with using this mathematical tool. 3. They will be able to calculate physical problem using Fourier series, special function, special integrals, and partial differential equation 4. They will be able to apply Hamiltonian and Lagrangian mechanics in solving simple problem in Physics and able to understand the difference between Newtonian mechanics and Advance mechanics.
CC-PH-08 Electricity and Magnetism	1. To enhance the basic knowledge of the learner in electricity and magnetism. 2. To get an advance idea about Electrical Potential, Dielectric material, and magnetic material. 3. To learn about application of electrical instruments and electromagnetic theory.	1. Learner will be able to understand the different process of electricity and magnetism. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically.

		3. Learners' understanding about electricity and magnetism will also increase. 4. They can solve problem of different kind of electrical circuits.
CC-PH-09 Waves and Optics	1. To enhance the basic knowledge of the learner in waves and optics. 2. To get an advance idea about superposition of waves and its related phenomenon. 3. To learn about Laser, Holography, and application of optics.	1. Learner will be able to understand the different process of waves and optics. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically. 3. Learners' understanding about superposition of waves will increase. 4. They can explain about modern optical application like optical fibre. 5. Learner will have good knowledge about holography and laser.
CC-PH-10 Mathematical Methods in Physics-III	1. To enhance the basic knowledge of the learner in mathematical methods used in Physics. 2. To get an advance idea about Complex analysis, Integral transform as well as Laplace transform. 3. To learn about tensor and its application.	1. Learner will be able to understand the different process of mathematical methods. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically with using this mathematical tool. 3. They will be able to calculate physical problem using Complex analysis, Integral transform as well as Laplace transform 4. They will be able use Tensor and solve problems.

CC-PH-11 Lab-V	1. To enhance the instrumental handling and measuring ability of the learner. 2. To design a project which is applicable in daily life. 3. To learn how to plot the graph and get the result of any physical quantity. 4. To learn how to handle electrical and electronics related instruments. 5. To enhance the idea of digital circuit elements.	1. Learner will be able to understand the different process of measurement and application of different theory of Physics. 2. Learners' ability of creating any electronics project will increase. 3. They will be able to understand different electrical circuits and their operation. 4. They can design the experimental setup and able to find possible faults in the set up.
CC-PH-12 Thermodynamics and Statistical Mechanics	1. To enhance the basic knowledge of the learner in heat and thermodynamics. 2. To get an idea about entropy and its importance in thermal physics. 3. To learn about different kind of distribution of particles.	1. Learner will be able to understand the different process of thermodynamics. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically. 3. Learners' understanding about thermodynamics will increase. 4. They will have the ability of solving problem in thermal physics and using entropy to explain different thermal phenomenon. 5. Learner will understand MB, BE and FD distribution and will be able apply different kind of distribution in different system.
CC-PH-13 Quantum Physics	1. To enhance the basic knowledge of the learner in Quantum Mechanics. 2. To get an idea about application of quantum mechanics.	1. Learner will be able to understand quantum mechanics. 2. And they will be able to explain physical quantity and able to explain different natural event scientifically.

		3. They will have the ability of solving simple problem in quantum Mechanics.
CC-PH-14 Electronics	1. To enhance the basic knowledge of the learner in Electronics and digital circuit. 2. To get an idea about sequential circuit and computer organization.	1. Learner will be able to understand the different process of electronics. 2. They will be able to explain digital counter and binary operation in computer system. 3. They will have the ability of explaining mobile computer organization.
Discipline Specific Elective Courses		
DS-PH-11 Physics of Devices and Communication	1. To enhance the basic knowledge of the learner in Electronic devices and electronic communication system. 2. To get an idea about satellite communication system and mobile communication.	1. Learner will be able to understand the different process of digital. 2. They will be able to explain digital communication system and its application.
DS-PH-21 DSE Lab-I	1. To enhance the instrumental handling and measuring ability of the learner. 2. To design a project which is applicable in daily life. 3. To learn how to plot the graph and get the result of any physical quantity. 4. To learn how to handle electrical and electronics related instruments. 5. To enhance the idea of digital circuit elements.	1. Learner will be able to understand the different process of measurement and application of different theory of Physics. 2. They will be able to understand different electrical circuits and their operation. 3. They can design the experimental setup and able to find possible faults in the set up.
DS-PH-31 Solid State Physics	1. To enhance the basic knowledge of the learner in solid state physics. 2. To get an idea about dielectric and superconductivity.	1. Learner will be able to understand the solid sate physics and able to explain different property of the solids. 2. They will be able to explain super conductivity and able to solve problem in solid state physics.

DS-PH-41 Nuclear and Particle Physics	1. To enhance the basic knowledge of the learner in nuclear physics and particle physics. To get an idea about nuclear reaction and its application in daily life.	1. Learner will be able to understand the nuclear physics and its application. 2. They will be able to explain relevant facts and able to solve problem in nuclear physics. 3. After going through the course they will be able to explain nuclear fission and fusion and energy source of the earth in future.
Skill Enhancement Courses		
SE-PH-11 Electrical Circuits and Network Skills	1. To enhance the basic knowledge of the learner in Electrical Circuits and Network Skills	1. Learner will be able to understand the different process of Electrical Circuits and Network Skills.
SE-PH-21 Renewable Energy and Energy Harvesting	1. To enhance the basic knowledge of the learner in Renewable Energy and Energy Harvesting	1. Learner will be able to understand about Renewable Energy and Energy Harvesting.
Generic Elective Courses		
GE-PH-11 Mechanics	1. To enhance the basic knowledge of the learner in mechanics and general properties of matter. 2. To get an general idea about different kind of motion in central force. 3. To learn about relative motion and its actual and apparent consequence.	1. Learner will be able to understand the different process of mechanics. 2. Learners' ability of calculating different theory will also increase. 3. They will be able to understand different relative motion.
GE-PH-21 Thermal Physics	1. To enhance the basic knowledge of the learner in heat and thermodynamics. 2. To get an idea about entropy and its importance in thermal physics.	1. Learner will be able to understand the different process of thermal physics. 2. Learners' understanding about thermodynamics will increase. 3. They will have the ability of solving problem in thermal physics and

		using entropy to explain different thermal phenomenon. Learner will understand MB, BE and FD distribution and will be able apply different kind of distribution in different system.
GE-PH-31 Wave and Optics	1. To enhance the basic knowledge of the learner in waves and optics. 2. To get an advance idea about superposition of waves and its related phenomenon.	1. Learner will be able to understand the different process of waves and optics. 2. Learners' understanding about superposition of waves will increase.
GE-PH-41 Elements of Modern Physics	1. To enhance the basic knowledge of the learner in modern physics. 2. To get basic idea about quantum mechanics and radioactivity.	1. Learner will be able to understand the different process of modern physics. 2. Learners' understanding about radioactivity and nuclear structure.

Detailed Syllabus

Semester-I
Core Course-1 (Practical) Credit-6, Full Marks-70
Course Code: CC-PH-01, Course Title: Lab-I

Unit 1: Extension of spring and to find out spring constant from vertical Oscillations.

Unit 2: To find out modulus of rigidity from torsional oscillation of a wire. Unit 3: Determination of Moment of Inertia of a Fly-wheel.

Unit 4: Determination of refractive index of a liquid by travelling microscope.

Unit 5: To find Fourier coefficients of different periodic vibrations by graphical method Unit 6: To determine the coefficient of Viscosity of water by capillary flow method.

Unit 7: Determination of g using a Bar pendulum/Kater's pendulum.

Unit 8: Determination of thermal conductivity of a bad conductor by Lee's and choltron's method.

Unit 9: To determine the surface tension of a liquid by Jagger's method.

Unit 10: To determine focal lengths of convex & concave lenses bydisplacement and Combination methods.

Unit 11: To adjust a Spectrometer for parallel rays by Schuster's method and to find

out the angle of a prism.

Unit 12: To determine an unknown Low Resistance using Potentiometer.

Unit 13:Write a programme and verify to find out sum and average of given number set (By using C/C++).

Unit 14:Write a programme and verify to find out largest number and its position in a given number set.(By using C/C++).

Unit 15: Write a programme and verify to arrange a number in ascending/descending order for a given number set (By using C/C++).

Semester-I
Core Course-2 (Practical) Credit-6, Full Marks-70
Course Code: CC-PH-02, Course Title: Lab-II

Unit 1: To draw the forward bias and reverse bias characteristics of a junction diode and to find the value of r_p in active region.

Unit 2: To draw the Zener Diode–characteristics in forward and reverse bias condition and find the break down voltage and the break down current.

Unit 3: To verify Thevenin, Norton theorem, Maximum Power Transfer Theorem.

Unit 4: To determine the Y of a material by flexure method.

Unit 5: To draw the input-out-put characteristics of a common emitter Transistor.

Unit 6: To determine the band gap energy of a semiconductor by four probe method.

Unit 7: To determine H by Vibrational magnetometer.

Unit 8: To determine the self-inductance of a coil by Anderson's bridge.

Unit 9: To draw e - T of a thermocouple.

Unit 10: To determine the elastic Constants of the material a wire by Searle's method

Unit 11: To study the V-I curve of a solar cell and find the maximum power point and efficiency.

Unit 12: To study the variation of mutual inductance of a given pair of coaxial coils by using a ballistic galvanometer.

Unit 13: To find out temperature co-efficient of the material of a wire by *Carey- Foster bridge*

Unit 14: To find leakage resistance by discharging a capacitor Unit 15: To study Lissajous Figures

Semester-II

Core Course-3 (Theory) Credit-6, Full Marks-70

Course Code: CC-PH-03, Course Title: Mechanics and General Physics

Laws of Motion: Inertial and non-inertial frame, Galilean transformations; Galilean invariance. Dynamics of a system of particles. Concept of Centre of Mass, determination of centre of mass for discrete and continuous bodies having cylindrical and spherical symmetry.

Application of Newton's law for variable mass system. Conveyer belt feeding raw material,

Rocket motion in gravity and gravity free space.

Conservative and non-conservative forces, Force as a gradient of Potential Energy, stability and potential energy, conservation of momentum and energy. Elastic and in-elastic collisions, in laboratory frame and centre of mass frame.

Rotational Dynamics: Angular velocity, Angular momentum, Torque, Conservation of angular momentum, Moment of Inertia, product of inertia, Parallel and perpendicular axes theorem, calculation of Moment of Inertia of discrete and continuous objects (1-D, 2-D and 3-D), Euler's equations; K.E of rotation involving both translation and rotation.

Rotating reference frame and the pseudo forces,non-inertial frames and idea of fictitious forces.Equation of motion with respect to a uniformly rotating frame - Centrifugal and Coriolisforces. Laws of Physics in a laboratory on the surface of the earth.

Gravitation: Gravitational potential and intensity, Gauss's law, applications of Gauss's law, Poisson's equation, Laplace's equation, gravitational self-energy, gravitational field and potential due to spherical bodies. Effect of Coriolis force on a falling body. Foucault pendulum.

Central Force Motion: Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram.

Satellite motion: Kepler's laws and its deduction for elliptic orbit. Geo-synchronousorbits, Weightlessness. Basic idea of Global Positioning System (GPS).

Elasticity: Interrelationships between the various elastic constants for isotropic medium, Torsion of a cylinder and torsional rigidity, Bending of beams and cantilevers, flexural rigidity, geometrical moment of inertia, strain-energy relations.

Viscosity and fluid dynamics: Coefficient and Newton's law. Poiseullie's equation, Stoke's method and terminal velocity. Equation of continuity in differential form, Bernoulli's theorem and its applications,Toricelli's theorem.

Special Theory of Relativity: Discovery of constancy of speed of light from theoretical and experimental consequence, Postulates of Special Theory of Relativity, Lorentz Transformation, Length Contraction, Time Dilation, Examples. Lorentz Invariance; Velocity Addition Theorem, Doppler Effect,

Variation of Mass with Velocity, Energy-Mass Equivalence, Relativistic Energy and Momentum and their Transforms; Newton's Laws of Motion in Relativistically Covariant Form

Semester-II

Core Course-4 (Theory) Credit-6, Full Marks-70

Course Code: CC-PH-04, Course Title: Mathematical methods in Physics-I

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Intuitive ideas of continuous, differentiable, functions and plotting of curves. Approximation: Taylor and binomial series (statements only).

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement ofexistence and Uniqueness Theorem for Initial Value Problems. Particular Integral.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor with simple illustration. Constrained Maximization using Lagrange Multipliers.

Vector Calculus: Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl andLaplacian in Cartesian, Spherical and Cylindrical Coordinate Systems

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Matrices: Addition and Multiplication; Transpose and conjugate transpose of a matrix; Adjoint and Inverse of a Matrix; rank of a matrix; Normal Forms; Characteristics equation of a square matrix and diagonalization; Trace of a Matrix; Inner Product.

Types of matrices – Null Matrices, Singular and non-singular matrices, Symmetric and Skew-symmetric Matrix, Hermitian and Skew-Hermitian Matrix, Orthogonal and unitary matrices and their properties.

Solution of systems of linear homogenous and non-homogeneous equations by matrix method; Cayley- Hamiltontheorem.

Eigen-values and Eigenvectors. Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations, Functions of a Matrix.

C & C^{++} Programming fundamentals:

Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator.Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops).

Semester-III
Core Course-5 (Practical) Credit-6, Full Marks-70
Course Code: CC-PH-05, Course Title: Lab-III

Unit 1: To find mutual inductance by Carey-Foster method
Unit 2: To measure the field strength B and its variation with distance by using a search coil.
Unit 3: To study the variation of refractive index(μ) of the material of a prism with wave length and to verify Cauchy's dispersion formula and to find the dispersive power of the material of the prism by spectrometer.
Unit 4: To draw the regulation characteristics of a bridge rectifier (i) without using any filter and (ii) using C filter. Determination of ripple factor in both cases by measuring the ripple voltage with the help of an A.C meter.
Unit 5: To find the optical rotation of a sugar solution by a Polarimeter. Unit 6: To find wavelength of Na-light by Fresnel's bi-prism.
Unit 7: To draw $\delta-\lambda$, $\delta-1/\lambda^2$graphs and find an unknown wavelength bya prism Spectrometer
Unit 8: To draw: sin $\theta-\lambda$ graph with the help of a diffraction grating and find wavelengths.
Unit 9: To study response curve of a Series LCR circuit and determine its Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
Unit 10: To find the resistance of a Galvanometer by Half Deflection Method.
Unit 11: Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
Unit 12: To determine wavelength of sodium light using Newton's Rings.
Unit 13: To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
Unit 14: To determine refractive index of the Material of a prism using sodium source.
Unit 15: To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

Semester-III
Core Course-6 (Practical) Credit-6, Full Marks-70
Course Code: CC-PH-06, Course Title: Lab-IV

Unit 1: To find the number of lines per centimetre of a transmission grating and to measure the wave length of an unknown spectral line.

Unit 2: To study photo current versus intensity and wave length of light; maximum of photo electrons versus frequency of light.

Unit 3: Determination of slit width by studying the single slit diffraction pattern.

Unit 4: Use of an OP-AMP as adder, Subtractor, inverting and non-inverting amplifier.

Unit 5: To test a Transistor using a Multimeter. To design a switch (NOT gate) using a Transistor and study its performance.

Unit 6: To verify and design AND, OR, NOT and XOR gates using NAND gates.

Unit 7: To design a combinational logic system for a specified Truth Table.

Unit-8: To design Half Adder, Full Adder and 4-bit binary Adder.

Unit 9: To design a Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

Unit 10: To study the diffraction pattern of a crossed grating with the help of a LASER source.

Unit 11: To draw the characteristics of a JFET and hence to determine relevant parameters.
Unit 12: Determination of thickness of a thin film by Fresnel‟s bi-prism.

Unit 13: To calibrate a thermocouple to measure temperature in a specified Range using (i) Null Method, (ii) Direct measurement using Op- Amp difference amplifier and to determine Neutral Temperature.

Semester-III

Core Course-7 (Theory) Credit-6, Full Marks-70

Course Code: CC-PH-07, Course Title: Mathematical Methods in Physics-II

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series.

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations Properties of Legendre Polynomials: Rodrigues Formula, Generating Function Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Lawof Errors. Standard and Probable Error.

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular membrane.

Advance Mechanics

Constraints, Generalized co-ordinates, Virtual displacement and virtual work done; D'Alembert's principle and derivation of Euler-Lagrange equations; Lagrange’s equations for velocity-dependent potential; Application to Lagrange's equation to some simple cases(one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity). Cyclic

coordinates Isotropy and Homogeneity of space, Lagrangian formulation of conservation laws of linear momentum, angular momentum and energy.
Hamilton formalism: Variational principles; Hamilton's principle; Derivation of Lagrange's equation from Hamilton's principle.
Hamilton's equation of motions; Hamiltonian; Applications of Hamilton's equation of motion to some simple cases (Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy).

Semester-IV
Core Course-8 (Theory) Credit-6, Full Marks-70
Course Code: CC-PH-08, Course Title: Electricity and Magnetism

Electric Field and Electric Potential:

Conservative nature of Electrostatic Field,Gauss' Law and its applications with spherical, cylindrical and planar symmetry of charge distribution, Laplace's and Poisson equations, the Uniqueness Theorem.Electrostatic energy of a system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter:

Electric Field in a medium, Dielectric Polarization, Electrical Susceptibility and Dielectric Constant. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.Linear dielectrics, boundary conditions at the dielectric surface, energy density in electrostatic field, microscopic theory of dielectric polarizability, Clausius-Mossotti relation, atomic radius from dielectric constant, polar molecules and Langevin-Debye (formula only).

Magnetic Field: Electric current as a source of magnetic field,Biot-Savart's Law and its simple applications: straight wire and circular loop, Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid.

Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loopin a uniform Magnetic Field.

Magnetic Properties of Matter: Magnetization vector (**M),**Magnetic Intensity(**H),**Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism, B-H curve and hysteresis loss.

Electromagnetic Induction: Faraday's Law, Lenz's Law. Self-Inductance, Mutual Inductance, Energy stored in a Magnetic Field.

Maxwell`s equations and Electromagnetic wave propagation:

Maxwell's equations: Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between

Different Media. Wave Equations. Plane Waves in Dielectric Media. PoyntingTheorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

Network theorems: Ideal Constant-voltage and Constant-current Sources.

Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power theorem, Reciprocity theoremand their applications.

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series and parallel LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width.

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping, CDR. Conversion of ballistic to dead beat Galvanometer.

Semester-IV
Core Course-9 (Theory) Credit-6, Full Marks-70
Course Code: CC-PH-09, Course Title: Waves and Optics

Recapitulation of SHM: Setting up of differential eqn. and to find out general soln. Calculation of energy of SHM.

Damped harmonic motion: Setting up of differential eqn. and to find out general soln. study of the effect of damping factor on motion.

Forced oscillations: Transient and steady state solution, Resonance, band width, sharpness of resonance; power dissipation and Quality Factor. Pendulum with length comparable with the radius of earth. Compound pendulum with corrections, centre of percussion, Kater's Pendulum. **Superposition of Harmonic Oscillations:** Superposition Principle. Superposition of two collinear oscillations with equal an unequal frequencies and their uses. Superposition of two perpendicular SHMs, Lissajous figs.

Wave motion:(a) Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive Waves. Wave Equation. Particle and Wave Velocities. Differential Equation of a wave. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave.(b) Water Waves: Ripple.

Velocity of Waves:(a) Velocity of Transverse Vibrations of Stretched Strings.(b) Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formulafor Velocity of Sound. Laplace's Correction.

Superposition of Harmonic Waves:(a) Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. (b) Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. (c) Superposition of N Harmonic Waves. Phase and Group Velocities.

Wave optics: (a) Electromagnetic nature of light. Definition and properties of wavefront. Huygens Principle, Temporal and Spatial coherence.

Interference :(a) Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Bi-prism. Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Interferometers :(a) Michelson Interferometer-(1) Idea of formation of fringes (No theory required), (2) Determination of Wavelength, (3)Wavelength Difference,(4) Refractive Index, and (5) Visibility of Fringes.(b) Fabry-Perot interferometer.

Diffraction and Holography:

1. Fraunhofer diffraction: Single slit. Circular aperture, Resolving Powerof a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.
2. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

LASER: Characteristics, Spontaneous and stimulated emission, meta-stable states, population inversion. Three level, four level LASERs, optical resonator, Ruby Laser, He-Ni Laser.

Holography: Principle of Holography Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Polarization of Light: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uni-axial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Specific rotation. Laurent's half-shade Polarimeter.

Optical Fibres: -Propagation of light in fibre, Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Semester-IV
Core Course-10 (Theory) Credit-6, Full Marks-70
Course Code: CC-PH-10, Course Title: Mathematical methods in Physics-III

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric ,Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with

examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives, and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1^{st}order. Solution of heat flow along infinite bar using Laplace transform.
Tensors: Tensors as multilinear transformations (functionals) on vectors. Examples: Moment of Inertia, dielectric susceptibility. Components of a tensor in basis. Symmetric and antisymmetric tensors. The completely antisymmetric tensor. Non-orthonormal and reciprocal bases. Summation convention. Inner product of vectors and the metric tensor.

Coordinate systems and coordinate basis vectors. Reciprocal coordinate basis. Components of metric in a coordinate basis and association with infinitesimal distance.
Change of basis: relation between coordinate basis vectors. Change of tensor components under change of coordinate system. Example: Inertial coordinates & bases in Minkowski space, Lorentz transformations as coordinate transformations,
Electro-magnetic tensor and change in its components under Lorentz transformations.

Semester-V
Core Course-11 (Practical) Credit-6, Full Marks-70
Course Code: CC-PH-11, Course Title: Lab-V

Unit 1: To design d.c power supply with a specified output following the steps and to measure its

a) ripple factor

b) study its input and output by CRO

c) draw load and line regulation.

a) Half wave rectifier

i) With L/C type filter

ii) With pi filter

b) Full wave rectifier

i) With L/C typefilter

ii) With pi filter

c) Use a Zener diode to stabilize the output

d) Use IC to stabilize the output

Unit 2. To design an amplifier (Transistor/ OPAMP/FET) of a specified out-put and study its input and output signal by CRO.

Unit 3. To design an inverter with specified input and output resistance.

Unit 4. To design a 4-bit ripple counter using IC gates and study its performance.

Unit 5. To design a circuit to check water level of a water tank/reservoir and automate the filling motor.

Unit 6: To design a circuit by using LDR to check pollution level. Unit 7: To design a fan speed electronic regulator using SCR.

Unit 8: To design a Wein's Bridge oscillator of given frequency.

Unit 9: To design PWM, PPM, PAM and Pulse code modulation using ICs.

Semester-V
Core Course-12 (Theory) Credit-6, Full Marks-70
Course Code: CC-PH-12, Course Title: Thermodynamics and Statistical mechanics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_v, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence.

Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale

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. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables.

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's

Free Energy. Their Definitions, Properties and simple applications. First and second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest equations.

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius-Clapeyron equation, (2) Values of C_P - C_V, (3) TdS Equations,

(4) Joule-Kelvin coefficient for Ideal and Vander Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Kinetic theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Statistical Mechanics: Phase space, Macro-states and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann lawand distribution of velocity.

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

Semester-VI
Core Course-13 (Theory) Credit-6, Full Marks-70
Course Code: CC-PH-13, Course Title: Quantum Physics

Foundation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.Planck's quantum hypothesis, Planck's constant and light as a collection of photons.

Quantum theory of Light: Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them.

Uncertainty Principle and its Consequences. [Estimating minimum energy of a confined particle using uncertainty principle]

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern- Gerlach Experiment. Normal and Anomalous Zeeman Effect, Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

X-ray: production, Continuous and characteristic spectra, Moseley's law.

Schrodinger Equation: Time Dependent and Time Independent Schrodinger Equation in One Dimension, Statistical Interpretation of Wave Function, Probability Current Density and Continuity Equation, Normalization of Wave Functions, Wave Function in Momentum Space; Observables and Operators, Linear Momentum, Orbital Angular Momentum, Commutation Relations, Expectation Values.

Applications of Quantum Mechanics: One Dimensional Rectangular Potential Barrier, Tunnelling, Parity Operator and its Eigenvalues; One Dimensional Potential Well, Particle in a Box, Free Particle, Simple Harmonic Oscillator (Energy Eigenvalues only); Quantum Numbers and Constants of Motion; Spin Angular Momentum: the Magnetic Moment of Electron, Stern- Gerlach Experiment, the Total Angular Momentum Vector, Space Quantization; Optical Spectra of Hydrogenic Atoms.

Semester-VI
Core Course-14 (Theory) Credit-6, Full Marks-70
Course Code: CC-PH-14, Course Title: Electronics

Diodes: Principle and structure of Junction diode, Zener diode, LED, Photodiode, Solar Cell. Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode as Voltage Regulation.
Bipolar Junction transistors: Transistor characteristics; CB, CE and CC Configurations. α and β and their relationship. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current flow. Active, Cut-off and Saturation Regions.
Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis ofa single-stage CE amplifier using Hybrid Model. Input and Output Impedance, Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.
Coupled Amplifier: RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.
Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shiftoscillator, determination of Frequency and condition of oscillation. Hartley &Colpitts oscillators. **Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR andNOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates.XOR and XNOR Gates and application as Parity Checkers
Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.
Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders,Encoders.Circuits: Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement.Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops.Pre-set and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.
Timers: (a) IC 555: block diagram and applications: A stable multivibratorand Mono stable multivibrator.
A/D and D/A converter: Weighted and R-2R latter DAC, Successive approximation method ADC.

Computer Organization: Basic structure of computer. Input/Output Devices. Data storage (idea of RAM and ROM), Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Discipline Specific Elective Courses

Semester-V
Discipline Specific Elective Course-1 (Theory) Credit-6, Full Marks-70
Course Code: DS-PH-11, Course Title: Physics of Devices And Communication

Operational Amplifiers (Black Box approach)**:** Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

FET: JFET, MOSFET& UJT, Structure and Characteristics. Small signal equivalent circuits of UJT and JFET. Metal semiconductor Junction. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS and their characteristics, CMOS. Charge coupled devices. Tunnel diode.

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. Line and load regulation, Short circuit protection Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.

Multivibrators: A stable and Monostable Multivibrators using transistors. Phase Locked Loop (PLL): Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Processing of Devices: Basic process flow for IC fabrication, electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.

1. **Electronic communication**

(a) Introduction to communication: means and modes. Need for modulation. Block diagram of an electronic communication system. Briefidea of frequency allocation for radio communication system in India. (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

2. Analog Modulation: (a) Amplitude Modulation, modulation index and frequency spectrum, power of carrier and side bands, Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super Heterodyne Receiver.

3. Analog Pulse Modulation

(a) Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Satellite Communication– Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IME number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only). GPS navigation system (qualitative idea only)

Semester-V

Discipline Specific Elective Course-2 (Practical) Credit-6, Full Marks-70

Course Code: DS-PH-21, Course Title: DSE Lab

1. To design the active Low pass and High pass filters of given specification.
2. To design the active filter (wide band pass and band reject) of givenspecification.
3. To study the output and transfer characteristics of a JFET.
4. To measure the Dielectric Constant of a dielectric Materials with frequency.
5. To study the output characteristics of a MOSFET.
6. To study the characteristics of a UJT and design a simple Relaxationoscillator.
7. Design and Verification of op-amp as integrator and differentiator
8. To design an Amplitude Modulator using Transistor.
9. To design an Astable-multivibrator of given specifications using transistor.
10. To study envelope detector for demodulation of AM signal.
11. Study of ASK and FSK modulator.
12. Design clocked SR and JK Flip-Flop`s using NAND Gates
13. Design 4-bit asynchronous counter using Flip-Flop ICs
14. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
15. To determine the Hall coefficient of a semiconductor sample

Semester-VI

Discipline Specific Elective Course-3 (Theory) Credit-6, Full Marks-70

Course Code: DS-PH-31, Course Title: Solid State Physics

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon

Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law.

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin theory of dia– and Paramagnetic Domains. Quantum Mechanical treatment of Para-magnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials:

Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Piezo-electric effect

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (p and n type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

Semester-VI

Discipline Specific Elective Course 4 (Theory) Credit-6, Full Marks-70

Course Code: DS-PH-41, Course Title: Nuclear and Particle Physics

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. Concept of nuclear forces.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Siand Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Particle Accelerators: Accelerator facility available in India: Linear accelerator, Cyclotron, Synchrotrons.

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, colour quantum number and gluons.

Skill Enhancement Courses

Semester-III

Skill Enhancement Course 1 (Theory) Credit-2, Full Marks-60

Course Code: SE-PH-11, Course Title: Electrical Circuits and Network Skills

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series- parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyse DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three- phase alternating current sources. Rules to analyse AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

Semester-IV

Skill Enhancement Course 2 (Theory) Credit-2, Full Marks-60

Course Code: SE-PH-21, Course Title: Renewable Energy and Energy Harvesting

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need

and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity.

Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability.

Generic Elective Courses

(For learners of Honours programmes other than Physics)

Semester-I
Generic Elective Course-1 (Theory) Credit-6, Full Marks-70
Course Code: GE-PH-11, Course Title: Mechanics

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector withrespect to a parameter.

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.
Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.
Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.
Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts.
Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure -Application to spherical and cylindrical drops and bubbles - variation of surfacetension with temperature - Jaegar's method. Viscosity - Rate flow of liquid in acapillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature- lubrication.

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and □ by Searles method.

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities

Semester-II
Generic Elective Course-2 (Theory) Credit-6, Full Marks-70
Course Code: GE-PH-21, Course Title: Thermal Physics

Laws of Thermodynamics: Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy,

Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity –

Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics

Semester-III

Generic Elective Course-3 (Theory) Credit-6, Full Marks-70

Course Code: GE-PH-31, Course Title: Wave and Optics

Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).
Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.
Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.
Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.
Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. Interference: Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.
Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength,
Wavelength difference, Refractive index, and Visibility of fringes
Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.
Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization

Semester-IV

Generic Elective Course-4 (Theory) Credit-6, Full Marks-70

Course Code: GE-PH-41, Course Title: Elements of Modern Physics

Planck's quantum, Planck's constant and light as a collection of photons; Photoelectric effect and Compton
scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment.
Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.
Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.
Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension.
One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α- decay; β-decay -
energy released, spectrum and Pauli's prediction of neutrino; Y-ray emission.
Fission and fusion - mass deficit, relativity and generation of energy; Fission – nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.