

**Department of Physics
Mizoram University, Aizawl
School of Physical Sciences**



**Curriculum and Credit Framework for Under
Graduate Programmes (CCFUP)**

B.Sc. Physics Syllabus (2nd Revision)

under

NEP2020 Guidelines

Date of Approval by BOS: 13th April, 2026

Date of Approval by School Board: ~~4th Nov., 2024~~

Date of Approval by AC: ~~25th Nov., 2024~~ [AC:47:4(5)]

(To be effective from)

July – 2026

Course Structure of CCFUP B.Sc. (Physics) under NEP2020

Sem	Course No.	Name of Paper	Marks Scale	Credit	Page No.
1 st	PHY100	Mathematical Physics-I	100	4	6
	PHY101*	Electricity Fundamentals	100	4	7
	Minor Course1	<i>From other subject</i>	100	4	
	PHY110	Physics For All	100	3	8
	ENG150	AEC: Communication Skill	100 (any one)	3	
	MIZ150	AEC: Introduction to Mizo Language			
	HIN150	AEC: Devanagiri Lipi			
	VAC100	Universal Human Values	100	2	
			600	20	
2 nd	PHY160	Mechanics, Properties of Matter and Oscillation	100	4	9
	PHY161*	Basic Electronics	100	4	10
	Minor Course1	<i>From other subject</i>	100	4	
	PHY110	Physics For All	100	3	11
	SEC160	Skill Enhancement Course	100	3	
	VAC120	Understanding India	100	2	
			600	20	
UG Certificate					
3 rd	PHY200	Heat and Thermodynamics	100	4	12-13
	PHY201*	Ray Optics and Optical Instruments	100	4	14
	Minor Course1	<i>From other subject</i>	100	4	
	PHY110	Physics For All	100	3	15
	SEC270	Skill Enhancement Course	100	3	
	VAC230	Environmental Science	100 (any one)	2	
	VAC231	Digital and Technological Solution			
			600	20	
4 th	PHY260	Mathematical Physics-II	100	4	16-17
	PHY261*	Modern Physics	100	4	18
	Minor Course1	<i>From other subject</i>	100	4	
	ENG250	AEC: Grammar and Comprehension Skills	100 (any one)	3	
	MIZ250	AEC: Mizo Grammar and Writing Skill			
	HIN250	AEC: Hindi Kamyuting			
	SEC280	Skill Enhancement Course	100	3	
	VAC240	Sports and Fitness	100 (any one)	2	
	VAC241	Health and Wellness			
	VAC242	Yoga Education			
			600	20	
UG Diploma					
5 th	PHY300	Electromagnetic Theory	100	4	19-20
	PHY301	Classical and Statistical Mechanics	100	4	21-22
	PHY302*	Wave Optics	100	4	23
	Minor Course1	<i>From other subject</i>	100	4	
	ENG350	AEC: Writing Skills	100 (any one)	2	
	MIZ350	AEC: Mizo Language-Status and Development			
	HIN350	AEC: Bhasha Shikshan			
	IAF300	Internship/Apprenticeship/Field Project	100	2	
			600	20	
	PHY360	Quantum Mechanics	100	4	24-25
	PHY361	Atomic and Molecular Physics	100	4	26-27

6 th	PHY362	Mathematical Physics-III	100	4	28
	PHY363*	Nuclear and Particle Physics	100	4	29
	Minor Course1	From other subject	100	4	
			500	20	
		Total	3500	120	
Bachelor's Degree					
7 th	PHY400	Solid State Physics	100	4	30-31
	PHY401*	Advanced Classical and Quantum Mechanics	100	4	32
	PHY402*	Advanced Nuclear and Particle Physics	100	4	33
	Minor Course1	From other subject	100	4	
	Minor Course2	From other subject	100	4	
			500	20	

* signifies Minor Courses offered for other subjects

8 th	Bachelor's Degree (Honours without Research)				
(Any five)	PHY460	Numerical Techniques	100	4	34-35
	PHY461	Materials Science and Nanomaterials	100	4	36-37
	PHY462	Digital and Analog Electronics	100	4	38-39
	PHY463	Energy Sources and Harvesting	100	4	40
	PHY464	Plasma Physics	100	4	41
	PHY465	Radiation Safety	100	4	42
			500	20	
		Total	4500	160	
8 th	Bachelor's Degree (Honours with Research)				
	PHY460	Numerical Techniques	100	4	34-35
(Any one)	PHY461	Material Science and Nanomaterials	100	4	36-37
	PHY462	Digital and Analog Electronics			38-39
	PHY463	Energy Sources and Harvesting			40
	PHY464	Plasma Physics			41
	PHY465	Radiation Safety			42
	RPD470	Research Project/Dissertation	100	12	43-44
			300	20	
		Total	4300	160	

Note: AEC = Ability Enhancement Course, VAC = Value Added Course, SEC = Skill Enhancement Course, RPD=Research Project & Dissertation, C/A= Continuous Assessment, ESE = End Semester Examination.

Detailed Course Structure of CCFUP (NEP2020) B.Sc.(Physics)

Sem	Course No.	Name of Paper	Marks Scale			Credit				Exam(hrs)	
			C/A	ESE	Tot	L	T	P	Tot	Th	Pr
1 st	PHY100	Mathematical Physics-I	25	75	100	4	0	0	4	3	-
	PHY101*	Electricity Fundamentals	25	75	100	4	0	0	4	3	-
	Minor Course 1	<i>From other subject</i>	25	75	100	4	0	0	4	3	-
	PHY/110	Physics For All	25	75	100	3	0	0	3	3	-
	AEC150	-	25	75	100	3	0	0	3	3	-
	VAC100	-	25	75	100	2	0	0	2	2	-
			600			20					
2 nd	PHY160	Mechanics, Properties of Matter and Oscillation	25	75	100	4	0	0	4	3	-
	PHY161*	Basic Electronics	25	75	100	4	0	0	4	3	-
	Minor Course 1	<i>From other subject</i>	25	75	100	4	0	0	4	3	-
	PHY110	Physics For All	25	75	100	3	0	0	3	3	-
	SEC160	-	25	75	100	3	0	0	3	3	-
	VAC120	-	25	75	100	2	0	0	2	2	-
			600			20					
3 rd	PHY200	Ray Optics and Optical Instruments	25	75	100	3	0	1	4	3	3
	PHY201*	Heat and Thermodynamics	25	75	100	4	0	0	4	3	-
	Minor Course 1	<i>From other subject</i>	25	75	100	4	0	0	4	3	-
	PHY110	Physics For All	25	75	100	3	0	0	3	3	-
	SEC270	-	25	75	100	3	0	0	3	3	-
	VAC230/231	-	25	75	100	2	0	0	2	2	-
			600			20					
4 th	PHY260	Mathematical Physics-II	25	75	100	3	0	1	4	3	3
	PHY261*	Modern Physics	25	75	100	4	0	0	4	3	-
	Minor Course 1	<i>From other subject</i>	25	75	100	4	0	0	4	3	-
	AEC250	-	25	75	100	3	0	0	3	3	-
	SEC280	-	25	75	100	3	0	0	3	3	-
	VAC240/241/242	-	25	75	100	2	0	0	2	2	-
			600			20					
5 th	PHY300	Electromagnetic Theory	25	75	100	3	0	1	4	3	3
	PHY301	Classical and Statistical Mechanics	25	75	100	3	0	1	4	3	3
	PHY302*	Wave Optics	25	75	100	4	0	0	4	3	-
	Minor Course 1	<i>From other subject</i>	25	75	100	4	0	0	4	3	-
	AEC350	-	25	75	100	2	0	0	2	2	-
	IAF300	-	25	75	100	0	0	2	2	-	3
			600			20					
6 th	PHY360	Quantum Mechanics	25	75	100	3	0	1	4	3	3
	PHY361	Atomic & Molecular Physics	25	75	100	3	0	1	4	3	3
	PHY362	Mathematical Physics-III	25	75	100	4	0	0	4	3	-
	PHY363*	Nuclear & Particle Physics	25	75	100	4	0	0	4	3	-
	Minor Course 1	<i>From other subject</i>	25	75	100	4	0	0	4	3	-
			500			20					
			Total			3500				120	

7th	PHY400	Solid State Physics	25	75	100	3	0	1	4	3	3
	PHY401*	Advanced Classical and Quantum Mechanics	25	75	100	4	0	0	4	3	-
	PHY402*	Advanced Nuclear and Particle Physics	25	75	100	4	0	0	4	3	-
	Minor Course 1	From other subject	25	75	100	4	0	0	4	3	-
	Minor Course 2	From other subject	25	75	100	4	0	0	4	3	-
					500				20		

Bachelor's Degree (Honours without Research)											
8 th (Any five)	PHY460	Numerical Techniques	25	75	100	3	0	1	4	3	3
	PHY461	Materials Science and Nanomaterials	25	75	100	3	0	1	4	3	3
	PHY462	Digital and Analog Electronics	25	75	100	3	0	1	4	3	3
	PHY463	Energy Sources and Harvesting	25	75	100	4	0	0	4	3	-
	PHY464	Plasma Physics	25	75	100	4	0	0	4	3	-
	PHY465	Radiation Safety	25	75	100	4	0	0	4	3	-
			500					20			
		Total	4500						160		
Bachelor's Degree (Honours with Research)											
8 th (Any one)	PHY460	Numerical Techniques	25	75	100	3	0	1	4	3	3
	PHY461	Materials Science and Nanomaterials	25	75	100	3	0	1	4	3	3
	PHY462	Digital and Analog Electronics	25	75	100	3	0	1	4	3	3
	PHY463	Energy Sources and Harvesting	25	75	100	4	0	0	4	3	-
	PHY464	Plasma Physics	25	75	100	4	0	0	4	3	-
	PHY465	Radiation Safety	25	75	100	4	0	0	4	3	-
	RPD470	Research Project/ Dissertation	25	75	100	0	0	12	12	-	6
					300						
		Total	4300						160		

Minor Course 1 & 2 means Courses offered by other Departments

*means Minor Courses offered for other subjects

Key Points:

1. Contact hour: Theory-1 Contact hour is 1 Credit and Practical- 2 Contact hours is 1 Credit.
2. Internal Tests/Assignments will be conducted as a part of Internal Assessment as per CCFUP Regulations (UG) of Mizoram University.

Detailed Syllabus of B.Sc. Physics (NEP 2020)

First Semester (Major)

Name of Paper: Mathematical Physics-I

Course No: PHY100

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Apply vector differentiation and integration techniques, including gradient, divergence, curl and integral theorems, in physical problems. • Use Cartesian, cylindrical and spherical coordinate systems and perform transformations between them. • Solve problems involving matrices, eigenvalues and diagonalisation of simple systems. • Expand functions using Fourier series and understand the properties and applications of Beta and Gamma functions.

Unit-1: Vector Calculus (10 Lectures)

Vector differentiation: Differentiation formulae for Vector Function (no proof), Chain rule for vector functions, Partial Derivatives of Vectors, Differentials of Vectors, Gradient of a scalar field and its geometrical interpretation, Divergence and Curl of a vector field, Expansion Formulae for Operators involving Del.

Vector Integration: Line, Surface and Volume integrals of Vector fields, Statements of Gauss' divergence theorem, Green's and Stokes Theorems (statement only).

Unit-2: Coordinate Systems (10 Lectures)

Coordinate Systems: Cartesian, Cylindrical and Spherical Coordinate systems, Transformation relations between coordinate systems.

Orthogonal Curvilinear Coordinates: Scale factors (Lamé coefficients), Unit vectors in cylindrical and spherical coordinates, gradient, divergence and curl in Cylindrical and Spherical polar coordinates (with derivation), problem solving in curvilinear coordinates.

Unit-3: Matrices and Linear Algebra (10 Lectures)

Matrices: Transpose and conjugate transpose of a matrix, Adjoint and inverse of a matrix.

Special matrices: Symmetric and skew symmetric matrices, Hermitian and Skew-Hermitian matrices, orthogonal and unitary matrices.

Eigenvalue Problems: Characteristic equation, eigen values and eigen vectors of (2×2) matrices, Properties of eigen values and eigen vectors of Hermitian and unitary matrices, Trace of a matrix, diagonalisation of symmetric (2×2) matrix.

Unit-4: Fourier Series and Special Functions (10 Lectures)

Beta and Gamma functions: Definitions of beta and gamma function, Fundamental property of Gamma functions, Transformation of Gamma function, Beta function, different forms, Relationship between Beta and Gamma functions. Applications of β and Γ functions.

Fourier Series: Definition, Fourier series on finite intervals, half range expansions, Complex form of a Fourier series, even and odd function, Fourier series for half wave and full wave rectifier.

Recommended Books:

1. H.K. Das: *Mathematical Physics*, S. Chand & Co.
2. B D Gupta: *Mathematical Physics*, Vikash Publishing House (latest edition).
3. Satya Prakash: *Mathematical Physics*, S Chand & Co., New Delhi.
4. S. Gurung and L. Sailo: *A Handbook of Mathematical Physics*, PUC and GSC joint publication.
5. C. Lalramliana, et. al., *Vector Analysis: Fundamentals and Applications*, South Eastern Book, Agencies, Guwahati.

First Semester (Major/Minor)
Name of Paper: Electricity Fundamentals
Course No: PHY101*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Revise knowledge about electric current, current density, ohm's law, Kirchoff's law and combination of resistors. • Understand magnetic effect of current and electromagnetic induction. • Apply phasor rules to analyse AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to understand the basic workings of common electrical appliances.

Unit 1: Electrical Circuits (10 Lectures)

Steady Current: Current density, drift velocity and mobility, derivation of microscopic form of Ohm's law ($J = \sigma E$), Equation of continuity and charge conservation, Resistance, resistivity, conductivity, Ohmic and non-ohmic conductors.

Network theorems and circuit analysis: Kirchoff's law and its application (two- and three-loop circuits only), Series and Parallel combination of resistance, Current and Voltage division rule, Wheatstone bridge and condition for balance (no sensitivity derivation), Superposition principle (linear DC circuits only), Thevenin's and Norton's theorem (DC resistive circuits only).

Transient current: Growth and decay of current of currents in LR, CR and LCR circuits, time constant.

Unit 2: Magnetic Effects of Current and Electromagnetic Induction (10 Lectures)

Magnetic effect of current: Lorentz force and motion of charged particles in uniform electric and magnetic fields, Force on a current carrying conductor, definition of magnetic field, Biot-Savart law and its application to straight conductor, circular loop and solenoid. Ampere's law and its application to straight conductor and long solenoid. Magnetic field due to a current loop along the axis, magnetic dipole moment of a current loop, torque on a magnetic dipole in uniform magnetic field.

Electromagnetic Induction: Faraday's laws, Lenz's law, self and mutual inductance, Energy stored in an inductor.

Unit 3: AC Circuits (10 Lectures)

AC fundamentals: Sinusoidal voltage and current; complex representation of AC quantities; phasors and phasor algebra; RMS and average values; impedance and reactance of (R, L, C); power in AC circuits and power factor, Wattless current.

Circuit analysis: Series and Parallel LCR circuits using complex impedance method; resonance in series and parallel LCR circuits; condition for resonance, sharpness of resonance and Q-factor; comparison between series and parallel resonance; LC oscillations and energy exchange in oscillatory circuits; basic idea of three-phase AC circuits and star-delta connections (conceptual only).

Unit 4: Electrical Measuring Instruments and Machines (10 Lectures)

Moving coil galvanometer: Construction, working and theory; current and voltage sensitivity; conversion of galvanometer into ammeter and voltmeter.

Electrical machines: Principle, construction and working of: DC generator, DC motor; AC generator and single phase induction motor; Comparison of AC and DC systems.

Hot-wire instruments: Ammeter and Voltmeter, principle and applications.

Transformer: Principle and working, power transfer and efficiency. Step-up and step-down transformer.

Recommended Books:

1. V. K. Mehta, *Principles of Electrical Engineering*.
2. B. L. Theraja, *Basic Electrical Engineering*.
3. E. M. Purcell, *Electricity and Magnetism*: Berkeley Physics Course Vol 2, McGraw Hill, 2017.
4. D.C. Tayal, *Electricity and Magnetism*, Himalaya Publishing House Pvt. Ltd., 2019, 4e.
5. D. Chattopadhyay and P.C. Rakshit, *Electricity and Magnetism*, Central Book Agency, Kolkata.

First Semester (Multidisciplinary)
Name of Paper: Physics for All
Course No: PHY110

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 3

Course Outcome: • *Understand how scientific ideas about motion and the universe evolved over time.* • *Explain basic laws of motion using everyday examples.* • *Describe the structure and evolution of the universe in simple terms.* • *Relate concepts of sound and light to daily life and technology.* • *Develop scientific awareness and critical thinking skills.*

Unit 1: How Humans Learned the Laws of Nature (10 Lectures)

Early ideas about nature and motion: How ancient thinkers explained the world – ideas of Aristotle and Plato; contributions of Archimedes; Indian contributions of Aryabhata and Bhaskara; the geocentric model of the universe and why people believed Earth was at the centre of the universe.

The Scientific Revolution: Copernicus and the heliocentric model; observations of Tycho Brahe and laws of planetary motion by Kepler; Galileo's experiments and the importance of questioning authority.

Newton and the laws of motion: Newton's three laws of motion explained through simple daily examples (walking, vehicles, sports, falling objects); how these laws helped explain both earthly motion and planetary motion.

Unit 2: The Universe and Our Place in It (10 Lectures)

The universe at a glance: Age and size of the universe (conceptual idea); the solar system; the Milky Way; billions of galaxies; our place in the cosmos.

Life cycle of stars: How stars are formed; how they shine; stages in their life; simple idea of white dwarfs, neutron stars and black holes.

Origin and evolution of the universe: Basic idea of the Big Bang theory; expansion of the universe; alternative ideas such as the Steady State theory; simple discussion on how scientific understanding changes with new evidence.

Unit 3: Motion, Sound and Light in Everyday Life (10 Lectures)

Motion around us: Distance and displacement; speed; relative motion (examples from trains, buses and rain); acceleration; force and its effects; practical understanding of motion in everyday situations.

Sound and light around us: Vibrations and simple oscillations; frequency and pitch of sound; musical notes; colours of visible light; basic idea of the electromagnetic spectrum and its role in communication, medicine and daily technology.

Recommended Books/ Suggestion for Reading:

1. Stephen Hawking, *The Universe in a Nutshell*, Bantam Press, 2001.
2. G. Srinivasan, *What are the Stars?* Orient Blackswan Private Limited - New Delhi, 2011.
3. Pankaj Saxena, *Basic Physics*, Notion Press, 2023.
4. Bruce Henderson, *Introductory Physics*, Discovery Publishing House, India, 2024

Course Outcome: • Understanding laws of motion and their application to various dynamical situations. • Understand the analogy between translational and rotational dynamics, collisions and STR. • Understand the concept of Elasticity and equations governing fluid dynamics. • Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.

Unit-1: Laws of Motion and Gravitation (10 Lectures)

Laws of motion: Newton's laws of motion and its basic applications, Velocity and acceleration in Cartesian and polar coordinates, Uniformly rotating frame, Centrifugal force and Coriolis force with applications.

System of particles: Linear and angular momentum of a system of particles, conservation of linear momentum and angular momentum; Work-energy theorem; conservative and non-conservative forces.

Gravitation: Newton's law of gravitation; gravitational field and potential; relation between gravitational field and potential; gravitational field and potential due to spherical shell and solid sphere; escape velocity and orbital velocity; Kepler's laws of planetary motion and derivation of third law from inverse square law.

Unit-2: Centre of Mass, Collisions and Rigid Body Dynamics (10 Lectures)

Centre of mass and collisions: Centre of mass and its motion, equation of motion of centre of mass; conservation laws in centre of mass frame; elastic and inelastic collisions in one-dimension.

Rigid Body Dynamics: Kinematics of rotation; angular velocity, torque and angular momentum of a rigid body; rotational kinetic energy; moment of inertia and its physical meaning; parallel and perpendicular axis theorems (with derivations); calculation of moment of inertia for: circular ring and disc, hollow and solid cylinder, rectangular lamina and bar, hollow and solid sphere.

Unit-3: Elasticity and Fluid Mechanics (10 Lectures)

Elasticity: Stress and strain, Hooke's law, elastic constants for an isotropic solid, relations between elastic constants (with derivations), Torsion of a cylinder, Twisting couple.

Fluid Mechanics: Streamline and turbulent flow, rate of flow and equations of continuity, Bernoulli's theorem, viscosity and coefficient of viscosity, Reynold's number, Poiseuille's law, Stokes law.

Surface tension: Surface Energy, Excess pressure inside a liquid drop and soap bubble, angle of contact, capillarity and rise of liquid in capillary tube.

Unit-4: Oscillations (10 Lectures)

Simple Harmonic Oscillations: Differential equation of SHM and its solution, energy of harmonic oscillator; Physical examples: Spring-mass system, simple pendulum (small-angle approximation), Compound pendulum.

Superposition of Harmonic Motions: Superposition of two mutually perpendicular SHM of (a) same frequency and (b) different frequencies in the ratio 1:2, Lissajous figures.

Damped and Forced Oscillations: Differential equation of damped oscillation and its solution; underdamped, critically damped and overdamped cases; Forced oscillations and steady-state solution resonance and sharpness of resonance; Q-factor.

Recommended Books:

1. R Sengupta and H. Chatterjee: *A Treatise on General Properties of Matter*, New Central Agency, Calcutta.
2. D.S. Mathur: *Elements of Properties of Matter*, S. Chand & Co.
3. R P Feynman, R B Leighton and M Sands: *The Feynman Lectures in Physics*, Vol.1, B I Publications.
4. S. Garg, C.K. Ghosh, S. Gupta: *Oscillations and Waves*, PHI India Ltd
5. L. Pachuau and L. Sailo: *A Textbook of Properties of Matter, Oscillations and Acoustics*, PUC and GSC joint publication.

Second Semester (Major/Minor)
Name of Paper: Basic Electronics
Course No: PHY161*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Understand intrinsic and extrinsic semiconductors, carrier mobility, drift velocity and fabrication of PN junctions. • Apply PN junction diodes in rectifiers, voltage regulators and special diode applications. • Understand BJT characteristics, biasing methods and basic amplifier configurations. • Analyse and design basic OPAMP circuits such as inverting and non-inverting amplifiers. • Perform binary number operations and analyse digital logic circuits using Boolean algebra and logic gates. • Explain the working of CRO and its applications in waveform analysis.

Unit-1: Semiconductors and Diodes (10 Lectures)

Semiconductors: Intrinsic and extrinsic semiconductors; P-type and N-type semiconductors; qualitative idea of Fermi level.

PN junction diode: Formation of depletion layer; electric field and potential barrier; forward and reverse bias; current-voltage characteristics; static and dynamic resistance.

Special diodes: Zener diode (voltage regulation), LED and photodiode (working and applications).

Rectifiers and power supply: Half-wave and full-wave rectifiers; ripple factor and rectification efficiency (derivations); basic idea of filter circuits (L, C and π filters); regulated power supply (block diagram only).

Unit 2: Bipolar Junction Transistors and Amplifiers (10 Lectures)

Transistor basics: Structure and working of PNP and NPN transistors; transistor currents and their relations.

Configurations: CB, CE and CC configurations; input and output characteristics; current and voltage gains; active, cutoff and saturation regions.

Biasing and stabilization: DC load line; operating point (Q-point); voltage divider bias circuit for CE amplifier.

Transistor amplifiers: CE amplifier; RC coupled amplifier; voltage gain and frequency response.

Unit 3: Operational Amplifiers and Oscillators (10 Lectures)

Operational Amplifier: Characteristics of ideal OPAMP; inverting amplifier; non-inverting amplifier; voltage follower; summing amplifier; integrator and differentiator (basic circuits and working).

Oscillators: Barkhausen criterion; Tank circuit; RC phase shift oscillator; Hartley and Colpitts oscillator (circuit and working principle).

Unit 4: Digital Electronics and CRO (10 Lectures)

Boolean algebra and number systems: Binary number system; conversion from one number system to another; binary addition and subtraction; Boolean algebra; De Morgan's theorem.

Logic gates: AND, OR, NOT, NAND, NOR and XOR gates; truth tables; combination of logic gates, Sum of product rules, Product of Sum.

Cathode Ray Oscilloscope: Block diagram of CRO, construction of CRT, electron gun, electrostatic focusing and deflection (no mathematical treatment), applications in waveform study and measurement of voltage, frequency and phase difference.

Recommended Books:

1. R.L. Boylestad, L. Nashelsky, *Electronic Devices and Circuit Theory*, Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, *Electronic Devices and Circuits*, McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, *Solid State Electronic Devices*, Pearson Education India, 2015.
4. Remlalsiama, et. al., *Basic Electronics*, South Eastern Book Agencies, Guwahati.

Second Semester (Multidisciplinary)

Name of Paper: Physics for All
Course No: PHY110

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 3

Course Outcome: • *Understand how scientific ideas about motion and the universe evolved over time.* • *Explain basic laws of motion using everyday examples.* • *Describe the structure and evolution of the universe in simple terms.* • *Relate concepts of sound and light to daily life and technology.* • *Develop scientific awareness and critical thinking skills.*

Unit 1: How Humans Learned the Laws of Nature (10 Lectures)

Early ideas about nature and motion: How ancient thinkers explained the world – ideas of Aristotle and Plato; contributions of Archimedes; Indian contributions of Aryabhata and Bhaskara; the geocentric model of the universe and why people believed Earth was at the center of the universe.

The Scientific Revolution: Copernicus and the heliocentric model; observations of Tycho Brahe and laws of planetary motion by Kepler; Galileo's experiments and the importance of questioning authority.

Newton and the laws of motion: Newton's three laws of motion explained through simple daily examples (walking, vehicles, sports, falling objects); how these laws helped explain both earthly motion and planetary motion.

Unit 2: The Universe and Our Place in It (10 Lectures)

The universe at a glance: Age and size of the universe (conceptual idea); the solar system; the Milky Way; billions of galaxies; our place in the cosmos.

Life cycle of stars: How stars are formed; how they shine; stages in their life; simple idea of white dwarfs, neutron stars and black holes.

Origin and evolution of the universe: Basic idea of the Big Bang theory; expansion of the universe; alternative ideas such as the Steady State theory; simple discussion on how scientific understanding changes with new evidence.

Unit 3: Motion, Sound and Light in Everyday Life (10 Lectures)

Motion around us: Distance and displacement; speed; relative motion (examples from trains, buses and rain); acceleration; force and its effects; practical understanding of motion in everyday situations.

Sound and light around us: Vibrations and simple oscillations; frequency and pitch of sound; musical notes; colours of visible light; basic idea of the electromagnetic spectrum and its role in communication, medicine and daily technology.

Recommended Books/ Suggestion for Reading:

1. Stephen Hawking, *The Universe in a Nutshell*, Bantam Press, 2001.
2. G. Srinivasan, *What are the Stars?* Orient Blackswan Private Limited - New Delhi, 2011.
3. Pankaj Saxena, *Basic Physics*, Notion Press, 2023.
4. Bruce Henderson, *Introductory Physics*, Discovery Publishing House, India, 2024

Third Semester (Major)
Name of Paper: Heat and Thermodynamics
Course No: PHY200

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4
Theory Credit: 3

Course Outcome: • *Understand the fundamental laws of thermodynamics, entropy and thermodynamic temperature scale.* • *Apply thermodynamic potentials and Maxwell's relations to derive important thermodynamic relations.* • *Explain the kinetic theory of gases, equipartition of energy and Maxwell–Boltzmann distribution.* • *Analyse transport phenomena, mean free path and Brownian motion, relating macroscopic thermodynamics to microscopic behaviour.*

Unit–1: Laws of Thermodynamics (10 Lectures)

Fundamental laws: Zeroth law of thermodynamics, thermodynamic equilibrium, First law of thermodynamics, work and heat, reversible and irreversible processes.

Heat engines: Carnot cycle, Carnot engine and its efficiency, Carnot theorem, Second law of thermodynamics and Kelvin–Planck and Clausius statements.

Entropy: Entropy as a state function, Clausius theorem, principle of increase of entropy, thermodynamic temperature scale, Third law of thermodynamics and unattainability of absolute zero.

Unit–2: Thermodynamic Potentials and Applications (10 Lectures)

Thermodynamic potentials: Internal energy, enthalpy, Helmholtz free energy, Gibbs free energy, natural variables and physical significance.

Maxwell's relations: Derivation of Maxwell's relations, TdS equations, latent heat equation (Clapeyron equation), variation of internal energy with volume.

Specific heats: Relation between C_P and C_V for ideal and real gases, variation of C_V with volume and C_P with pressure.

Unit–3: Kinetic Theory of Gases (10 Lectures)

Ideal gas: Postulates of kinetic theory, expression for pressure, kinetic interpretation of temperature, equipartition of energy, rms speed, specific heats of monoatomic, diatomic and triatomic gases, isothermal and adiabatic processes.

Real gases: Van der Waals equation of state, critical constants; reduced equation of state.

Maxwell–Boltzmann distribution: Law of distribution of molecular velocities, most probable, average and rms velocities; energy distribution law (qualitative discussion).

Unit–4: Transport Phenomena and Non-equilibrium Processes (10 Lectures)

Mean free path: Deduction of mean free path, collision probability, distribution of free path.

Transport phenomena in gases: Elementary kinetic theory of viscosity, thermal conductivity and diffusion, dependence on temperature and pressure.

Brownian motion: Experimental observations, Einstein's theory (outline only).

Heat conduction: Thermal conductivity and thermal diffusivity, differential equation of one-dimensional heat flow, Ingen-Hauz experiment.

Recommended Books:

1. M. N. Saha and B. N. Srivastava: *A Textbook on Heat*, The Indian Press, (latest edition)
2. P. K. Chakaraborty: *Advanced Text Book on Heat*, Modern Book Agency, Kolkata.
3. D. S. Mathur: *Fundamentals of Heat*, S. Chand & Co. (latest edition)
4. M. W. Zemansky: *Heat and Thermodynamics*, Student Edition – McGraw Hill Ltd.
5. F.W. Sears: *Thermodynamics*, Addison-Wesley Publications.
6. Brij Lal and N. Subrahmanyam: *Heat and Thermodynamics*, S.Chand& Co. Ltd.
7. S. K. Roy: *Thermal Physics*, New Age International (P) Ltd.
8. S. Lokanathan & R.S. Gambhir: *Statistical Mechanics & Thermal Physics*, PHI (2007)

Third Semester (Major)
Name of Paper: Heat and Thermodynamics (Lab-1)
Course No: PHY200P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. A minimum of 5 experiments must be performed by the students during the semester.

1. To determine the resistance of a lamp at room temperature and when incandescent.
2. Determine the specific heat of a liquid by the method of cooling.
3. Determine the coefficient of apparent expansion of a liquid by weight thermometer.
4. Verification of Stefan's law.
5. Determine the pressure coefficient by using a constant volume thermometer.
6. Determine the value of mechanical equivalent of heat by Joule's electrical calorimeter.
7. Determine the coefficient of linear expansion of a rod by optical lever method.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata
5. C. R. Dasgupta: *A Textbook of Practical Physics*, Book Syndicate(P) Ltd, Kolkata

Third Semester (Major/Minor)
Name of Paper: Ray Optics & Optical Instruments
Course No: PHY201*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Understanding the phenomenon of reflection and refraction of light. • Concept of image formation in mirrors and lenses. • Thick lens and associated aberrations. • Understanding the workings of basic optical instruments: Microscope, eye-piece, telescope, camera and human eye.

Unit 1: Basic Optics (10 Lectures)

Fermat's principle and reflection: Fermat's principle and its application to the laws of reflection, reflection at plane and spherical surfaces, mirror formula and magnification.

Refraction at spherical surfaces: Fermat's principle and laws of refraction, refraction at convex and concave spherical surfaces, derivation of refraction formula at a spherical surface.

Thin lenses and combination of media: Thin lens, image formation by ray method, lens formula and magnification; Lens maker's formula.

Unit 2: Thick Lens and Lens Combinations (10 Lectures)

Thick lens: Principal planes, principal foci and focal lengths, cardinal points and their significance (without full matrix treatment), Newton's formula, magnification by a thick lens.

Combination of lenses: Equivalent focal length of two thin lenses in contact and separated by a distance, power of a lens, equivalent power of lens combinations, Magnification by a thick lens.

Unit 3: Aberrations, Dispersion and Scattering (10 Lectures)

Monochromatic Aberrations: Spherical aberration, calculation of spherical aberration, Coma, Astigmatism and Distortion, methods of reduction.

Aplanatism: Aplanatic surface and points, Abbe's oil immersion objective.

Chromatic aberration: Dispersion and dispersive power, chromatic aberration in lens, achromatism of two lenses in contact, achromatic prism, dispersion without deviation and deviation without dispersion.

Scattering of light: Basic concept of scattering, Rayleigh scattering, qualitative explanation of rainbow formation.

Unit 4: Optical Instruments (10 Lectures)

Eyepieces: Huygens and Ramsden eyepieces, construction, working and magnifying power.

Microscope: Working of Compound microscope, magnifying power.

Telescopes: Astronomical and Terrestrial telescopes; refracting and reflecting telescopes; magnifying power.

Camera: Basic construction and working; telephoto and zoom lenses (qualitative treatment), Human eye, defects of vision (myopia, hypermetropia, astigmatism) and their correction.

Recommended Books:

1. A.B. Gupta: *Modern Optics*, Books and Allied (P) Ltd. Kolkata, 2013.
2. Ajoy Ghatak: *Optics*, Tata McGraw Hill, 7e 2020.
3. B. Ghosh and K. G. Majumdar: *A Text Book on Light*, Shreedhar Publishers, 2017.
4. L. Sailo, *et al.*, *Fundamentals of Optics*, South Eastern Book Agencies, Guwahati.

Course Outcome: • *Understand how scientific ideas about motion and the universe evolved over time.* • *Explain basic laws of motion using everyday examples.* • *Describe the structure and evolution of the universe in simple terms.* • *Relate concepts of sound and light to daily life and technology.* • *Develop scientific awareness and critical thinking skills.*

Unit 1: How Humans Learned the Laws of Nature (10 Lectures)

Early ideas about nature and motion: How ancient thinkers explained the world – ideas of Aristotle and Plato; contributions of Archimedes; Indian contributions of Aryabhata and Bhaskara; the geocentric model of the universe and why people believed Earth was at the center of the universe.

The Scientific Revolution: Copernicus and the heliocentric model; observations of Tycho Brahe and laws of planetary motion by Kepler; Galileo's experiments and the importance of questioning authority.

Newton and the laws of motion: Newton's three laws of motion explained through simple daily examples (walking, vehicles, sports, falling objects); how these laws helped explain both earthly motion and planetary motion.

Unit 2: The Universe and Our Place in It (10 Lectures)

The universe at a glance: Age and size of the universe (conceptual idea); the solar system; the Milky Way; billions of galaxies; our place in the cosmos.

Life cycle of stars: How stars are formed; how they shine; stages in their life; simple idea of white dwarfs, neutron stars and black holes.

Origin and evolution of the universe: Basic idea of the Big Bang theory; expansion of the universe; alternative ideas such as the Steady State theory; simple discussion on how scientific understanding changes with new evidence.

Unit 3: Motion, Sound and Light in Everyday Life (10 Lectures)

Motion around us: Distance and displacement; speed; relative motion (examples from trains, buses and rain); acceleration; force and its effects; practical understanding of motion in everyday situations.

Sound and light around us: Vibrations and simple oscillations; frequency and pitch of sound; musical notes; colours of visible light; basic idea of the electromagnetic spectrum and its role in communication, medicine and daily technology.

Recommended Books/ Suggestion for Reading:

1. Stephen Hawking, *The Universe in a Nutshell*, Bantam Press, 2001.
2. G. Srinivasan, *What are the Stars?* Orient Blackswan Private Limited - New Delhi, 2011.
3. Pankaj Saxena, *Basic Physics*, Notion Press, 2023.
4. Bruce Henderson, *Introductory Physics*, Discovery Publishing House, India, 2024

Fourth Semester (Major)
Name of Paper: Mathematical Physics-II
Course No: PHY260

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4
Theory Credit: 3

Course Outcome: • Acquire knowledge to solve ordinary and partial differential equations with the examples of important partial differential equations in Physics. • Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their applications in various physical problems such as in quantum mechanics which the students will learn in future courses in detail.

Unit-1: Ordinary Differential Equations (10 Lectures)

First-order differential equations: Separation of variables, homogeneous equations, exact differential equations without reducible form, linear differential equation.

Second-order differential equations: Linear homogeneous differential equations with constant coefficients, complementary function and particular integral, Wronskian and linear independence of solutions.

Unit-2: Partial Differential Equations (10 Lectures)

Formation and solution of PDEs: Method of separation of variables.

One-dimensional problems: One-dimensional heat equation, one-dimensional wave equation, equation of vibrating string, solution of wave equation by D'Alembert's method.

Laplace's equation: Laplace's equation in two dimensions (Cartesian coordinate only); solution by separation of variables in simple cases.

Unit-3: Special Functions – I (10 Lectures)

Legendre polynomials: Legendre differential equation (no series solution), generating function, explicit forms of first few polynomials, recurrence relations, Rodrigues formula and orthogonality (statements only), expansion of functions in Legendre polynomials.

Hermite polynomials: Hermite differential equation (no series solution), generating function, first few Hermite polynomials, Rodrigues formula and orthogonality (statements only), First few polynomials.

Unit-4: Special Functions – II (10 Lectures)

Bessel functions: Bessel's differential equation (no series solution), Bessel functions of first kind, recurrence relations, orthogonality (statement only), integrals involving $J_0(x)$ and $J_n(x)$.

Laguerre polynomials: Laguerre differential equation (no series solution), generating function; Rodrigues formula and orthogonality (statement only).

Recommended Books:

1. B.D. Gupta: *Mathematical Physics*, Vikas Publishing House.
2. RK Gupta and HC Sharma: *Mathematical Physics*, Meenakshi Prakashan.
3. H.K. Das: *Mathematical Physics*, S. Chand & Co. (latest edition)
4. G. B. Arfken and H.J. Weber: *Mathematical Methods for Physicists*, Academic Press, 6th Ed.
5. P. K. Chattopadhyay: *Mathematical Physics*, Wiley & Sons.
6. Mathews & Walker: *Mathematical Methods of Physics*, W.A. Benjamin, Inc. (latest edition)
7. S. Gurung and L. Sailo: *A Handbook of Mathematical Physics*, PUC and GSC publication (2021).
8. L. Sailo, et. al., *Differential Equations*, South Eastern Book Agencies, Guwahati.

Fourth Semester (Major)
Name of Paper: Mathematical Physics-II (Lab-2)
Course No: PHY260P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. A minimum of 5 experiments must be performed by the students during the semester.

1. To measure unknown resistance by using Post Office Box.
2. Determine the current and voltage in a given network and hence verify Kirchhoff's laws.
3. Use CRO for the study of A.C. supply waveform and compare the frequencies.
4. To determine horizontal component H and the magnetic moment M of a bar magnet with the help of a deflection and vibration magnetometer.
5. To determine the angle of dip at a place by dip circle.
6. Verification of inverse square law in magnetism.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Fourth Semester (Major/Minor)
Name of Paper: Modern Physics
Course No: PHY261*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • *Understand atomic structure, Bohr's theory and X-ray spectra.* • *Explain blackbody radiation and the significance of Planck's quantum hypothesis.* • *Describe matter waves, uncertainty principle and basic ideas of special relativity.* • *Understand thermal and electrical properties of solids using Einstein, Debye and free electron theories.*

Unit-1: Atomic Structure and X-Rays (10 Lectures)

Atomic structure: Determination of e/m by Thomson's method, Millikan's oil drop experiment, Review of Bohr's theory of Hydrogen-like atoms and its limitations.

Electronic configuration: Quantum numbers, degeneracy of atomic orbitals, Pauli exclusion principle, Aufbau principle, Hund's rule.

Positive rays and mass spectrograph: Thomson's method, Aston and Bainbridge mass spectrographs (principle and applications).

X-ray spectra: Hard and soft X-rays, continuous spectrum and Duane–Hunt law, Characteristic X-rays, energy level diagram, Moseley's law and its significance.

Unit-2: Black Body Radiation and Quantum Theory (10 Lectures)

Classical theory: Properties of thermal radiation, Kirchhoff's law, spectrum of blackbody radiation, Stefan–Boltzmann law, Wien's displacement law.

Quantum theory: Planck's radiation law, derivation of Stefan–Boltzmann law and Wien's displacement law from Planck's law, Failure of classical theory and significance of quantum hypothesis, Compton effect, Photo-electric effect.

Unit-3: Matter Waves and Relativity (10 Lectures)

Matter waves: De Broglie hypothesis, wave–particle duality, Phase and Group velocities, Davisson–Germer experiment.

Uncertainty principle: Heisenberg's uncertainty relation, extension to energy–time, applications to non-existence of electrons inside the nucleus, ground state energy and radius of the hydrogen atom.

Special theory of relativity: Galilean invariance, Einstein's postulates, Lorentz transformations (without full derivation), time dilation, length contraction, energy momentum relation, mass–energy equivalence.

Unit-4: Thermal and Electrical Properties of Solids (10 Lectures)

Specific heat of solids: Dulong and Petit's law, Einstein's theory of specific heat and its limitations, Debye T^3 law.

Free electron theory: Classical free electron model, electrical conductivity, relaxation time, mean free path; thermal conductivity, Wiedemann–Franz law.

Introduction to quantum free electron theory: Fermi energy, Fermi velocity (conceptual treatment only).

Recommended Books:

1. Arthur Beiser: *Concepts of Modern Physics*, 2009, McGraw-Hill
2. J.R. Taylor, C.D. Zafiratos, M.A. Dubson: *Modern Physics*, 2009, PHI Learning
3. Thomas A. Moore: *Six Ideas that Shaped Physics: Particle Behave like Waves*, 2003, McGraw Hill
4. E.H. Wichman: *Quantum Physics*, Berkeley Physics, Vol.4., 2008, Tata McGraw-Hill Co.
5. R.A. Serway, C.J. Moses, and C.A. Moyer: *Modern Physics*, 2005, Cengage Learning
6. G. Kaur and G.R. Pickrell: *Modern Physics*, 2014, McGraw Hill

Fifth Semester (Major)
Name of Paper: Electromagnetic Theory
Course No: PHY300

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4
Theory Credit: 3

Course Outcome: • Review of Gauss law and its application. • Articulate knowledge of capacitors and capacitance, dielectric constant and polarization. • Explain Maxwell's modification of Ampere's law, displacement current. • Achieve an understanding of the Maxwell's equations, gauge transformations, scalar and vector potentials, Coulomb and Lorentz gauge, boundary conditions at the interface between different media.

Unit-1: Electrostatics and Dielectrics (10 Lectures)

Gauss's law: Gauss's law in integral form; applications to symmetric charge distributions; electric field at the surface of a conductor.

Electrostatic potential: Relation between electric field and potential; Poisson's and Laplace's equations (statement and physical significance).

Dielectrics: Polarization and polarization vector; bound charges; electric displacement vector **D**; relation between **E**, **P** and **D**; dielectric constant and electric susceptibility; Gauss's law in dielectric medium.

Capacitors: Parallel plate capacitor with dielectric; energy stored in a capacitor.

Unit-2: Maxwell's Equations (10 Lectures)

Continuity equation and Displacement current: Equation of continuity; conservation of charge; Maxwell's modification of Ampere's law; Displacement current.

Maxwell's equations: Maxwell's equations in integral form and their physical significance; differential form of Maxwell's equations.

Electromagnetic potentials and wave equation: Scalar and vector potentials (basic idea); Gauge transformations (Coulomb and Lorentz gauges); electromagnetic wave equation in free space; Poynting theorem and Poynting vector.

Unit-3: Electromagnetic Waves in Media (10 Lectures)

Plane electromagnetic waves: Plane waves in vacuum; transverse nature of electromagnetic waves; relation between electric and magnetic fields; speed of electromagnetic waves in vacuum.

Propagation in dielectrics: Propagation in isotropic dielectric medium; refractive index and dielectric constant; wave impedance.

Propagation in conductors: Relaxation time; attenuation; skin depth.

Unit-4: Reflection and Refraction of Electromagnetic Waves (10 Lectures)

Boundary conditions: Boundary conditions at the interface between two media.

Reflection and refraction: Reflection and refraction of plane electromagnetic waves at a plane dielectric interface; normal incidence and oblique incidence; laws of reflection and refraction.

Fresnel's formulae: Fresnel's formulae for perpendicular and parallel polarization cases; Brewster's law; total internal reflection.

Metallic reflection: Reflection from a conducting surface at normal incidence.

Recommended Books:

1. D.J. Griffiths: *Introduction to Electrodynamics*, 3rd Edition, PHI, New Delhi (2002)
2. J. D. Jackson: *Classical Electrodynamics*, 3rd Ed., John Wiley, 2005.
3. B. B. Laud: *Laser and Non-linear Optics*, Second Edition, New Age International (Pvt.) Ltd., New Delhi, 2005.
4. Lalhriatzuala, et. al., *Electromagnetic Theory*, South eastern Book Agencies, Guwahati (2026).

Fifth Semester (Major)
Name of Paper: Electromagnetic Theory (Lab-3)
Course No: PHY300P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. A minimum of 3 experiments must be performed by the students during the semester.

1. Determine the focal length of two convex lenses and their combination by Displacement method.
2. Determine the magnifying power of a Telescope.
3. Determine the refractive index of a liquid/solid by using a Traveling microscope.
4. Determine the radius of curvature of a convex lens by Newton's rings method
5. Determination of the diameter of a thin wire using laser.
6. Determination of wavelength of laser light using ruler/diffraction grating.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Fifth Semester (Major)
Name of Paper: Classical and Statistical Physics
Course No: PHY301

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4
Theory Credit: 3

Course Outcome: • Acquire the knowledge of the Lagrangian and the Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems. • Understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function. • Ensembles and associated relations. • Derivation of M-B, B-E and F-D distribution laws of particles and their applications.

Unit-1: (10 Lectures)

Constraints, Classification of Constraints, Generalized Co-ordinates, Generalized momenta, Cyclic Co-ordinates, Virtual displacement and principle of virtual work, D'Alembert Principle, Lagrangian and Lagrange's equations, Applications to simple pendulum, harmonic oscillator, Keplerian motion and LC oscillations.

Unit-2: (10 Lectures)

Calculus of variation- Euler- Lagrange Equation, Application of Variational Principle to geodesics and brachistochrone, Principle of least action, Hamilton's principle, Hamilton's equations and its applications to simple pendulum and harmonic oscillator.

Central force problem: Properties and conservation laws, Kepler problem.

Unit-3: (10 Lectures)

The statistical basis of thermodynamics: Probability and thermodynamic probability; principle of equal a priori probabilities, Accessible and inaccessible states. Thermal equilibrium between two systems, beta parameter, probability and entropy, Boltzmann entropy relation,

Ensembles: Canonical, Micro-canonical, Grand canonical ensemble, probability distribution in canonical ensemble, Thermodynamic quantities in canonical ensemble -internal energy, entropy, free energy, partition function. Thermodynamic quantities in grand canonical ensemble - mean particle number, entropy and grand potential.

Unit-4: (10 Lectures)

Maxwell-Boltzmann statistics: Boltzmann canonical distribution law.

Quantum statistics: Phase space, density distribution in phase space and its application to one-dimensional oscillator and free particles, the function $\phi(E)$ and $\Omega(E)$, cases of particles in a box and simple harmonic oscillator, Bose-Einstein and Fermi-Dirac statistics, FD statistics to free electron metals and calculation of Fermi level and Fermi energy.

Recommended Books:

1. H. Goldstein: *Classical Mechanics*, Pearson Education (2011)
2. B. Laud: *Fundamentals of Statistical Mechanics*, New Age Intl. Ltd. (1998)
3. K Huang: *Statistical Mechanics* (2nd Ed) John Wiley & Sons (2002).
4. Brij Lal and N. Subrahmanyam: *Heat and Thermodynamics*, S.Chand & Co. Ltd.
5. L. Sailo, *et. al.*, *Foundations of Mechanics*, South Eastern Book Agencies, Guwahati.

Fifth Semester (Major)
Name of Paper: Classical and Statistical Physics (Lab-4)
Course No: PHY301P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. A minimum of 3 experiments must be performed by the students during the semester.

1. Determine the acceleration due to gravity by Bar pendulum.
2. Determine the frequency of tuning fork by Melde's experiment.
3. Verify laws of vibrations of strings by using a Sonometer.
4. Determine the Young's modulus of a wire by Searle method.
5. Determine the coefficient of viscosity of water by Capillary method.
6. Determination of surface tension of a liquid by Capillary rise method.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Fifth Semester (Major/Minor)
Name of Paper: Wave Optics
Course No: PHY302*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Understand the principles of wave motion and superposition to explain the Physics of interference, diffraction and polarisation. • Understand the working of selected optical instruments like biprism, interferometer and diffraction grating. • Know resolution and resolving power of optical instruments. • Understand the methods of production of LASER and its application.

Unit-1: Interference of Light (10 Lectures)

Interference of light: Principle of superposition, coherent sources; condition for sustained interference. *Division of Wavefront:* Young's double slit experiment, derivation of fringe width and intensity, Fresnel biprism, determination of wavelength of light and thickness of a transparent sheet. *Division of amplitude:* Interference in thin films (parallel and wedge-shaped films – reflected system only), Newton's rings (derivation of radius formula), determination of wavelength and refractive index.

Unit-2: Interferometers and Lasers (10 Lectures)

Michelson interferometer: Construction and working, determination of wavelength, determination of difference in wavelengths, determination of refractive index of a gas. *Fabry-Perot interferometer (Etalon):* Construction and working, determination of wavelength. *Lasers:* Spontaneous and stimulated emission, Einstein's A and B coefficients and their relations, population inversion and metastable states, pumping schemes, conditions for laser action; three-level and four-level laser systems (qualitative only), basic principles of He-Ne laser and semiconductor laser.

Unit-3: Diffraction (10 Lectures)

Fresnel diffraction: Half-period zones, zone plate, diffraction at a straight edge, diffraction at a narrow wire. *Fraunhofer diffraction:* Single slit diffraction (derivation of intensity distribution), double slit diffraction (intensity and visibility), plane transmission diffraction grating, grating equation, dispersive power.

Unit-4: Polarization and Resolving Power (10 Lectures)

Resolving power: Rayleigh's criterion of resolution, resolving power of telescope, resolving power of diffraction grating (without derivation). *Polarization:* Plane, circular and elliptical polarization, polarization by reflection, Brewster's law, Malus' law, polarization by double refraction, anisotropic crystals, Nicol prism. *Optical rotation:* Optical activity, Fresnel's explanation of optical rotation (qualitative), specific rotation, Faraday effect and Faraday's law.

Recommended Books:

1. A. K. Ghatak: *Physical Optics*, Tata McGraw-Hill
2. D. P. Khandelwal: *Optics and Atomic Physics*, Himalaya Publishing House (1988).
3. K. D. Maller: *Optics*, Oxford University Press.
4. L. Sailo, *et al.*, *Fundamentals of Optics*, South Eastern Book Agencies, Guwahati.

Course Outcome: • Knowledge of Quantum theory formulation through Schrodinger equation. • Understanding wave function of quantum particle and probabilistic nature of its location and subtler points of quantum phenomena. • Operator formalism in quantum mechanics, angular momentum operators. • Through understanding of the behaviour of quantum particle encountering different physical situations, solving non-relativistic hydrogen atom.

Unit-1: Foundations of Quantum Mechanics (10 Lectures)

Postulates and wave mechanics: Basic postulates and mathematical formalism; state function and probabilistic interpretation; normalization and boundary conditions; operators and observables; commutators and uncertainty principle.

Schrödinger equation: Time-dependent and time-independent Schrödinger equations; stationary states and eigenvalue problems.

One-dimensional applications: Particle in an infinite potential well; finite potential well (bound and unbound states); potential step; reflection and transmission; quantum tunnelling.

Unit-2: Linear Vector Space and Operator Formalism (10 Lectures)

Linear vector space: Linear combinations; linear dependence and independence; basis and orthonormal basis; Gram-Schmidt orthogonalization, inner product; expansion of arbitrary state; Hilbert space (basic ideas).

Dirac formalism: Bra-ket notation; matrix representation of states and operators.

Operator method: Linear operators; eigenvalues and eigenfunctions; Hermitian operators and their properties; commutator algebra; expectation values; Ehrenfest theorem.

Unit-3: Angular Momentum and Three-Dimensional Quantum Systems (10 Lectures)

Orbital angular momentum: Operators L^2 and L_z ; eigenvalues and eigenfunctions; spatial quantization; ladder operators (basic idea); orbital magnetic moment; Bohr magneton.

Three-dimensional systems: Particle in a three-dimensional cubical box; degeneracy of energy levels.

Spin angular momentum: Pauli spin matrices; eigenvalues and eigenfunctions; spin magnetic moment.

Unit-4: Central Potentials and the Hydrogen Atom (10 Lectures)

Harmonic oscillator: Quantum mechanical treatment of Linear harmonic oscillator; energy eigenvalues and eigenfunctions; zero-point energy.

Spherically symmetric potentials: Separation of variables in spherical polar coordinates (outline).

Hydrogen atom: Schrödinger equation in spherical polar coordinates; separation into radial and angular equations; solution of angular part, outline of radial equation solution; quantization of energy; energy levels and degeneracy; physical significance of principal, orbital and magnetic quantum numbers.

Recommended Books:

1. D.J. Griffiths: *Introduction to Quantum Mechanics*, Pearson Education (2nd Edition)
2. Nouredine Zettili: *Quantum Mechanics: Concepts and Applications*, John Wiley & Sons
3. R. Shankar: *Principles of Quantum Mechanics*, 2nd Ed., Springer, 2008.
4. E. Merzbacher: *Quantum Mechanics*, 3rd Ed., John Wiley & Sons, 1998.
5. R. Liboff: *Introductory Quantum Mechanics*, Pearson Education (2006)
6. Lalhriatzuala, *et. al.*, *Quantum Mechanics*, South Eastern Book Agencies, Guwahati (2026).
7. Feynman, Leighton, Sands: *The Feynman Lectures on Physics - Volume III*
8. Arthur Beiser: *Modern Physics*, McGraw Hill Company.
9. G. Aruldas: *Quantum Mechanics*, Prentice Hall of India (2002)
10. Arup Kumar: *Introductory Quantum Mechanics*, Levant Books India (2026)

Sixth Semester (Major)
Name of Paper: Quantum Mechanics (Lab-5)
Course No: PHY360P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. A minimum of 5 experiments from each Group must be performed by the students during the semester.

1. Draw the characteristics curves of semiconductor diode.
2. To study the characteristics of a Zener diode
3. To determine the energy gap of a Semiconductor diode.
4. To study the various Transistor biasing configurations.
5. Study the static characteristics of a transistor in CE/CB configuration
6. Study the dynamic characteristics of a transistor in CE/CB configuration
7. To determine the reduction factor of a Tangent galvanometer and hence the value of H.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata
5. K K Dey & B N Dutta: *Practical Physics*, Kalyani Publishers (latest edition)
6. B.L. Flint and H.T. Worsnop: *Advanced Practical Physics for students*, 1971, Asia Publishing House.
7. Michael Nelson and Jon M. Ogborn: *Advanced level Physics Practicals*, 4th Edition, 1985, Heinemann Educational Publishers.
8. I. Prakash & Ramakrishna: *A Text Book of Practical Physics*, 11th Ed., 2011, Kitab Mahal

Sixth Semester (Major)

Name of Paper: Atomic and Molecular Physics

Course No: PHY361

Credit: 4

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Theory Credit: 3

Course Outcome: • *Review of Bohr's atomic model, Sommerfeld's model, shortcomings.* • *Vector model, spin-orbit coupling, coupling schemes.* • *Understanding effect of electric and magnetic field: Zeeman, Paschen-Back and Stark effect.* • *Acquire knowledge of Molecular spectra: Rotational, vibrational and electronic spectra.*

Unit-1: Atomic Models and Vector Atom Model (10 Lectures)

Early atomic models: Review of Bohr's atomic model; shortcomings; Sommerfeld's elliptical orbits; relativistic correction; limitations of Sommerfeld model.

Vector atom model and fine structure: Magnetic moments of the atom; Larmor precession (statement and physical meaning), Spatial quantization; electron spin; spin-orbit interaction; Stern-Gerlach experiment; quantum numbers and their physical interpretation; selection rules; Fine structure of hydrogen and alkali spectra; doublet structure and its explanation.

Coupling schemes: L-S and J-J coupling (non-equivalent electron).

Unit-2: External Field Effects and X-Rays (10 Lectures)

Zeeman effect: Classical theory of normal Zeeman effect; quantum theory of normal Zeeman effect; anomalous Zeeman effect for one-electron system; Paschen-Back effect.

Stark effect: Linear and quadratic Stark effect (qualitative treatment).

X-rays: Continuous and characteristic X-ray spectra; Moseley's law; fine structure of X-ray levels; X-ray fluorescence and Auger effect.

Unit-3: Molecular Rotation and Vibration Spectra (10 Lectures)

Born-Oppenheimer approximation: Physical basis and significance.

Rotational spectra: Rigid rotator model; energy levels; selection rules; rotational spectra; non-rigid rotator; determination of bond length (HCl, CO, N₂).

Vibrational spectra: Diatomic molecule as harmonic oscillator; anharmonic oscillator; energy levels and selection rules; vibration-rotation interaction and basic spectral features.

Unit-4: Electronic Spectra and Raman Effect (10 Lectures)

Electronic states of diatomic molecules: Electronic configurations and term symbols of homonuclear diatomic molecules; electronic band systems; sequences and progressions in emission and absorption; Franck-Condon principle; selection rules.

Rotational fine structure: P, Q and R branches; Fortrat diagram (interpretation only).

Raman effect: Classical and semi-quantum explanation; rotational and vibrational Raman spectra; comparison of infrared and Raman spectroscopy.

Recommended Books:

1. H. S. Mani and G K Mehta: *Introduction to Modern Physics*, Affiliated East-West Press.
2. Gupta, Kumar and Sharma: *Elements of Spectroscopy*, PragatiPrakashan.
3. G. M. Barrow: *Molecular Spectroscopy*, McGraw Hill Book Co.
4. H. Barrow: *Theory of Atomic Spectra*
5. Harvey E. White: *Introduction to Atomic Spectra*, McGraw Hill Book Co.
6. G. Aruldhass: *Modern Physics*, PHI India Ltd.
7. E. Murugesan: *Modern Physics*, S. Chand & Co.

Sixth Semester (Major)
Name of Paper: Atomic and Molecular Physics (Lab-6)
Course No: PHY361P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. A minimum of 5 experiments from each Group must be performed by the students during the semester.

1. Determine the value of e/m of electron (any method).
2. Determine the unknown resistance by Metre bridge.
3. Determine the resistance per unit length of a wire by Carey Foster's method.
4. Calibration of an ammeter and a voltmeter by using a potentiometer.
5. Determine the ECE of copper by using a potentiometer
6. Draw the plateau of a GM counter and carry out the statistical analysis.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata
5. K K Dey & B N Dutta: *Practical Physics*, Kalyani Publishers (latest edition)
6. B.L. Flint and H.T. Worsnop: *Advanced Practical Physics for students*, 1971, Asia Publishing House.
7. Michael Nelson and Jon M. Ogborn: *Advanced level Physics Practicals*, 4th Edition, 1985, Heinemann Educational Publishers.
8. I. Prakash & Ramakrishna: *A Text Book of Practical Physics*, 11th Ed., 2011, Kitab Mahal

Name of Paper: Mathematical Physics - III

Course No: PHY362

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Review of complex numbers, complex functions, analyticity, Cauchy-Riemann equation. • Taylor's and Laurent's series, poles and residues. • Understand Residue theorem and techniques of contour integration. • Acquire knowledge of Integral transforms, Fourier and Laplace transforms and their application in solving physical problems. • Knowledge of Dirac delta function and its properties.

Unit I: Complex Variable-I (10 Lectures)

Functions of a complex variable: Limits and continuity; differentiability; analytic functions; Cauchy-Riemann equations in Cartesian form and polar form (proof and applications).

Series expansions and singularities: Taylor and Laurent series expansions (without proof); Milne-Thomson method for construction of analytic functions; Classification of isolated singularities.

Unit II: Complex Variable-II (10 Lectures)

Complex integration: Curves and contours in the complex plane; parametrization of contours; complex line integrals; path independence (basic idea).

Cauchy's theorems: Cauchy-Goursat theorem and its applications; Cauchy's integral formula (statement only) and its applications.

Residues and contour integration: Residues at simple poles and poles of order two; Cauchy's residue theorem (statement only) and its applications; evaluation of real definite integrals using contour

integration around a unit circle and integrals of the standard forms: $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} dx$, and $\int_0^{\infty} \frac{\sin mx}{x} dx$;

Jordan's lemma (statement only).

Unit III: Fourier Transforms (10 Lectures)

Fourier integrals: Fourier integral theorem; different forms of Fourier integrals and their applications.

Fourier transforms: Definition of Fourier transform and inverse Fourier transform; Fourier sine and cosine transforms; properties of Fourier transforms; Fourier transform of derivatives, applications in solving differential equations.

Dirac delta function: Definition and properties; Fourier transform of delta function and simple problems.

Unit-IV: Laplace Transforms (10 Lectures)

Laplace transform: Definition and properties, Laplace transform of derivatives and periodic function.

Inverse Laplace transform: Methods of finding inverse transforms; residue method, method of partial fractions; Convolution theorem (without proof).

Applications: Evaluation of definite integrals; solution of ordinary differential equations with initial conditions using Laplace transform.

Recommended Books:

1. B.D. Gupta: *Mathematical Physics*, Vikas Publishing House.
2. RK Gupta and HC Sharma: *Mathematical Physics*, MeenakshiPrakashan.
3. H.K. Das: *Mathematical Physics*, S. Chand & Co. (latest edition)
4. P. K. Chattopadhyay: *Mathematical Physics*, Wiley & Sons.
5. Mathews & Walker: *Mathematical Methods of Physics*, W.A. Benjamin, Inc. (latest edition)
6. S. Gurung and L. Sailo: *A Handbook of Mathematical Physics*, PUC and GSC publication (2021).

Name of Paper: Nuclear and Particle Physics

Course No: PHY363*

Credit: 4

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Theory Credit: 4

Course Outcome: • Understand the general properties of nuclei, binding energy, binding energy curve, semi-empirical mass formula and stability of nuclei. • Explain basic nuclear models and their role in describing nuclear structure – liquid drop and shell model. • Describe radioactivity, alpha, beta and gamma decay processes, Geiger–Nuttall law, beta spectrum, and interaction of gamma rays with matter. • Apply conservation laws to nuclear reactions and evaluate Q-value; understand basic concepts of nuclear fission, fusion and nuclear reactors. • Understand the working principles of particle accelerators and nuclear radiation detectors. • Acquire basic knowledge of cosmic rays, classification of elementary particles, antiparticles and fundamental conservation laws.

Unit-1: Nuclear Structure and Radioactivity (10 Lectures)

General properties of nucleus: Nuclear size, mass and density; binding energy and its variation with mass number; binding energy curve and its significance; semi-empirical mass formula (qualitative discussion and simple applications); neutron–proton ratio and stability curve; odd–even effect in nuclear stability.

Radioactivity: Alpha decay and Geiger–Nuttall law; beta decay (qualitative treatment only), conditions for β^- and β^+ decay and electron capture; beta-ray spectrum; gamma decay and internal conversion; interaction of gamma rays with matter - photoelectric effect, Compton scattering and pair production.

Unit-2: Nuclear Models and Nuclear Reactions (10 Lectures)

Nuclear models: Liquid drop model and shell model (basic features and limitations).

Nuclear reactions: Conservation laws; Q-value and threshold energy; basic idea of reaction cross-section; artificial transmutation.

Nuclear fission and fusion: Nuclear fission (qualitative discussion); concept of chain reaction and critical size; basic idea of nuclear reactor; nuclear fusion and conditions for fusion; Source of stellar energy, p-p and C-N cycle, calculation of fusion energy.

Unit-3: Particle Accelerators and Detectors (10 Lectures)

Particle accelerators: Need for particle accelerators; Van de Graaff accelerator and cyclotron (principle and working); synchrotron (principle and working).

Interaction of radiation with matter: Interaction of charged particles and neutrons with matter (qualitative treatment).

Particle detectors: Ionization chamber; Geiger–Müller counter; scintillation counter; basic idea of neutron detection.

Unit-4: Cosmic Rays and Elementary Particles (10 Lectures)

Cosmic rays: Primary and secondary cosmic rays; latitude and altitude effects; air showers (qualitative discussion); origin of cosmic rays.

Elementary particles: Classification into bosons and fermions, leptons, mesons and baryons; antiparticles; fundamental conservation laws (charge, baryon number and lepton number); discovery of strange particles; basic idea of quarks - flavour and colour charge (introductory level).

Recommended Books:

1. Arthur Beiser: *Modern Physics*, McGraw Hill Company.
2. H.S. Mani, G. K. Mehta: *Introduction to Modern Physics*, Tata McGraw Hill Company,
3. D. C. Tayal: *Nuclear Physics*, Himalaya Publishing House (1991)
5. S. N. Ghosal: *Nuclear Physics*, S. Chand & Co. (2006)
6. A. E. S. Green: *Nuclear Physics*, McGraw Hill Book Co., (Latest Edn, Student Ed.)
7. D.J. Griffiths: *Introduction to Elementary Particles*, John Wiley & Sons (1987)

Seventh Semester (Major)
Name of Paper: Solid State Physics
Course No: PHY400

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4
Theory Credit: 3

Course Outcome: • *Brief idea of crystalline and amorphous substances, miller indices, reciprocal lattice and diffraction of X-rays.* • *Knowledge of crystal binding, lattice vibrations, phonons and concept of Brillouin zones.* • *Understanding different types of magnetism dia, para and ferromagnetism, hysteresis loops.* • *Understanding the dielectric and ferroelectric properties of materials.* • *Knowledge of band theory of solids and concept of effective mass.*

Unit-1: (10 Lectures)

Crystal Structure: Periodicity of crystals, unit cells, primitive cells, fundamental translational vectors, symmetry operations: translation, rotational and inversion symmetry, Fundamental types of lattices in 2 and 3-dimensions, Crystal planes, sc, bcc and fcc crystal structure, Miller indices, coordination numbers, atomic packing factor.

X-Ray diffractions: X-ray diffraction by crystal planes, Bragg's law of diffraction, Laue's equations, Reciprocal Lattice and lattice vectors, reciprocal lattice vectors of sc, bcc and fcc, properties of reciprocal lattice vectors, Relation between direct and reciprocal lattice vectors.

Unit-2: (10 Lectures)

Crystal Bonding: Bonding in covalent crystals, ionic crystals, inert gas crystals, metallic crystals and hydrogen bonded crystals and their properties. Madelung energy and Madelung constant in ionic crystals.

Lattice vibration: Elastic vibrations in a continuous media, quantization of lattice vibration, Vibrations of one-dimensional monoatomic and diatomic chain of linear atoms, Dispersion relations, Acoustic and Optical modes of vibrations, concept of Brillouin zones and phonons.

Unit-3: (10 Lectures)

Magnetism in matter: Dia, Para, Ferri and Ferromagnetic Materials. Classical Langevin Theory of diamagnetic and paramagnetic domains, Curie's law, Ferromagnetism, anti-ferromagnetism and Ferromagnetic Domains, Discussion of B-H Curve, Hysteresis and Energy Loss.

Electric field in matter: Polarization vector, potential and field due to a polarized matter, Local Electric Field at an Atom, Depolarization Field, Polar and non-polar molecules, Dielectric Constant, Electric Susceptibility, Polarizability, Classical Theory of Electric Polarizability, Clausius-Mossotti Equation, Normal and Anomalous Dispersion.

Unit-4: (10 Lectures)

Band Theory of Solids: Periodic potential in crystalline solids, Origin of energy bands and Band Gaps, Bloch Theorem, Kronig-Penney Model, Energy (E) versus wave vector (k) relationship, concept of Effective Mass of Electron and Holes, crystal momentum. Distinction between metals, insulator and semiconductor using band theory- effect of temperature, qualitative idea of band structure in solids.

Recommended Books:

1. C. Kittel: *Introduction to Solid State Physics*, 8th Edn., John Wiley & Sons (1999)
2. H.P. Myers: *Introduction to Solid State Physics*, 2nd Edn, Viva Books(P) Ltd. (1998)
3. J.P. Srivastava: *Elements of Solid State Physics*, PHI (2001)
4. H. Ibach and H. Luth: *Solid State Physics*, 2nd Edition, Springer (1996)
5. R.E. Hummel: *Electronic Properties of Materials*, 3rd Edition, Springer (2001)
6. N.W. Ashcroft & N.D. Mermin: *Solid State Physics*, Hault & Saunders (1981)

Seventh Semester (Major)
Name of Paper: Solid State Physics (Lab-7)
Course No: PHY400P

Practical Credit: 1

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 3 experiments is to be performed by the students.

1. Draw the B-H curve of an iron sample.
2. To determine the value of g by Kater's pendulum.
3. Determine the modulus of rigidity of a cylindrical body by statical method
4. Determine the wavelength of monochromatic light by Michelson's interferometer.
5. Measure the width of a single slit from the study of its Fraunhofer diffraction.
6. Determine the wavelength of sodium D-lines by using Fresnel biprism.
7. Determine the refractive index of the material of a prism at different wavelengths by using a spectrometer.
8. Determine the figure of merit of a galvanometer.
9. Determine the number of lines per unit length of the grating by using a spectrometer.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Advance Practical Physics*, New Central Book Agency, Kolkata
5. A. Wadhwa: *Microprocessor 8085: Architecture, Programming and interfacing*, 2010, PHI
6. R.S. Goankar: *Microprocessor Architecture Programming and applications with 8085*, 2002, PHI
7. P.B. Zbar, A.P. Malvino, M.A. Miller: *Basic Electronics: A text lab manual*, 1994, Mc-Graw.
8. R.P. Jain: *Modern Digital Electronics*, 4th Edition, 2010, Tata McGraw Hill.

Name of Paper: Advanced Classical and Quantum Mechanics

Course No: PHY401*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Students will be able to apply Hamiltonian mechanics and central force concepts to analyse classical dynamical systems and motion • Demonstrate understanding of quantum mechanics fundamentals, including angular momentum, spin, symmetries, and time evolution of systems. • Utilize approximation methods and relativistic quantum theories to solve advanced problems in quantum mechanics and scattering.

Unit 1: Hamiltonian formulation and central force problem

Legendre transformations, symmetries and conservation laws in Hamiltonian picture, canonical transformations, Poisson brackets and its applications to simple problems, Hamilton-Jacobi equation, action-angle variables. Central force problem: Two body problem in central force, Equations of motion, effective potential energy, nature of orbits, Virial theorem, condition for closure of orbits, scattering in a central force field. Rigid body, Euler angles, the symmetrical top.

Unit 2: Angular momentum algebra and evolution of quantum system with time

Raising and lowering operators, Clebsch-Gordon Coefficients, spin angular momentum, Pauli matrices, interaction of spin with magnetic field. Identical particles, Pauli exclusion principle, spin-statistics connection.

Evolution of system with time: Equations of motion. Schrödinger picture. Heisenberg picture. Heisenberg's matrix mechanics for linear harmonic oscillator.

Unit 3: Approximation methods

Variational method – Linear Variation Methods, Applications to particle in a 1D box, Time-independent perturbation theory and applications – Stark effect, Fine Structure of Hydrogen, Zeeman Effect. Time dependent perturbation theory and Fermi's golden rule, transition probability, selection rules. WKB approximation, Born-Oppenheimer Approximation.

Unit 4: Relativistic quantum mechanics and Scattering

Relativistic Hamiltonian and Schrodinger equation (with the limitations), Klein-Gordon and its plane wave solution, limitations of KG equation. Dirac equations. Dirac matrices, plane wave solution of the Dirac equation with positive and negative energy states.

Elementary theory of scattering: phase shifts, partial waves, Born approximation.

Recommended Books:

1. H. Goldstein: *Classical Mechanics*, Pearson Education (2011)
2. B.H. Bransden & C.J. Joachain: *Quantum Mechanics*, Pearson Education (2000)
3. D.J. Griffiths: *Introduction to Quantum Mechanics*, Pearson Education (2nd Edition)
4. J.J. Sakurai: *Modern Quantum Mechanics*
5. Eugen Merzbacher: *Quantum Mechanics*, 3rd Ed., Wiley (2003).

Name of Paper: Advanced Nuclear and Particle Physics

Course No: PHY402*

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Understand nuclear forces, interactions, and scattering phenomena. • Analyse nuclear reactions, decay processes, and radiation interactions. • Apply nuclear models and particle physics concepts to explain nuclear structure and fundamental particles.

Unit I: Nuclear forces

Meson exchange theory, properties of nuclear force, the deuteron ground state problem, Nucleon - Nucleon potential and scattering, spin dependence of nuclear forces, scattering cross section, low energy neutron-Proton scattering (scattering length, Phase shift analysis), exchange forces.

Unit II: Nuclear Reactions and radioactive decay

Types of reactions and conservation laws, Reaction Q-values and Thresholds, Breit-Wigner formula, Reaction mechanisms: Direct, pre-equilibrium, compound nucleus theory, reaction cross sections. Radioactivity decay: Theory of alpha, beta and gamma decay and selection rules, neutron induced reactions.

Unit III: Nuclear Models and Particle Accelerators

Liquid drop model, semi-mass empirical formula and its significance. Nuclear Shell, Shell Model, Single particle model of nucleus, spin-orbit coupling prediction of nuclear ground state spin and parity, magnetic moments, electric quadrupole moment.

Particle Accelerators: Linear accelerator, Cyclotron, Synchrotrons.

Unit IV: Fundamental forces and elementary particles

Classification of fundamental forces, classification of elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness etc.), conservation laws, eightfold way of classification, Gell-Mann Nishijima scheme.

Quark model, baryons and mesons. Basic concepts of symmetry arguments to particle reactions, Parity non-conservation in weak interaction.

Recommended Books:

1. Kennet S. Krane: *Introductory Nuclear Physics*, Wiley India Pvt. Ltd. (2011)
2. John M. Blatt and Victor F. Weisskopf: *Theoretical Nuclear Physics*, John Wiley & Sons Inc., (1966)
3. K. Heyde: *Basic Ideas and Concepts in Nuclear Physics*, IOP Publishing Ltd. (2005)

Additional Readings:

1. B.L. Cohen: *Concepts of Nuclear Physics*, Tata McGraw Hill Edition, reprint (2004)
2. S.N. Ghoshal: *Nuclear Physics*, S Chand & Co Ltd. (2010)

Bachelor's Degree (Honours without Research) - Any five
Bachelor's Degree (Honours with Research) - Any one
Eighth Semester (Major)

Name of Paper: Numerical Techniques

Course No: PHY460

Credit: 4

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Theory Credit: 3

Course Outcome: • *Gain basic knowledge of numerical computation: solution of algebraic, transcendental equation.* • *Knowledge of numerical interpolation and various numerical techniques.* • *Use of numerical technique to solve differential equations, boundary value problems.*

Unit-1: (10 Lectures)

Concepts of errors in numerical computation, solution of algebraic and transcendental equation, fixed point iteration method, bisection and Regula Falsi method, Newton-Raphson method, Ramanujan's method, secant method, finite difference operators, differences of a polynomial.

Unit-2: (10 Lectures)

Numerical interpolation, Newton's interpolation formula and Lagrange interpolation formula, interpolation by iteration, numerical differentiation (using Newton's forward and backward formulae), numerical integration, trapezoidal rule, Simpson's 1/3 rule and 3/8 rule, Gauss quadratic formula.

Unit-3: (10 Lectures)

Matrices, Gauss elimination, partial and full pivoting, matrix inversion and Gauss-Jordon method, LU decomposition, LU decomposition from Gauss elimination, solution of linear system of equations-iterative methods (Jacobi's iteration method and Gauss Seidel iteration method), Eigen value problem.

Unit-4: (10 Lectures)

Numerical methods for solutions of ordinary differential equations, Euler's method, Runge-Kutta method, finite difference methods for solving second order two-point linear boundary value problems, solution of 2D Laplace's and Poisson's equations, solution of 1D heat equation and 1D wave equation.

Recommended Books:

1. S.S. Sastry: *Introductory Methods of Numerical Analysis*, Fourth Edition, PHI.
2. S. Sankara Rao: *Numerical Methods of Scientists and Engineer*, 3rd ed., PHI.
3. F.B. Hidebrand: *Introduction to Numerical Analysis*, TMH.
4. J.B. Scarborough: *Numerical Mathematical Analysis*, Oxford and IBH.
5. Suresh Chandra: *Computer Application in Physics*, Narosa Pub. House, New Delhi.

Eighth Semester (Major)
Name of Paper: Numerical Techniques (Lab-8)
Course No: PHY460P

Practical Credit: 1

*One (1) experiment must be performed within 6 hours in the End Semester examination.
Students must perform a minimum of 10 experiments during the semester.*

(Programming using FORTRAN/C++)

1. Write a program to solve a Quadratic Equation.
2. Write a program to calculate matrix addition.
3. Write a program to calculate matrix multiplication.
4. Write a program for differentiation of a function.
5. Write a program for integration of a function.
6. Write a program for solving an algebraic equation by Newton-Raphson method.
7. Write a program for solving an algebraic equation by Bisection method.
8. Solution of transcendental or polynomial equation by Bisection methods
9. Solution of transcendental or polynomial equation by Newton-Raphson methods
10. Solution of transcendental or polynomial equation by False position methods
11. Numerical integration using Trapezoidal method
12. Numerical integration using Simpson/ Gaussian quadrature method
13. Solution of first order differential equation using Runge-Kutta method
14. Linear curve fitting and calculation of linear correlation coefficients
15. Matrix inversion and solution of simultaneous equations
16. Numerical first order differentiation of a given function

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Advance Practical Physics*, New Central Book Agency, Kolkata
5. A. Wadhwa: *Microprocessor 8085: Architecture, Programming and Interfacing*, 2010, PHI
6. R.S. Goankar: *Microprocessor Architecture Programming and Applications with 8085*, 2002, PHI
7. P.B. Zbar, A.P. Malvino, M.A. Miller: *Basic Electronics: A text lab manual*, 1994, Mc-Graw.
8. R.P. Jain: *Modern Digital Electronics*, 4th Edition, 2010, Tata McGraw Hill.
9. V. Rajaraman: *Computer Programming in C*, PHI (2005).
10. C. Xavier: *C Language and Numerical Methods*, New Age Intl. Ltd. (2004).
11. E. Balagurusamy: *Programming in ANSI C*, Tata McGraw Hill Publications.
12. B. Kernigan and D. Ritchie: *The ANSI C Programming Language*, PHI Publications.
13. Y Kanetkar, 2016: *Let us C*, BPB Publications, 15th Edition.
14. Suresh Chandra, 2014: *Computer application in Physics*, Alpha Science Intl. Ltd., 3rd Edn.

Name of Paper: Materials Science and Nanomaterials

Course No: PHY461

Credit: 4

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Theory Credit: 3

Course Outcome: • *Understand the structure and properties of materials, bonding in crystals.* • *Basic idea of thin films and thin film deposition techniques.* • *Application of coating as finishes.* • *Brief history and overview of nanomaterials, nanostructures in nature.* • *Surface effect of nano materials, band structure and density of states in nano scale, charge carrier, mobility and conductivity of states in reduced dimension system. Carbon based Nanomaterials.*

Unit-1 (10 Lectures)

Introduction and structure of materials and study of properties of materials, Structure of atoms - Quantum states- atomic bonding in solids- binding energy - interatomic spacing - variation in bonding characteristics - Single crystals – polycrystalline - Non crystalline solids - Imperfection in solids – Schmid's law - Surface imperfection - grain size distribution

Unit-2 (10 Lectures)

Film deposition techniques: Physical method: Sputter deposition of thin films and coatings by RF, MF, DC, Magnetron, Pulsed laser, Ion beam, Ion implantation; Chemical method - electroplating, electroless plating, electro polishing, electroforming, chemical vapour deposition (CVD) and plasma enhanced CVD; Other techniques - Spin coating Inter diffusion, reactions and transformations in thin films.

Unit-3 (10 Lectures)

Applications of coatings as finishes for various substrates: UV resistant, atomic oxygen resistant and antistatic coating; Optical coatings for thermal control application- thermal barrier and thermal protective coating; Self-healing coating, Testing and evaluation of coatings.

Unit-4 (10 Lectures)

Introduction of Nanomaterials: Brief history and overview of nanomaterials, Nanostructures in nature, surface effect of nano materials, band structure and density of states of nano scale, charge carriers mobility and conductivity of states in reduced dimension system. Carbon based Nanomaterials: Nature of carbon bond, Carbon structures, small carbon clusters; Introduction to synthesis and Applications of Fullerenes, Graphene and Carbon nanotubes.

Recommended Books:

1. W. D. Callister, *Materials Science and Engineering: An Introduction*, John Wiley & Sons, 2007.
2. C. Kittel, *Introduction to Solid State Physics*, Wiley Eastern Ltd, 2005.
3. V. Raghavan, *Materials Science and Engineering: A First Course*, Prentice Hall, 2006.
4. M. H. Francombe, S. M. Rossnagel, A. Ulman, *Frontiers of Thin Film Technology*, Vol. 28, Academic press, 2001.
5. R.F. Bunshah, *Deposition Technologies for Films and Coatings*, Noyes Publications, New Jersey.
6. C.P. Poole Jr. and F.J. Oweus, *Introduction to Nanotechnology*, Wiley Interscience.
7. Gregory Timp, *Nano-Technology* (Edition), AIP Press, Springer
8. Pradeep T., *A Textbook of Nanoscience and Nanotechnology*, Tata McGraw Hill Education.
9. Hari Singh Nalwa, *Nanostructured Materials and Nanotechnology*, Academic Press
10. Wonbong Choi and Jo-won Lee (Ed), *Graphene: Synthesis and Applications*
11. M.A. Shah and Tokeer Ahmad: *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House.

*One (1) experiment must be performed within 3 hours in the End Semester examination.
Students must perform a minimum of 6 experiments from each group during the semester.*

1. Determine the self and mutual inductances of a given coil by Carey-Foster's method.
2. Determine the thermal conductivity of a bad conductor by Lee's method.
3. To study the Frequency Response and Voltage Gain of a RC-Coupled Amplifier.
4. Study the Hall effect and determine the Hall coefficient and Hall voltage.
5. Measure the capacitance by de Sauty's method.
6. Determine the thermal conductivity of a metallic rod by Searle's method.
7. To determine the coefficient of viscosity of a liquid by rotating viscometer.
8. Determine the work function and Plank's constant by using a photocell.
9. Study the series and parallel resonance circuits with A.C. source and draw the current frequency curve and calculate Q.
10. Determine the electrolytic conductivity of a substance by Kohlrausch's method
11. Determine the melting point of a wax using a Thermocouple.

Recommended Books

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Advance Practical Physics*, New Central Book Agency, Kolkata
5. A. Wadhwa: *Microprocessor 8085: Architecture, Programming and Interfacing*, 2010, PHI
6. R.S. Goankar: *Microprocessor Architecture Programming and Applications with 8085*, 2002, PHI
7. P.B. Zbar, A.P. Malvino, M.A. Miller: *Basic Electronics: A text lab manual*, 1994, Mc-Graw.
8. R.P. Jain: *Modern Digital Electronics*, 4th Edition, 2010, Tata McGraw Hill.

Course Outcome: • Understand basics of operational amplifier, open and close loop gain. • Secure first-hand idea of different components of an integrated circuit, active and passive components. • Understand fundamental logic gates, combinational, sequential logic and number systems, simplification, and construction of digital circuits by employing Boolean algebra. • Flip-Flop as building blocks, basic idea about memory including RAM, ROM and also about memory organization. • Understanding computer fundamentals, block diagram of communication system.

Unit-1: (10 Lectures)

Structure, working principle and characteristics of JFET and MOSFET, CMOS structure and fabrication basics, logic gates with CMOS

Integrated Circuits: Active and passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Difference between Analog and Digital Circuits.

Unit-2: (10 Lectures)

Boolean algebra and logic circuit simplifications.

Half and Full Adders. Half and Full Subtractors, 4-bit binary Adder/ Subtractor.

Combinational and sequential logic circuits, SR, D, and JK Flip-Flops. Clocked (Level and Edge triggered) Flip-Flops, Preset and Clear operations. Race-around conditions in JK Flip-Flop, M/S JK Flip-Flop. IC 555: block diagram and applications: Astable and Monostable multivibrators.

Unit-3: (10 Lectures)

Shift registers: Serial-in-Serial-out, parallel-in-serial-out and parallel-in-parallel-out shift registers (only up to 4 bits). Counters (4-bits): Ring Counter, Asynchronous counters, decade counter. Synchronous counter.

A/D and D/A converters – basic principles, types of D/A converters and A/D converters. Microprocessor – architecture and organization, basic assembly language concepts, microcontroller basics – architecture and features

Unit 4: (10 lectures)

Block diagram of electronic communication system. Need for modulation. Amplitude modulation. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude modulator. Demodulation of AM wave using diode detector. Basic idea of frequency and phase modulation.

Transducers (temperature, pressure/ vacuum, magnetic fields, vibration, optical, and particle detectors), measurement and control, signal conditioning and recovery.

Recommended Books:

1. Robert Boylestad, Louis Nashelsky: Electronic Devices and Circuit Theory, 8thEdn, Pearson Education, India (2004).
2. A. P. Malvino: Electronic Principles, Glencoe (1993).
3. John Morris: Analog Electronics.
4. Allen Mottershead: Electronic Circuits and Devices, PHI (1997).
5. Ben G. Streetman & Sanjay Banerjee: Solid State Electronic Devices, Pearson Prentice Hall (2006).
6. N. N. Bhargava, D. C. Kulshreshtha & SC Gupta : Basic Electronics & Linear Circuits, Tata McGrawHill (2006).
7. Handbook of Electronics, Gupta and Kumar, S. Chand.
8. Digital Principle & Application, Malvino and Leech

Eighth Semester (Major)
Name of Paper: Digital and Analog Electronics (Lab-10)
Course No: PHY462P

Practical Credit: 1

One (1) experiment must be performed within 3 hours in the End Semester examination. Students must perform a minimum of 10 experiments from each group during the semester.

Group-A

1. To design a combinational logic system for a specified Truth Table.
2. To measure the resistivity of a semiconductor (Ge) with temperature by two-probe method and to determine its band gap.
3. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 °C) and to determine its band gap.
4. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
5. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
6. To build JK Master-slave flip-flop using Flip-Flop ICs
7. To design an astable multivibrator of given specifications using 555 Timer.
8. To design a monostable multivibrator of given specifications using 555 Timer.
9. To verify AND, OR, NOT and XOR gates using NAND gates
10. Study of OP-AMP characteristics
11. OP-AMP as a) Adder and Subtractor b) Differentiator and Integrator.
12. Study of Half Adder, Full Adder and 4 bit Binary Adder.
13. Study of Half Subtractor, Full Subtractor, Adder, Subtractor using Full Adder
14. Study of a simple power circuit with a pi-section filter.
15. To study a CE amplifier of a given gain (mid-gain) using Voltage divider bias.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Advance Practical Physics*, New Central Book Agency, Kolkata
5. A. Wadhwa: *Microprocessor 8085: Architecture, Programming and Interfacing*, 2010, PHI
6. R.S. Goankar: *Microprocessor Architecture Programming and Applications with 8085*, 2002, PHI
7. P.B. Zbar, A.P. Malvino, M.A. Miller: *Basic Electronics: A text lab manual*, 1994, Mc-Graw.
8. R.P. Jain: *Modern Digital Electronics*, 4th Edition, 2010, Tata McGraw Hill.
9. V. Rajaraman: *Computer Programming in C*, PHI (2005).

Eighth Semester (Major)
Name of Paper: Energy Sources and Harvesting
Course No: PHY463

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Review knowledge of energy sources and to learn theories of renewable sources of energy. • Knowledge of Renewable sources of energy such as: (i) off-shore wind energy, (ii) tidal energy, (iii) solar energy, (iv) wave energy, (v) Geo-thermal energy and (vi) hydroelectricity.

Unit 1:

Introduction: Energy concept-sources in general, its significance & necessity.

Classification of energy sources: Primary and Secondary energy, Commercial and Non-commercial energy, Renewable and Non-renewable energy, Conventional and Non-conventional energy, Based on Origin- Examples and limitations. Importance of Non-commercial energy resources.

Renewable 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.

Unit 2:

Conventional energy sources: Fossil fuels & Nuclear energy-production & extraction, usage rate and limitations. Impact on environment and their issues & challenges. Overview of Indian & world energy scenario with latest statistics- consumption & necessity. Need of eco-friendly & green energy & their related technology.

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

Unit 3:

Solar energy: Solar Energy-Key features, its importance, Merits & demerits of solar energy, storage of solar energy, solar pond, non-convective solar pond.

Applications of solar energy: Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell -brief discussion of each. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit 4:

Wind energy: 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.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Recommended Books:

1. G.D Rai: *Non-conventional energy sources*- Khanna Publishers, New Delhi
2. M P Agarwal: *Solar energy*-S.Chand and Co. Ltd.
3. Suhas P Sukhative: *Solar energy* - Tata McGraw - Hill Publishing Company Ltd.
4. P Jayakumar: *Solar Energy: Resource Assessment Handbook*, 2009.

Eighth Semester (Major)
Name of Paper: Plasma Physics
Course No: PHY464

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • Gain knowledge about plasma, plasma temperature and application of plasma.
• Knowledge of magneto-plasma and associated phenomenon, fluid theory of plasma. • Gain knowledge about the nature and composition of atmosphere, concept of sand storms, space weather.

Unit-1: (10 Lectures)

Elementary Concept of Plasma: Definition of Plasma, Plasma as ionized gas, Saha's ionization equation, Concept of Plasma temperature, Debye shielding, Quasi-neutrality, Plasma parameters, Plasma approximation, Hydro dynamical description of plasma, fundamental equations. Occurrence of Plasma, Applications of Plasma in brief with special reference to nuclear fusion and particle acceleration. Single-particle motion, Dynamics of charged particles in electro-magnetic fields, particle drifts, EXB drifts, Grad-B drift, Curvature drift, Polarization drift

Unit-2: (10 Lectures)

Wave phenomena in magneto-plasma: polarization, phase velocity, group velocity, cut off, resonance for electromagnetic wave propagating parallel, perpendicular to magnetic field, Appleton-Hartree formula. Kinetic theory of Plasma: Vlasov equations, Solution of linearized Vlasov equation, Langmuir waves, Wave-particle interaction and Landau damping. Fluid theory of Plasma - Plasma oscillations, Electron-acoustic waves, Ion-acoustic waves. Applications of plasma physics (only theory in brief) to nuclear fusion and particle acceleration.

Unit-3: (10 Lectures)

Atmosphere, atmospheric layers, composition. Elements of Ionosphere and Magnetosphere, structure and density profile, ionosphere-magnetosphere coupling. Structure of the Sun: solar interior, solar atmosphere, photosphere, chromosphere, corona. Sunspots and their properties, Sun-Earth interactions, basic concept of storm and substorm phenomena. Solar activity cycles, solar wind, solar flares, coronal mass ejections (CMEs), Space weather, causes and consequences, space climate.

Unit-4: (10 Lectures)

Stellar structure (equilibrium, nuclear reactions, energy transport) and stellar evolution (with example of our Sun). Chandrasekhar limit for white dwarfs. Neutron stars and Blackholes. Exoplanets. Morphology and types of galaxies: Our Milky Way. Concept of dark matter. Cosmic microwave background radiation. HST and Planck observations. Redshifts. Accelerated expansion of the Universe and current explanations with and without dark energy. Evolution of the Universe.

Recommended Books:

1. Bittencourt, J. A., *Fundamentals of Plasma Physics*, Springer, New York, 2004.
2. Bellan, P. M., *Fundamentals of Plasma Physics*, Cambridge, UK, 2006.
3. Chen, F. F., *Introduction to Plasma Physics and Controlled Fusion*, 2nd ed., Plenum, NY
4. Piel, A., *Plasma Physics: An Introduction to Laboratory, Space and Fusion Plasmas*, Springer, Heidelberg, 2010.
5. Kevilson, M.G. and Russell, C.T., *Introduction to Space Physics*, Cambridge University.
6. Singhal, R.P., *Element of Space Physics*, Prentice Hall of India, New Delhi.
7. BasuBaidyanath, *Introduction to Astrophysics*, Prentice Hall of India, 2013.
8. Frank Shu, *The Physical Universe*, University Science Books.
9. Weinberg, S., *The First Three Minutes*, Basic Books, 1993.
10. Hawking, S.W., *A Brief History of Time*, Bantam, 1995.

Eighth Semester (Major)
Name of Paper: Radiation Safety
Course No: PHY465

Marks Scale: 100 marks

(End Sem.: 75+ Int.: 25)

Credit: 4

Course Outcome: • *Learn the basic aspects of nuclear Physics.* • *Gain knowledge about the nature of interaction of radiation with matter.* • *Gain awareness about the hazards of radiation and the safety measures.* • *The students are expected to learn radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control.*

Unit 1: Basics of Nuclear Physics

Radioactivity: Laws of radioactive disintegration, half-life, mean-life, decay constant. Properties of alpha, beta and gamma rays, Radio-carbon dating.

General properties of Nucleus: Nuclear size, nuclear mass, nuclear density, nuclear charge, Binding energy, stability of nucleus and binding energy, packing fraction.

Nuclear fission: Discovery, energy released in fission, secondary neutrons and their importance, multiplication factor, chain reaction.

Unit 2: Interaction of Radiation with matter

Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photo-electric effect, Compton Scattering, Pair Production.

Beta Particles-Collision and Radiation loss (Bremsstrahlung),

Interaction of Neutrons- Collision, slowing down and Moderation.

Unit 3: Radiation detection and monitoring devices

Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC).

Radiation detection: Basic concept and working principle of gas detectors, Ionization Chambers, Proportional Counter, Geiger-Muller Counter, Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors.

Unit 4: Radiation safety management

Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy).

Recommended Books:

1. G.F.Knoll, *Radiation Detection and Measurements*, Wiley
2. Mcknlly, A.F., Bristol, Adam Hilger, *Thermoluminescence Dosimetry*, (Medical Phys. Handbook 5)
3. W.J. Meredith and J.B. Massey, *Fundamental Physics of Radiology*. John Wand Sons, UK, 1989.
4. J.R. Greening, *Fundamentals of Radiation Dosimetry*, Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
5. G.C. Lowental and P.L. Airey, *Practical Applications of Radioactivity and Nuclear Radiations*, Cambridge University Press, U.K., 2001
6. A. Martin and S.A. Harbisor, *An Introduction to Radiation Protection*, John Willey & Sons, Inc. New York, 1981.

Eighth Semester (Major)
Name of Paper: Research Project
Course No: RPD470

Marks Scale: 100 marks

(Int: 25, ESE: 75)

Credit: 12

Course Outcomes: *Through a supervised project, a student will get exposure to one of the areas of research, preferably of his own choice. During the Project Work, the student will learn about the literature survey, identification of the research problem and then work on the problem during the project duration. The student will get the feel and methodology of the research work and rigorously do focused work in the area of the topic of the major research project chosen. The endeavour will be to prepare the student research-ready in the fourth year of graduation, as the student will have the opportunity to directly enter into the Ph. D. programme immediately after the B.Sc. degree with research. The student will learn to focus and complete desired task within a specified time frame.*

Course Objectives:

- a) To provide student with skill and knowledge in conducting research in fundamental and application aspects of Physics.
- b) To train students in developing analytical as well as argumentative skill.

MARK DISTRIBUTION FOR PROJECT WORK:

Total marks allotted: 100

Distribution of Marks component wise:

Internal Assessment (C1+C2) : 25

As per CCFUP guidelines of MZU(NEP2020)

End Semester Examination : 75

Criteria for End Semester Examination:

Sl. No.	Criteria	Marks
1	Originality and relevance The research is carried out with sufficient originality and creativity	5
2	Purpose and Objective The research problems, questions and objectives are well defined	5
3	Literature Evidence of appropriate selection and discussion of relevant literature	5
4	Methodology Appropriateness and justification of the methodology to achieve the research objectives	10
5	Discussion of findings Discussion of findings reflect learning from analysis and understanding of the implications	10
6	Presentation, Structure & Language The research is presented in an academic style Language used is good and easy to understand Use of appropriate graphics, illustrations and accurate referencing. Well structured, logical and coherent, use appropriate chapter headings.	10
7	Conclusion Conclusions add new insight to the topic of the dissertation and identify clear and practical recommendations/opportunities for further development	10

8	Contribution to knowledge The research produces new results. The results are of interest to academia or industry or otherwise relevant to professionals in the field.	5
9	Viva-Voce Presentation skills (style of presentation, language, structure, completeness and uses of time etc.) Ability to clarify questions	15
	Total	75

Evaluation of the Dissertation:

The Project Work shall be evaluated by a Board of Examiners consisting of Supervisor, Head of concerned Department and an External Examiner approved by COE as per CCFUP guidelines of Mizoram University. The evaluation of the Project Work shall be completed before the commencement of 4th Semester Theory Examinations. The Project Work as evaluated by this Board will be final.

It is to be noted that copy and pasting of articles from internet without proper permission, copying from dissertation or thesis without quoting proper references will not be accepted. If any kind of plagiarism is practised by the student, his/her Project Work shall be liable to be rejected.

Presentation & Viva-Voce:

The presentation of the Project Work will be conducted by the Board of Examiners. Other members of the faculty and students may be present. It will be presentation of 15 minutes duration and 5 minutes for Viva Voce. The logic, analysis and conclusion relevant to the Project Work mentioned under assessment would be the main subject matter for the Viva Voce.