Department of Physics
Mizoram University, Aizawl
School of Physical Sciences

Curriculum and Credit Framework for Under Graduate Programmes (CCFUP)

B.Sc. Physics Syllabus (1st Revision)

under

NEP2020 Guidelines

Date of Approval by AC: 14th June, 2023 [AC:44:4(4)]
Date of Approval 1st Rev. by BOS: 18th Oct., 2024
Date of Approval by 1st Rev. School Board: 4th Nov., 2024
Date of Approval by AC: 25th Nov., 2024 [AC:47:4(5).V]

(To be effective from July 2025)

November – 2024

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

Sem	Course No.	Name of Paper	Marks Scale	Credit	Page No.
1st	PHY100	Mathematical Physics-I	100	4	6
	PHY101*	Electricity Fundamentals	100	4	7
	Minor Course1	*From other subject*	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**	
2nd	PHY160	Mechanics, Properties of Matter and Oscillation	100	4	9
	PHY161*	Basic Electronics	100	4	10
	Minor Course1	*From other subject*	100	4	
	PHY110	Physics For All	100	3	11
	SEC160	Skill Enhancement Course	100	3	
	VAC120	Understanding India	100	2	
			600	**20**	
	UG Certificate				
3rd	PHY200	Heat and Thermodynamics	100	3	12
	PHY201*	Ray Optics and Optical Instruments	100	4	13
	PHY200P	Laboratory-1	100	1	14
	Minor Course1	*From other subject*	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			
			700	**20**	
4th	PHY260	Mathematical Physics-II	100	3	16
	PHY261*	Modern Physics	100	4	17
	PHY260P	Laboratory-2	100	1	18
	Minor Course1	*From other subject*	100	4	
	ENG250	AEC: Grammar and Comprehension Skills	100 *(any one)*	3	
	MIZ250	AEC: Mizo Grammar and Writing Skill			
	HIN250	AEC: Hindi Kampyuting			
	SEC280	Skill Enhancement Course	100	3	
	VAC240	Sports and Fitness	100	2	
	VAC241	Health and Wellness			
	VAC242	Yoga Education			
			700	**20**	
	UG Diploma				
5th	PHY300	Wave Optics	100	3	19
	PHY301	Classical and Statistical Mechanics	100	3	20
	PHY302*	Electromagnetic Theory	100	4	21
	PHY300P	Laboratory-3	100	2	22
	Minor Course1	*From other subject*	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	

			700	**20**	
6th	PHY360	Quantum Mechanics	100	3	23
	PHY361	Nuclear and Particle Physics	100	3	24
	PHY362	Mathematical Physics-III	100	3	25
	PHY363*	Atomic and Molecular Physics	100	4	26
	PHY360P	Laboratory-4	100	3	27
	Minor Course1	*From other subject*	100	4	
			600	**20**	
		Total	***3900***	**120**	
	Bachelor's Degree				
7th	PHY400	Solid State Physics	100	3	28
	PHY401*	Radiation Safety	100	4	29
	PHY402*	Energy Resources and Harvesting	100	4	30
	PHY400P	Laboratory-5	100	1	31
	Minor Course1	*From other subject*	100	4	
	Minor Course2	*From other subject*	100	4	
			600	**20**	

***** *signifies Minor Courses offered for other subjects*

8th	**Bachelor's Degree (Honours without Research)**				
(Any five)	PHY460	Numerical Techniques	100	3	32
	PHY461	Medical Physics	100	3	33
	PHY462	Materials Science and Nanomaterials	100	3	34
	PHY463	Digital Electronics	100	3	35
	PHY464	Plasma Physics	100	3	36
	PHY465	Biological Physics	100	3	37
	PHY460P	Laboratory-6	100	2	38
	PHY461P	Laboratory-7	100	3	39-40
			700	**20**	
		Total	***5200***	**160**	
8th	**Bachelor's Degree (Honours with Research)**				
	PHY460	Numerical Techniques	100	3	32
(Any one)	PHY461	Medical Physics	100	3	33
	PHY462	Material Science and Nano materials			34
	PHY463	Digital Electronics			35
	PHY464	Plasma Physics			36
	PHY465	Biological Physics			37
	PHY460P	Laboratory-6	100	2	38
	RPD470	Research Project/Dissertation	100	12	41-42
			400	**20**	
		Total	***4900***	**160**	

Note: NAEC = 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
1st	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	*From other subject*	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**		
2nd	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	*From other subject*	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**		
3rd	PHY200	Ray Optics and Optical Instruments	25	75	100	3	0	0	**3**	3	-
	PHY201*	Heat and Thermodynamics	25	75	100	4	0	0	**4**	*3*	-
	PHY200P	Laboratory-1	25	75	100	0	0	1	**1**	-	2
	Minor Course 1	*From other subject*	25	75	100	3	0	0	**3**	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	-
					700				**20**		
4th	PHY260	Mathematical Physics-II	25	75	100	3	0	0	**3**	3	-
	PHY261*	Modern Physics	25	75	100	4	0	0	**4**	*3*	-
	PHY260P	Laboratory-2	25	75	100	0	0	1	**1**	-	3
	Minor Course 1	*From other subject*	25	75	100	3	0	0	**3**	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	-
					700				**20**		
5th	PHY300	Wave Optics	25	75	100	3	0	0	**3**	3	-
	PHY301	Classical and Statistical Mechanics	25	75	100	3	0	0	**3**	3	-
	PHY302*	Electromagnetic Theory	25	75	100	4	0	0	**4**	3	-
	PHY300P	Laboratory-3	25	75	100	0	0	2	**2**	-	6
	Minor Course 1	*From other subject*	25	75	100	3	0	0	**3**	3	-
	AEC350	-	25	75	100	2	0	0	**2**	2	-
	IAF300	-	25	75	100	2	0	0	**2**	-	2
					700				**20**		
6th	PHY360	Quantum Mechanics	25	75	100	3	0	0	**3**	3	-
	PHY361	Nuclear and Particle Physics	25	75	100	3	0	0	**3**	3	-
	PHY362	Mathematical Physics-III	25	75	100	3	0	0	**3**	3	-

	PHY363*	Atomic and Molecular Physics	25	75	100	4	0	0	**4**	3	-
	PHY360	Laboratory-4	25	75	100	0	0	3	**3**	-	6
	Minor Course 1	*From other subject*	25	75	100	4	0	0	**4**	3	-
					600				**20**		
				Total		***3900***			**120**		
7th	PHY400	Solid State Physics	25	75	100	4	0	0	**3**	3	-
	PHY401*	Radiation Safety	25	75	100	4	0	0	**4**	3	-
	PHY402*	Energy Resources and Harvesting	25	75	100	4	0	0	**4**	3	-
	PHY400P	Laboratory-5	25	75	100	0	0	1	**1**	-	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	-
					600				**20**		

** signifies Minor Courses offered for other subjects*

Bachelor's Degree (Honours without Research)											
8th	PHY460	Numerical Techniques	25	75	100	4	0	0	**3**	3	-
	PHY461	Medical Physics	25	75	100	4	0	0	**3**	3	-
(Any five)	PHY462	Materials Science and Nanomaterials	25	75	100	4	0	0	**3**	3	-
	PHY463	Digital Electronics	25	75	100	4	0	0	**3**	3	-
	PHY464	Plasma Physics	25	75	100	4	0	0	**3**	3	-
	PHY465	Biological Physics	25	75	100	4	0	0	**3**	3	-
	PHY460P	Laboratory- 6	25	75	100	0	0	2	**2**	-	3
	PHY461P	Laboratory- 7	25	75	100	0	0	3	**3**	-	3
					700				**20**		
		Total		***5200***					**160**		
Bachelor's Degree (Honours with Research)											
8th	PHY460	Numerical Techniques	25	75	100	4	0	0	**3**	3	-
(Any one)	PHY461	Medical Physics	25	75	100	4	0	0	**3**	3	3
	PHY462	Materials Science and Nanomaterials									
	PHY463	Digital Electronics									
	PHY464	Plasma Physics									
	PHY465	Biological Physics									
	PHY460P	Laboratory- 6	25	75	100	0	0	2	**2**	-	3
	RPD470	Research Project/ Dissertation	25	75	100	0	0	5	**12**	-	6
		Total		***4900***					**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: • Revise the knowledge of vectors, vector calculus and matrices. These basic mathematical structures are essential in solving problems in various branches of Physics.

• Learn the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries and beta-gamma functions and their application in solving special integrals.

Unit-1: (10 Lectures)

Vector Algebra: dot and cross products, scalar and vector triple product and their interpretation in terms of area and volume respectively.

Vector calculus: vector differentiation, Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators.

Vector Integration: Ordinary Integration of Vectors, Line, Surface, and Volume integrals of Vector fields. Flux of a vector field. Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their simple applications (*no proof*).

Unit-2: (10 Lectures)

Coordinate Systems: 2D& 3D Cartesian, Spherical and Cylindrical coordinate systems, transformation equations. Components of velocity and acceleration in different coordinate systems.

Curvilinear co-ordinates: Orthogonal curvilinear co-ordinates, unit vectors in curvilinear co-ordinates, gradient, divergence and curl- cylindrical and spherical polar co-ordinates, problem solving in curvilinear coordinates.

Unit-3: (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.

Characteristic equation: eigen values, eigen vectors, calculation of eigen values and eigen vectors of (2x2) matrices, properties of eigen values & eigen vectors of Hermitian & unitary matrices, Trace of a matrix, diagonalisation of symmetric (2x2) matrix with examples.

Unit-4: (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 for the interval $(-\pi, \pi)$, $(0, \pi)$ and $(0, 2\pi)$, Fourier series for half wave and full wave rectifier, complex representation of a Fourier series.

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.

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

Steady Current: current density, drift velocity, Ohm's law, Equation of continuity, Resistance, resistivity, conductivity, ohmic and non-ohmic conductors. Kirchoff's law, series and parallel combination of resistance, Wheatstone bridge, current and voltage division rule, principle of superposition, Thevenin's and Norton's theorem.

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

Unit 2: Magnetic Circuits

Magnetic effect of current: Lorentz force, force on a current carrying conductor, origin of $\vec{B}$. Biot-Savart's law, calculation of magnetic field in simple geometrical situations. Ampere's law and its simple applications. Magnetic field due to a current loop, magnetic dipole moment, current loop in an external magnetic field.

Electromagnetic Induction: Faraday's laws, Lenz's law, self and mutual inductance, B-H curve, Fleming's left and right-hand rule.

Unit 3: AC Circuits

AC circuits: AC current, mean, peak and rms value, phasors and phasor diagrams, Power in AC circuits, Power factor, wattless current, Average power associated with pure R, L and C. Single phase and three phase circuits. AC circuits containing L, C, R and their combinations, Resonance in LCR circuits (series and parallel), condition for resonance, sharpness of resonance and quality factor, LC oscillations.

Unit 4: Electrical machines

Galvanometer: Moving coil galvanometer, sensitivity, measurement of current and voltage, conversion of galvanometer to ammeter and voltmeter.

Generators: Principle and working of DC and AC generators, single phase induction motor, DC motor, Advantages and disadvantages of AC over DC.

Principle and working of choke coil, hot wire instruments- hot wire ammeter and voltmeter.

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

References:

1. H. K. Malik and A.K. Singh, *Engineering Physics*, McGraw Hill Education (India) Private Limited, 2018.
2. D. J. Griffiths, *Introduction to Electrodynamics*, Prentice-Hall of India Private Limited, 2002, 3e.
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, 2005.

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 the foundation of fundamental Newtonian Mechanics. • Understand how scientific theory evolves over the time • Have basic knowledge of our universe and how it evolves • Acquire basic knowledge in laws of motion and oscillation

Unit:1 Newtonian Mechanics

Historical survey – From the Greeks to Copernicus: Short introduction to the works of - Aristotle, Plato, Socrates, Archimedes, Aryabhata, Bhaskara, Kepler, Bruno, Tycho Brahe, Copernicus, Geocentric model and Heliocentric model.

From Galileo to Newton - Galileo's works, Galileo's notion of relative velocity and acceleration. Newton's notion of space and time (absolute), principle of homogeneity of space, isotropy of space, absoluteness of space and time. Newton's laws of motion. Determinism in Newtonian mechanics.

Unit: 2 Evolution of Universe

Universe at glance - Age, Size. Solar system, Galaxy, Life cycle of stars – Birth of stars, Normal stars, Death of stars -White dwarf, Neutron star, Blackhole.
Theories of evolution of universe – Big bang theory, Steady state theory.

Unit: 3 Motion and Oscillation

Motion - Concept of distance, displacement, speed/velocity - average velocity, relative velocity, acceleration, force. Newton's laws of motion (qualitative ideas).

Oscillation - amplitude, frequency, wavelength. Visible and audible ranges of frequencies - colours and musical notes, electromagnetic spectrum (qualitative idea only)

Reference 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

Second Semester (Major)

Name of Paper: Mechanics, Properties of Matter & Oscillation

Course No: PHY160

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 4**

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: (10 Lectures)

Laws of motion: Newton's laws of motion, components of velocity and acceleration in Cartesian and polar coordinate system, uniformly rotating frame, centripetal force and Coriolis force with applications. System of particles: linear and angular momentum of system of particles, Law of conservation of momentum and energy, Conservative and non-conservative forces.

Gravitation: Newton's law of gravitation, Expressions for escape velocity and orbital velocity, gravitational field and potential, gravitational field and potential due to a spherical body. Kepler's laws of planetary motion.

Unit-2: (10 Lectures)

Centre of mass: Centre of mass and its equation of motion, expression for position vector, velocity, acceleration and force of centre of mass. Concept of elastic and inelastic collisions, elastic collision in one dimension.

Rigid body motion: angular velocity, moments of inertia and its physical meaning, radius of gyration, torque, theorems on moment of inertia, simple problems.

Unit-3: (10 Lectures)

Elasticity: Hooke's law, elastic constants for an isotropic solid, inter relations of elastic constants, torsion of a cylinder.

Kinematics of moving fluids: rate of flow, equations of continuity, Bernoulli's theorem, viscosity and coefficient of viscosity, streamline and turbulent flow, Reynold's number, Poiseuille's law, Stokes law.

Surface tension: Surface Energy, Excess pressure inside a liquid drop, air bubble, angle of contact, capillarity.

Unit-4: (10 Lectures)

Harmonic oscillations: differential equation and its solution, kinetic and potential energy, examples of simple harmonic oscillations- spring and mass system, simple and compound pendulum. Superposition of two mutually perpendicular simple harmonic vibrations of (a) same frequency and (b) different frequencies in the ratio 1:2, Lissajous figures.

Free and forced vibration: conditions of maximum amplitude, resonance, condition of resonance, sharpness of resonance and quality 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: • Understanding N- and P- type semiconductors, mobility, drift velocity, fabrication of P-N junctions. • Application of PN junction for different type of rectifiers and voltage regulators, special diodes. • Understanding NPN and PNP transistors and basic configurations, current and voltage gain. • Biasing and equivalent circuits, coupled amplifiers and feedback in amplifiers and oscillators. • Working of CRO and its application.

Unit 1: Semiconductors & Diodes

P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. PN junction diode and its characteristics, static and dynamic resistance. Special diodes: Zener, Light Emitting, and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits (L,C and Pi) and voltage regulated power supply.

Unit 2: Transistors

Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff& saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilization. Voltage divider bias circuit for CE amplifier.

Unit 3: Amplifiers

Classification of amplifiers: Class A, B, AB and C amplifiers, Push-pull amplifier- efficiency, dissipation, power output and distortion.

Multistage transistor amplifier: RC coupled amplifier and its frequency response.

Feedback in amplifiers: positive and negative feedback, effect of negative feedback on input impedance, output impedance, gain, stability, distortion, and noise.

Unit 4: Oscillators

Sinusoidal oscillators: Barkhausen's criterion for self-sustained oscillations, Colpitt's oscillator, Hartley Oscillator, Phase shift oscillator.

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (*no mathematical treatment*). Special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.

References:

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. A. Sudhakar, S.S. Palli, *Circuits and Networks: Analysis and Synthesis*, McGraw Hill, 2015, 5e
5. S.L. Gupta, V. Kumar, *Hand Book of Electronics*, Pragati Prakashan, Meerut, 2016, 43e

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 the foundation of fundamental Newtonian Mechanics. • Understand how scientific theory evolves over the time • Have basic knowledge of our universe and how it evolves • Acquire basic knowledge in laws of motion and oscillation

Unit:1 Newtonian Mechanics

Historical survey – From the Greeks to Copernicus: Short introduction to the works of - Aristotle, Plato, Socrates, Archimedes, Aryabhata, Bhaskara, Kepler, Bruno, Tycho Brahe, Copernicus, Geocentric model and Heliocentric model.

From Galileo to Newton - Galileo's works, Galileo's notion of relative velocity and acceleration. Newton's notion of space and time (absolute), principle of homogeneity of space, isotropy of space, absoluteness of space and time. Newton's laws of motion. Determinism in Newtonian mechanics.

Unit: 2 Evolution of Universe

Universe at glance - Age, Size. Solar system, Galaxy, Life cycle of stars – Birth of stars, Normal stars, Death of stars -White dwarf, Neutron star, Blackhole.
Theories of evolution of universe – Big bang theory, Steady state theory.

Unit: 3 Motion and Oscillation

Motion - Concept of distance, displacement, speed/velocity - average velocity, relative velocity, acceleration, force. Newton's laws of motion (qualitative ideas).

Oscillation - amplitude, frequency, wavelength. Visible and audible ranges of frequencies - colours and musical notes, electromagnetic spectrum (qualitative idea only)

Reference 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: 3**

Course Outcome: • Comprehend basic concepts of thermodynamics, First and Second law of thermodynamics, concept of entropy, heat engines and associated theorems. • Maxwell's thermodynamic relations, thermodynamic potentials and their physical interpretations. • Learn basic aspects of kinetic theory of gases, Maxwell-Boltzman distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.

Unit-1: (10 Lectures)

Ideal gas: Kinetic Theory of Matter: Expression for pressure, kinetic interpretation of temperature, rms speeds of molecules, Equipartition of energy, specific heat of mono, di and tri-atomic gases, Adiabatic and isothermal expansion of an ideal gas.

Real Gas: Van der Waals gas equation, critical constants, Reduced equation of state. Thermal conductivity and diffusivity, differential equation of rectilinear flow of heat (one dimension), Ingen-Hauz experiment.

Unit-2: (10 Lectures)

Laws of thermodynamics: The Zeroth law, First law of thermodynamics, Reversible and irreversible changes.

Heat Engines: Carnot cycle, Carnot's engine and its efficiency, Carnot's Theorem and the Second law of thermodynamics, Entropy, principle of increase of entropy, Thermodynamic scale of temperature-its identity with the perfect gas scale, Impossibility of attaining the absolute zero; T+hird law of thermodynamics.

Unit-3: (10 Lectures)

Thermodynamical relations: Thermodynamical energy functions- internal energy functions, enthalpy, Helmholtz function, Gibb's function, Derivation of Maxwell's relations from thermodynamical energy functions, Application of Maxwell's equation: latent heat equation, variation of intrinsic energy with volume, TdS equation, $C_P - C_v$ for perfect and real gases, variation of C_v with volume and C_P with pressure.

Unit-4: (10 Lectures)

Maxwell-Boltzmann law of distribution of velocity, average velocity, rms velocity, most probable velocity and energy distribution law. Mean free path: deduction, collision probability, law of distribution of free path.

Brownian motion, Einstein's theory of Brownian motion, Non-equilibrium of gases: transport phenomena in gases, viscosity, thermal conductivity, diffusion (*elementary deduction*), their dependence on pressure and temperature.

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. Zemannsky: *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/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

Reflection: Fermat's principle and laws of reflection, laws of reflection at a spherical surface, mirror formula, spherical mirrors, uses.

Refraction: Fermat's principle and laws of refraction, laws of refraction at a spherical surface, lens: image formation, lens formula, lens maker's formula, refraction through a combination of media.

Unit 2: Thick lens and lens combinations

Refraction at Spherical surfaces: convex and concave spherical surfaces, lens, power, principal foci and focal planes, magnification, Abbe's sine condition.

Thick Lens and lens combination: cardinal points, relation between cardinal points, significance of cardinal points, newton's method, equivalent lens, Equivalent focal length of two thin lenses, power of the equivalent lens. Magnification by a thick lens.

Unit 3: Aberrations

Aberrations: Spherical aberration, calculation of spherical aberration, Coma, Astigmatism and Distortion, their minimization.

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

Achromatism: Dispersion and dispersive power, dispersion without deviation and deviation without dispersion, achromatic prism, chromatic aberration in lens, calculation of chromatic aberration, achromatism of two lenses in contact and separated by a distance.

Scattering of light: scattering and types of scattering, scattering phenomenon, rainbow.

Unit 4: Optical Instruments

Eyepiece: Eyepieces or oculars, Ramsden and Huygens's eyepieces.

Microscope: working and utilities of simple microscope, compound microscope, electron microscope and binocular microscope.

Telescope: terrestrial and astronomical telescopes, Refracting and reflecting astronomical telescope.

Camera: camera and camera lenses, telephoto and zoom lenses, human eye – its working, defect of vision and their correction.

References:

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. Jenkins and White: *Fundamentals of Optics*, McGraw-Hill

Third Semester (Major)

Name of Paper: Laboratory-1

Course No: PHY200P

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **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. 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 coefficient of apparent expansion of a liquid by weight thermometer.
4. Determine the specific heat of a liquid by the method of cooling.
5. Determine the refractive index of a liquid/solid by using a Traveling microscope.
6. Determine the radius of curvature of a convex lens by Newton's rings 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 (Multidisciplinary)

Name of Paper: Physics for All

Course No: PHY110

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

Course Outcome: • Understand the foundation of fundamental Newtonian Mechanics. • Understand how scientific theory evolves over the time • Have basic knowledge of our universe and how it evolves • Acquire basic knowledge in laws of motion and oscillation

Unit:1 Newtonian Mechanics

Historical survey – From the Greeks to Copernicus: Short introduction to the works of - Aristotle, Plato, Socrates, Archimedes, Aryabhata, Bhaskara, Kepler, Bruno, Tycho Brahe, Copernicus, Geocentric model and Heliocentric model.

From Galileo to Newton - Galileo's works, Galileo's notion of relative velocity and acceleration. Newton's notion of space and time (absolute), principle of homogeneity of space, isotropy of space, absoluteness of space and time. Newton's laws of motion. Determinism in Newtonian mechanics.

Unit: 2 Evolution of Universe

Universe at glance - Age, Size. Solar system, Galaxy, Life cycle of stars – Birth of stars, Normal stars, Death of stars -White dwarf, Neutron star, Blackhole.
Theories of evolution of universe – Big bang theory, Steady state theory.

Unit: 3 Motion and Oscillation

Motion - Concept of distance, displacement, speed/velocity - average velocity, relative velocity, acceleration, force. Newton's laws of motion (qualitative ideas).

Oscillation - amplitude, frequency, wavelength. Visible and audible ranges of frequencies - colours and musical notes, electromagnetic spectrum (qualitative idea only)

Reference 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: 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: (10 Lectures) First and second order differential equation

First order differential equation: separation of variable, homogeneous equation, exact equation, integrating factor.

Second order differential equation: Homogeneous equation with constant and variable coefficients, Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral

Unit-2: (10 Lectures) Partial Differential Equation and Power series

Ordinary differential equations: Meaning of ordinary point, Power series solution of ordinary differential equation, Frobenius method.

Partial differential equation: solution of partial differential equations by the method of separation of variables, application in solving the (i) equation of heat flow in one dimension (ii) equation of a vibrating string and (iii) Laplace's equation in two dimensions (Cartesian and Polar coordinates).

Unit-3: (10 Lectures) Special Function-I

Legendre Polynomial: Legendre differential equation, Legendre polynomials $P_n(x)$, Rodrigue formula for $P_n(x)$, generating function for $P_n(x)$ and recurrence relations, orthogonal property of $P_n(x)$.

Associate Legendre polynomial: Recurrence relations, Orthogonal property.

Hermite Polynomials: Hermite differential equation, Hermite polynomials $H_n(x)$, Generating functions and recurrence relations.

Unit-4: (10 Lectures) Special Function-II

Bessel functions: Bessel's differential equation, Bessel function $J_n(x)$, Generating function of $J_n(x)$, Recurrence relation and Orthogonality of $J_n(x)$, Expansion involving Bessel's functions, Integrals of $J_0(x)$ and $J_n(x)$.

Laguerre equation: Generating function, Rodrigue formula, Orthogonal property, Recurrence relation, Associated Laguerre polynomials.

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).

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 the nuances of atomic structure, electronic configuration and atomic model. • Understand the origin of X-rays and associated laws. • Know classical and quantum theory of black body radiation. • Understand Dual nature of matter, Uncertainty principles and its application. • Understand Special Theory of Relativity, Know different crystal structure, direct and reciprocal lattice, X-ray diffraction.

Unit-1: (10 Lectures)

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

Electronic configuration: Hund rule, Aufbau's principle, Pauli's exclusion principle, quantum number for atomic orbitals and degeneracy.

Positive rays: Thomson's mass spectrograph, Aston and Bainbridge mass spectrograph (*brief outline*).

X-ray spectra: Hard and soft X-rays, continuous spectra and its explanation (Duane-Hunt law), Characteristics X-ray spectra, energy level diagram, Moseley's law and its importance.

Unit-2: (10 Lectures)

Classical Theory: Properties of thermal radiation, Kirchhoff's law, spectrum of blackbody radiation, Stefan-Boltzmann law and Wien's displacement law.

Quantum theory: Planck's law of black body radiation, Wien's radiation formula, Stefan-Boltzmann law and Wien's displacement law from Planck's law.

Unit-3: (10 Lectures)

Matter wave: De Broglie hypothesis, wave particle duality, wave packets, probability, Phase and Group velocities, Davisson-Germer experiment, probability density, probability current density, conservation of probability density. Uncertainty Principle: Heisenberg's uncertainty relation for p and x, its extension to energy and time, applications of Uncertainty principle.

Special Theory of Relativity: Inertial and non-inertial frames, Galilean invariance, Einstein's basic postulates, Lorentz transformations, length contraction, simultaneity, time dilation, twin paradox, Variation of mass with velocity, mass energy equivalence, relativistic formulae for momentum and energy.

Unit-4: (10 Lectures)

Thermal properties: Specific heat of solid, Deduction of Dulong and Petit's law from the harmonic oscillator concept, Einstein's theory of specific heat and its failures, Debye T3 law of specific heat.

Motion of electrons: Free electrons motion, conduction electrons, electron collisions, mean free path, relaxation time, current density and electrical conductivity formulae, Thermal conductivity, Weidmann-Franz law, Fermi energy, Fermi velocity, Energy levels and density of states in one dimensions.

Reference 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

Fourth Semester (Major)

Name of Paper: Laboratory-2

Course No: PHY260P

Marks Scale: 100 marks **(End Sem.: 75+Int.: 25)** **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. To determine the resistance of a lamp at room temperature and when incandescent.
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

Fifth Semester (Major)

Name of Paper: Wave Optics

Course No: PHY300

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: (10 Lectures)

Interference of light: Principle of superposition, condition for sustained interference, Interference: Division of Wavefront – Young's double slit experiment, Fresnel biprism-Production of Interference fringes, its application in determination of wavelength of light and thickness of a transparent sheet. Division of amplitude – Thin films (parallel and wedge-shaped films), theory of Newton's ring and its application.

Unit-2: (10 Lectures)

Interferometers: Michelson interferometer- construction and production of fringes, its application for precision determination of wavelength, wavelength difference and refractive index. Fabry-Perot interferometer- Etalon.

Lasers: Characteristics and uses of Lasers. condition for laser action, existence of metastable state, population inversion, pumping schemes, properties of laser light, three and four level laser systems (*qualitative ideas only*). Types of Lasers: He-Ne- laser and Semiconductor laser (*basic ideas*), Einstein's A & B coefficients.

Unit-3: (10 Lectures)

Diffraction: Fresnel Diffraction - Half period zones, Zone plate, diffraction at a straight edge and narrow wire; Fraunhoffer Diffraction – Diffraction at circular aperture, diffraction at single and double slits with derivation of equation for intensity and visibility; Diffraction grating, theory of plane diffraction grating.

Unit-4: (10 Lectures)

Resolving power: Rayleigh's criterion of resolution, Resolving power of grating and telescope. Polarization: polarization by reflection, polarizing angle, Brewster's law, Law of Malus, Polarization by dichroic crystals, birefringence, anisotropic crystals- Nicol prism, Retardation plates, Babinet compensator; Analysis of polarized light.

Optical Rotation: Fresnel's explanation of optical rotation, faraday's law, Half Shade & Biquartz polarimeters.

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. Jenkins and White: *Fundamentals of Optics*, McGraw-Hill.
5. K. Thyagarajan and A. K. Ghatak: *Lasers: Theory and Applications*, McMillan India Ltd.,

Fifth Semester (Major)

Name of Paper: Classical and Statistical Mechanics

Course No: PHY301

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **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)

Mechanics of a system of particles: Central forces, motion under central force, 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, Keplerian motion, Simple problems.

Unit-2: (10 Lectures)

Calculus of variation- Euler- Lagrange Equation, Application of Variational Principle, Variation under constraints-Lagrange's multipliers, Principle of least action, Hamilton's principle, Hamilton's equations and its applications

Central force problem: Kepler problem, inverse square law force. Scattering in central force field, Rutherford formula, Virial theorem.

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 and grand canonical ensembles-internal energy, entropy, free energy, partition function. Probability distribution in micro-canonical, canonical and grand-canonical ensemble, Thermodynamic quantities in grand canonical ensembles- mean particle number, entropy and grand potential.

Unit-4: (10 Lectures)

Maxwell-Boltzmann statistics: Boltzmann canonical distribution law, Application of MB statistics.

Quantum statistics: Phase space, density distribution in phase space and its application to one-dimensional oscillator and free particles, the function $\emptyset(E)$ 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. K C Gupta: *Classical Mechanics of Particles and Rigid Bodies*, New Age Intl. Ltd. (2018)
3. B. Laud: *Fundamentals of Statistical Mechanics*, New Age Intl. Ltd. (1998)
4. K Huang: *Statistical Mechanics* (2nd Ed) John Wiley & Sons (2002).
5. Brij Lal and N. Subrahmanyam: *Heat and Thermodynamics*, S.Chand & Co. Ltd.
6. S. K. Roy: *Thermal Physics*, New Age International (P) Ltd.
7. S. Lokanathan & R.S. Gambhir: *Statistical Mechanics & Thermal Physics*, PHI (2007)

Fifth Semester (Major/Minor)

Name of Paper: Electromagnetic Theory

Course No: PHY302*

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **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: (10 Lectures)

Gauss's law and its application for finding E for symmetric charge distributions, Fields at the surface of a conductor. Gauss's law in a dielectric medium, Poisson's and Laplace's equation.

Capacitors: electrostatic field energy, force per unit area on the surface of a conductor in an electric field, Dielectrics, Parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector D.

Unit-2 (10 lectures)

Maxwell Equations: Continuity equation, Maxwell's modification of Ampere's law. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Poynting Theorem and Poynting Vector.

Unit-3 (10 lectures)

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth.

Unit-4 (10 lectures)

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Total internal reflection. Metallic reflection (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.

Fifth Semester (Major)

Name of Paper: Laboratory-3

Course No: PHY300P

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 2**

Two (2) experiments (taking one form each Group) must be performed within 6 hours in the End Semester examination. A minimum of 5 experiments from each Group must be performed by the students during the semester.

Group – A

1. Use CRO for the study of A.C. supply waveform and compare the frequencies.
2. Determine the pressure coefficient by using a constant volume thermometer.
3. Determine the coefficient of linear expansion of a rod by optical lever method.
4. Determine the unknown resistance by Metre bridge.
5. To determine the reduction factor of a Tangent galvanometer and hence the value of H.
6. Determine the resistance per unit length of a wire by Carey Foster's method.

Group - B

1. Determine the acceleration due to gravity by Bar pendulum.
2. Determine the frequency of tuning fork by Meldes' 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 co-efficient 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

Sixth Semester (Major)

Name of Paper: Quantum Mechanics

Course No: PHY360

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

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: (10 Lectures)

Postulates of Quantum mechanics: Basic postulates and formalism, Schrodinger's equation, Schrodinger equation as eigen value equation, eigen value and eigen function, probabilistic interpretation, time dependent and time independent Schrodinger equation.

Schrodinger's equation to solve one dimensional problem, particle in a box, particle in a finite well, boundary conditions, normalized wavefunction, bound states, reflection and transmission by a finite potential step, quantum phenomenon of tunnelling.

Unit-2: (10 Lectures)

Operator method in quantum mechanics: quantum mechanical operators, Linear operators, commutator, matrix representation of linear operators, eigen values and eigen functions, eigen vectors of operators, Hermitian operators, and its properties, Adjoint operators, Expectation value of an operator, Ehrenfest theorem.

Angular momentum operators L^2 and L_z and their eigen values and eigen functions, Spatial quantization, Angular momentum, and magnetic moment of electron due to orbital motion; Bohr magneton,

Unit –3: (10 Lectures)

Linear simple harmonic oscillator, energy eigenvalues and wavefunction, zero-point energy. Particle in a three-dimensional cubical box, degeneracy. Spherically symmetric systems and potentials, orbital angular momentum and azimuthal quantum numbers, physical significance. Hydrogen atom problem, Solution of Schrodinger's equation in spherical polar coordinates, azimuthal, polar and radial wave equations, energy levels and degeneracy.

Unit-4: (10 Lectures)

Infinite dimensional vector space - Hilbert space (basic ideas only), definition of a linear vector space (LVS), Linear combinations, Linear dependence and independence, inner product of two vectors, concept of basis sets, orthonormal basis sets, expansion of an arbitrary vector, matrix representation of vector, Dirac's bra-ket notation.

Recommended Books:

1. Arthur Beiser: *Modern Physics*, McGraw Hill Company.
2. E. Merzbacher: *Quantum Mechanics*, 3rd Ed., John Wiley & Sons, 1998.
3. J. J. Sakurai: *Modern Quantum Mechanics*, Pearson Education, 2002.
4. R. Shankar: *Principle of Quantum Mechanics*, 2nd Ed., Springer, 2008.
5. D.J. Griffiths, *Introduction to Quantum Mechanics*, Pearson Education (2nd Edition)
6. G. Aruldhas, Quantum Mechanics, Prentice Hall of India (2002)
7. R. Liboff: *Introductory Quantum Mechanics*, Pearson Education (2006)

Sixth Semester (Major)

Name of Paper: Nuclear and Particle Physics

Course No: PHY361

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

Course Outcome: • Learn the ground state properties of a nucleus, packing fraction and binding energy. • Know nuclear models and their roles in explaining properties of the nucleus– liquid drop and shell model. • Radioactivity and radioactive laws, alpha, beta and gamma rays, Gamow's theory of alpha decay and Pauli's theory of beta decay, electron capture, fine structure of alpha particle spectrum, Geiger-Nuttall law, radioactive series. • Basic aspects of nuclear reactions, Q-value, interaction of radiation with matter. • Working principle of nuclear detectors. • Basic idea about Elementary particles and cosmic rays.

Unit-1: (10 Lectures)

General properties of nucleus: Binding energy and its variation with mass number, binding energy curve and its significance, Semi-empirical mass formula and its simple application, neutron-proton ratio in stable nuclei, stability curve, odd even rules of nuclear stability.

Radioactivity: α-decay, range and energy of α-decay, alpha particle disintegration energy, Geiger-Nuttal law. Fermi's theory of β-decay (qualitative treatment), conditions of β^+& β^-decay and K capture, β-ray spectrum,γ-decay: γ-ray emission, internal conversion, interaction of γ-rays with matter.

Unit-2: (10 Lectures)

Nuclear models and nuclear reaction: Liquid drop model and shell model of nucleus.

Artificial transmutation: scheme of nuclear reactions, Conservation laws, Q value, threshold energy, cross-section of nuclear reactions. Neutron: discovery, properties, mass, and classification.

Nuclear fission: Bohr-Wheeler's theory, condition of spontaneous fission, nuclear multiplication factor, concept of critical size, basic nuclear reactor.

Nuclear fusion: nuclear fusion, condition for maintaining fusion reaction, Source of stellar energy, P-P and C-N cycle, calculation of fusion energy.

Unit-3: (10 Lectures)

Particle accelerator: Need for particle accelerator, electrostatic accelerators, linear accelerators, cyclotron, betatron, electron synchrotron, proton synchrotron, accelerators in India.

Particle detectors: Interaction of charged particles and neutrons with matter. Ionisation chamber and Wilson cloud chamber, GM counter, scintillation counter, semiconductor counters, Cerenkov counter, Neutron Counters.

Unit-4: (10 Lectures)

Cosmic rays and elementary particles: Intensity of cosmic rays on earth's surface, latitude effect, altitude effect, primary cosmic rays, secondary cosmic rays, origin of cosmic rays, absorption showers, extensive air showers, theory of electron showers (Bhabha's theory), Discovery of positron, muon, pion, Ideas of leptons, baryons and mesons, concept of anti-particles, Universal conservation laws- statements and their applications to production and decay of mesons and baryons, Discovery of strange particles, isospin, strangeness, hypercharge, elementary particle symmetries, Quarks.

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. W.E. Burcham and M. Jobbs: *Nuclear and Particle Physics*, Addison Wesley (1998)
8. D.J. Griffiths: *Introduction to Elementary Particles*, John Wiley & Sons (1987)

Sixth Semester (Major)

Name of Paper: Mathematical Physics - III

Course No: PHY362

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

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

Complex Number: Definition, Fundamental algebraic laws, Argand diagram, polar form, properties of moduli and arguments and geometry of complex number.

Functions of a complex variable, Limit, continuity and differentiability of complex functions, Analytic function, Cauchy-Riemann conditions for analyticity of functions, Taylor series and Laurent series (*both without proof*), Expansion of a function in Taylor's and Laurent series, poles and residue, singularities and their classification, calculation of Residues.

Unit II: Complex variable-II

Cauchy's theorem, Cauchy's residue theorem, Cauchy integral theorem formula and its application.

Contour Integration: Integration around a unit circle, Integration around semi-circle of infinite radius, Jordan's lemma, Evolution of Integrals of the form $\int_{-\infty}^{\infty} \frac{\varphi(x)}{\psi(x)}\, dx$, $\int_{-\infty}^{\infty} \frac{\varphi(x)}{\psi(x)} \sin mx\, dx$, $\int_{-\infty}^{\infty} \frac{\varphi(x)}{\psi(x)} \cos mx\, dx$, Evolution of Integrals having poles on the real axis, Evolution of integrals with integrands involving many valued functions.

Unit III: Fourier transform

Fourier integrals: Fourier integral, different forms and its applications

Fourier Transforms: Finite Fourier Transforms, Fourier sine and cosine transform, properties of a Fourier transform, derivative of Fourier transform, Fourier transform of derivative, Inverse Fourier transform and its properties, application of Fourier transforms.

Dirac Delta function: definition and properties, Fourier transform of delta function.

Unit-IV: Laplace transform

Laplace transform: Definition, properties of Laplace transforms, methods of finding Laplace transform, some special functions, evaluation of integrals, Inverse Laplace transform, evaluation of integrals with Laplace and inverse Laplace transforms, Application of Laplace transforms to differential equation, boundary value problems.

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. 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).

Sixth Semester (Major/Minor)

Name of Paper: Atomic and Molecular Physics

Course No: PHY363*

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 4**

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: (10 Lectures)

Atomic model: Review of Bohr atomic model, shortcomings of Bohr's theory, Sommerfeld's elliptical orbits, Sommerfeld's relativistic correction, shortcomings of Sommerfeld's model.

Vector atom model: spatial quantisation and electron spin, spin-orbit interaction, Stern and Gerlach experiment, quantum numbers and their physical interpretation, magnetic moments of an atom, Lande's g-factor, Larmor's theorem, coupling scheme for two electron system: L-S and J-J coupling scheme and selection rules.

Pauli's exclusion principle, periodic table, fine structure, fine structure of H-line, Doublet fine structure of hydrogen and alkali atoms.

Unit-2: (10 Lectures)

Zeeman effect: classical and quantum interpretation of normal Zeeman effect, normal and anomalous Zeeman effect for one electron system, quantum theory of anomalous Zeeman effect for one electron system only. Paschen-Back effect, Stark effect - linear and quadratic (qualitative idea).

X-rays: Continuous and characteristic spectrum of X-rays, Concept of fine structure of X-rays levels, X-ray fluorescent and the Auger effect.

Unit-3: (10 Lectures)

Born Oppenheimer approximation (general idea), Pure rotational spectra, rigid rotator, energy levels, frequency of spectral line, selection rule and the spectrum, Non-rigid rotator, energy levels, spectrum, determination of inter-molecular distance (HCl, CO, N_2), Vibrating diatomic molecule as a harmonic oscillator, coupling of rotation and vibration, molecule as anharmonic oscillator, energy levels, transition rules, spectrum, application of vibrational spectroscopy.

Unit-4: (10 Lectures)

Electronic configurations and states of homonuclear diatomic molecules, Electronic band systems, Sequences and progressions in emission and absorption, Frank-Condon principal energy levels, selection rules, rotational fine structure of vibrational transitions, P, Q, R branches.

Fortrat diagram, Raman effect and its semi-quantum mechanical explanation, fundamentals of vibrational Raman spectra, comparison of infrared and Raman scattering.

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. Murugeshan: *Modern Physics*, S. Chand & Co.

Sixth Semester (Major)

Name of Paper: Laboratory-4

Course No: PHY360P

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

Two (2) experiments (one from each Group) must be performed within 6 hours in the End Semester examination. A minimum of 6 experiments from each Group must be performed by the students during the semester.

Part - A

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. Determine the Stefan's constant
8. Verification of Stefan's law
9. Determine the value of mechanical equivalent of heat by Joule's electrical calorimeter.

Part - B

10. Draw the B-H curve of an iron sample.
11. To determine the value of g by Kater's pendulum.
12. Determine the modulus of rigidity of a cylindrical body by statical method
13. Determine the wavelength of monochromatic light by Michelson's interferometer.
14. Measure the width of a single slit from the study of its Fraunhoffer diffraction.
15. Determine the wavelength of sodium D-lines by using Fresnel biprism.
16. Determine the refractive index of the material of a prism at different wavelengths by using a spectrometer.
17. Determine the figure of merit of a galvanometer.
18. 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 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

Seventh Semester (Major)

Name of Paper: Solid State Physics

Course No: PHY400

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **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-Mossoti 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*, 8thEdn., John Wiley & Sons (1999)
2. H.P. Myers: *Introduction to Solid State Physics*, 2ndEdn, 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/Minor)

Name of Paper: Radiation Safety

Course No: PHY401*

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).

Reference Books

1. G.F.Knoll, *Radiation Detection and Measurements*,Wiley
2. Mcknlay, A.F., Bristol, Adam Hilger,*Thermoluninescense 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.

Seventh Semester (Major/Minor)

Name of Paper: Energy Resources & Harvesting

Course No: PHY402*

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.

Reference 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.
5. http://en.wikipedia.org/wiki/Renewable_energy

Seventh Semester (Major)

Name of Paper: Laboratory-5

Course No: PHY400P

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 1**

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

1. Determine the value of e/m of electron (any method).
2. Determination of wavelength of laser light using ruler/diffraction grating.
3. Determination of the diameter of a thin wire using laser.
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 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.

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

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **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: Medical Physics

Course No: PHY461

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

Course Outcome: • Gain a broad understanding of use of Physics in medical applications. • Learn about the human body, its anatomy, physiology and biophysics, exploring its performance as a physical machine. • Gain working knowledge of various diagnostic tools, medical imaging techniques and safety practices.

Unit 1: (10 Lectures)

Physics of Body-I: Basic Anatomical Terminology, Standard Anatomical Position, Planes. Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal.
Mechanics of the body: Skeleton, forces, and body stability. Muscles and dynamics of body movement.
Physics of Locomotors Systems: joints and movements, Stability and Equilibrium.
Energy household of the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation.
Pressure system of body: Physics of breathing, Physics of cardiovascular system.

Unit 2: (10 Lectures)

Physics of Body-II: Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound.
Optical system of the body: Physics of the eye.
Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

Unit 3: (10 Lectures)

Medical Imaging Physics: Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy. Computed tomography scanner- principle and function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display)

Unit 4: (10 Lectures)

Radiation oncology physics: External Beam Therapy (Basic Idea): Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife. Contact Beam Therapy (Basic Idea): Brachytherapy- LDR and HDR, Intra Operative Brachytherapy.
Diagnostic nuclear medicine: Radioisotope imaging equipment, Single photon and positron emission tomography.
Therapeutic nuclear medicine: Interaction between radiation and matter, Dose and isodose in radiation treatment.
Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea and C-pap Machines, Ventilator and its modes.

Reference Books:

1. Basic Radiological Physics: Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
2. Physics of the human body: Irving P. Herman, Springer (2007).
3. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rd edition (2003)
4. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)

Eighth Semester (Major)

Name of Paper: Materials Science and Nanomaterials

Course No: PHY462

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **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.

References:

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. Owens,*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.

Eighth Semester (Major)

Name of Paper: Digital Electronics

Course No: PHY463

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

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)

Basic characteristics of Op-Amp without detailed internal circuit of IC; characteristics of ideal op-amp, open loop and close loop gain, inverting and noninverting amplifier, summer, differentiator, integrator. 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)

Logic gates, AND, OR, NOT, NAND, NOR, XOR gates, truth tables, combination of gates, De-Morgan's theorem, Simplification of Logic Circuit using Boolean Algebra, Binary Number System, conversion of binary into decimal and vice versa, Binary addition and subtraction (only 2's complement method), fundamental products, conversion of truth table into equivalent logic circuit.
Half and Full Adders. Half and Full Subtractors, 4-bit binary Adder/ Subtractor.

Unit-3: (10 Lectures)

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

Unit 4: (10 lectures)

Computer Organization: Input/ Output Devices. Data storage (idea of Ram and ROM). Computer Memory. Memory organization and addressing.
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.

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: Plasma Physics

Course No: PHY464

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

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.

References:

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: Biological Physics

Course No: PHY465

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

Course Outcome: • Acquire mastery of the fundamental principles and applications of various branches of Physics in understanding biological systems. • Relevance of chemistry principles and thermodynamics in understanding energy transfer mechanism and protein folding in biological systems. • Get exposure to complexity of life at (i) the level of Cell, (ii) level of multi cellular organism and (iii) at macroscopic system – ecosystem and biosphere

Unit-1: (10 Lectures)

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form. Types of cells. Multicellularity. Allometric scaling laws.

Unit-2: (10 Lectures)

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signalling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Physics Simplified mathematical models of transcription and translation, small genetic circuits and signalling pathways. Random walks and applications to biology. Mathematical models to be studied analytically and computationally.

Unit-3: (10 Lectures)

The complexity of life-I: At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell. Complex networks of molecular interactions: metabolic, regulatory and signalling networks. Dynamics of metabolic networks; the stoichiometric matrix. Living systems as complex organizations; systems biology. Models of cellular dynamics. The implausibility of life based on a simplified probability estimate, and the origin of life problem.

Unit-4: (10 Lectures)

The complexity of life-II: At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. Pattern formation and development.

Brain structure: neurons and neural networks. Brain as an information processing system. Associative memory models. Memories as attractors of the neural network dynamics.

At the level of an ecosystem and the biosphere: Food webs. Feedback cycles and self-sustaining ecosystems.

References:

1. Kim Sneppen & Giovanni Zocchi, *Physics in Molecular Biology*, (CUP 2005)
2. Philip Nelson, *Biological Physics: Energy, Information, Life*, (W H Freeman & Co, NY, 2004)
3. Rob Phillips *et al*, *Physical Biology of the Cell* (2nd Edition), (Garland Science, Taylor & Francis Group, London & NY, 2013)
4. Uri Alon, *An Introduction to Systems Biology*, (Chapman and Hall/CRC, Special Indian Edition, 2013)
5. M. Ridley, *Evolution:* (Blackwell Publishers, 2009, 3rd Edition)

Eighth Semester (Major)

Name of Paper: Laboratory-6

Course No: PHY460P

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 2**

Two (2) experiments must be performed within 6 hours in the End Semester examination, selecting one each from Group A and B. Students must perform a minimum of 5 experiments from each group during the semester.

Group - A

1. To study a CE amplifier of a given gain (mid-gain) using Voltage divider bias.
2. Determine the self and mutual inductances of a given coil by Carey-Foster's method.
3. Determine the thermal conductivity of a bad conductor by Lee's method.
4. To study the Frequency Response and Voltage Gain of a RC-Coupled Amplifier.
5. Study the Hall effect and determine the Hall coefficient and Hall voltage.
6. Measure the capacitance by de Sauty's method.

Group – B

7. Determine the thermal conductivity of a metallic rod by Searle's method.
8. To determine the coefficient of viscosity of a liquid by rotating viscometer.
9. Determine the work function and Plank's constant by using a photocell.
10. Study the series and parallel resonance circuits with A.C. source and draw the current frequency curve and calculate Q.
11. Determine the electrolytic conductivity of a substance by Kohlrausch's method
12. 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.

Eighth Semester (Major)

Name of Paper: Laboratory-7

Course No: PHY461P

Marks Scale: 100 marks **(End Sem.: 75+ Int.: 25)** **Credit: 3**

Two (2) experiments must be performed within 6 hours in the End Semester examination, selecting one each from Group A and B. 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 ^{o}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.

Group- B (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 Runga-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 International Ltd., 3rd Edition.

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.