PHYSICS

Teaching and Examination scheme of

UG- SEM I,II,III,IV,V,VI,VII and VIII

2024-25

INSTITUTE OF SCIENCE, NAGPUR
(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF PHYSICS

Teaching and Examination scheme
Name of Course (Subject): PHYSICS
Programme Outcomes (PO):

On completion of the B.Sc. PHYSICS students will be able to:

1. Develop Understanding of advanced concepts of physics
2. Solve the problems in physics.
3. Demonstrate the concepts of physics by performing experiments.
4. Develop algorithm using programming techniques for numerically solving physics problems.
5. Design and find solutions to innovative problems based on physics.
6. Pursue advanced studies and research in physical sciences.

Table 1: B.Sc. Semester I

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs) Theory	Tutorial	Practical	Total Credit	Evaluation Scheme Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	Subject (One will be Major and other Minor in Semester III)	Subject 1: Mechanics and Properties of Matter	B-PH111T	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	B-PH112P		--	--	2	1	4	30	20	25
		Subject 2:			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	GE	Everyday Physics	B-PH113T		2	--	--	2	2	30	20	25
		Storytelling Physics	B-PH114T		2	--	--	2	2	30	20	25
3	VSEC	Physical Measurement techniques	B-PH115P		--	--	4	2	4 - 6	60	40	50
		Designing Power Supplies	B-PH116P		--	--	4	2	4 - 6	60	40	50
4	AEC	English Compulsory			2	--	--	2	2	30	20	25
5	VEC	Environmental Studies			2	--	--	2	2	30	20	25
6	IKS	Introduction to Metaphysics	B-PH117T		2	--	--	2	2	30	20	25
7	CC	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					14	--	16	22	--	390	360	--

Table 2: B.Sc. Semester II

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	Subject (One will be Major and other Minor in Semester III)	Subject 1:- Thermodynamics and Statistical Physics	B-PH121T	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	B-PH122P		--	--	2	1	4	30	20	25
		Subject 2:			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	GE	Basic Concepts in Physics	B-PH123T		2	--	--	2	2	30	20	25
		Physics of Solar System	B-PH124T		2	--	--	2	2	30	20	25
3	VSEC	Maintenance of Household appliances	B-PH125P		--	--	4	2	4 - 6	60	40	50
		Electrical and Electronics Measurement techniques	B-PH126P		--	--	4	2	4 - 6	60	40	50
4	AEC	English Compulsory			2	--	--	2	2	30	20	25
5	VEC	Constitution of India			2	--	--	2	2	30	20	25
6	IKS	Indian Contribution to Astronomy	B-PH127T		2	--	--	2	2	30	20	25
7	CC	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					14	--	16	22	--	390	360	--

Table 3: B.Sc. Semester III

Sr No	Course Category	Name of the course(Title of the Paper)	**Course code**	Level	Teaching Scheme (hrs) Theory	Tutorial	Practical	Total Credit	Evaluation Scheme			
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1 Waves and Oscillations	B-PH231T	5.0	2	--	--	2	2	30	20	25
		Paper 2: Electrostatics and Magnetostatics	B-PH232T		2	--	--	2	2	30	20	25
		DSC Lab	B-PH233P		--	--	4	2	4 - 6	60	40	50
2	Minor	Paper 1: Physics of waves and Oscillations	B-PH234T		2	--	--	2	2	30	20	25
		Paper 2:- Static Electricity and Magnetism	B-PH235T		2	--	--	2	2	30	20	25
		Minor Lab	B-PH236P		--	--	4	2	4 - 6	60	40	50
3	GE	Physics of Planet Earth	B-PH237T		2	--	--	2	2	30	20	25
4	VSEC	C Programming	B-PH238P		--	--	4	2	4 - 6	60	40	50
5	AEC	Second Language			2	--	--	2	2	30	20	25
6	FP	Field Project			--	--	4	2	4 - 6	--	100	50
7	CC	NSS / NCC / Sports / Cultural			--	--	4	2	--	--	100	50
		Total			12	--	20	22	--	360	440	--

Table 4: B.Sc. Semester IV

Sr No	Course Category	Name of the course (Title of the Paper)	Course Code	Level	Teaching Scheme (hrs) Theory	Tutorial	Practical	Total Credit	Evaluation Scheme			
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- Introduction to Quantum Mechanics	B-PH241T	5.0	2	--	--	2	2	30	20	25
		Paper 2:- Concepts in Electricity	B-PH242T		2	--	--	2	2	30	20	25
		DSC Lab	B-PH243P		--	--	4	2	4 - 6	60	40	50
2	Minor	Paper 1:- Concepts in Quantum Mechanics	B-PH244T		2	--	--	2	2	30	20	25
		Paper 2:- Basic concepts in Electricity	B-PH245T		2	--	--	2	2	30	20	25
		Minor Lab	B-PH246P		--	--	4	2	4 - 6	60	40	50
3	GE	Our Universe	B-PH247T		2	--	--	2	2	30	20	25
4	VSEC	Biomedical Instrumentation	B-PH248P		--	--	4	2	4 - 6	60	40	50
5	AEC	Second Language			2	--	--	2	2	30	20	25
6	CEP	Community Service			--	--	4	2	4 - 6	0	100	50
7	CC	NSS / NCC / Sports / Cultural			--	--	4	2	--	0	100	50
Total					12	--	20	22	--	360	440	--

Table 5: **B.Sc. Semester V**

Sr No	Course Category	Name of the course (Title of the Paper)	Course Code	Level	Teaching Scheme (hrs) Theory Th	Tutorial Tu	Practical P	Total Credit	Evaluation Scheme: Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- Atomic and Nuclear Physics	B-PH351T	5.5	3	--	--	3	3	45	30	38
		Paper 2:- Modern Optics	B-PH352T		3	--	--	3	3	45	30	38
		DSC Lab	B-PH353P		--	--	6	3	6	90	60	75
		Paper 3:- Basic Electronics	B-PH354T		2	--	--	2	2	30	20	25
		DSC Lab	B-PH355P		--	--	2	1	4	30	20	25
2	DSE	Elective 1:- Astrophysics 2:- Acoustics	B-PH356T		2	--	--	2	2	30	20	25
		DSE Lab	B-PH357P		--	--	4	2	4 - 6	60	40	50
3	Minor	Paper 1:- Physics of Atoms and Nucleus	B-PH358T		2	--	--	2	2	30	20	25
		Minor Lab	B-PH358P		--	--	2	1	4	30	20	25
4	VSEC	Basic circuit Designs	B-PH358P		--	--	4	2	4 - 6	60	40	50
5	CEP	Community Service			--	--	2	1	--	--	50	25
Total					12	--	20	22		450	350	--

Table 6: B.Sc. Semester VI

Sr No	Course Category	Name of the course (Title of the Paper)	Course Code	Level	Teaching Scheme (hrs) Theory Th	Tutorial Tu	Practical P	Total Credit	Evaluation Scheme Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- LASER fundamentals and Fiber optics	B-PH361T	5.5	3	--	--	3	3	45	30	38
		Paper 2:- Theory of relativity	B-PH362T		3	--	--	3	3	45	30	38
		DSC Lab	B-PH363P		--	--	6	3	6	90	60	75
		Paper 3:- Introduction to Solid State Physics	B-PH364T		2	--	--	2	2	30	20	25
		DSC Lab	B-PH365P		--	--	2	1	4	30	20	25
2	DSE	Elective 1:- Complex analysis 2:- Communication Electronics	B-PH366T		2	--	--	2	2	30	20	25
		DSE Lab	B-PH367P		--	--	4	2	4 - 6	60	40	50
3	VSEC	Optical Components	B-PH368T		--	--	4	2	4 - 6	60	40	50
4	OJT	Internship / Apprenticeship (Related to DSC)			--	--	8	4	--	--	200	100
Total					10		24	22		390	460	--

Table 7: **B.Sc. Semester-VII (Honors)**

Sr No	Course Category	Name of the course (Title of the Paper)	Course Code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	DSC	Paper 1:- Mathematical Physics	B-PH471T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- Electrodynamics	B-PH472T		4	--	--	4	3	60	40	50
2	DSE	Elective:- 1. Numerical Methods 2. Solid State Electronics	B-PH473T		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab	B-PH474P		--	--	12	6	6 - 8	180	120	150
4	RM	Research Methodology	B-PH475T		4	--	--	4	3	60	40	50
Total					16	--	12	22		420	280	--

Table 8: **B.Sc. Semester-VIII (Honors)**

Sr No	Course Category	Name of the course (Title of the Paper)	Course Code	Level	Teaching Scheme (hrs) Theory	Tutorial	Practical	Total Credit	Evaluation Scheme			
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- Quantum Mechanics - I	B-PH481T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- Classical Mechanics	B-PH482T		4	--	--	4	3	60	40	50
2	DSE	Elective: 1:- Molecular Modeling and Simulations Elective: 2:- Applied Digital Electronics	B-PH483T		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab	B-PH484P		--	--	12	6	6 - 8	180	120	150
4	OJT	Internship / Apprenticeship (Related to DSC)	B-PH485P		--	--	8	4	--	--	200	100
Total					12	--	20	22		360	440	--

Table 9: B.Sc. Semester-VII (Honors with Research)

Sr No	Course Category	Name of the course (Title of the Paper)		Level	Teaching Scheme (hrs) Theory Th	Tutorial Tu	Practical P	Total Credit	Evaluation Scheme Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- Mathematical Physics	B-PH471T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- Electrodynamics	B-PH472T		4	--	--	4	3	60	40	50
2	DSE	Elective:- 1. Numerical Methods 2. Solid State Electronics	B-PH473T		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab	B-PH474P		--	--	4	2	4 - 6	60	40	50
4	RM	Research Methodology	B-PH475T		4	--	--	4	3	60	40	50
5	RP	Research Project / Dissertation (Core)	B-PH475P		--	--	8	4	--	--	200	100
Total					16	--	12	22		300	400	--

Table 10: **B.Sc. Semester-VIII (Honors with Research)**

Sr No	Course Category	Name of the course (Title of the Paper)	Course Code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- Quantum Mechanics - I	B-PH481T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- Classical Mechanics	B-PH482T		4	--	--	4	3	60	40	50
2	DSE	Elective: 1:- Molecular Modeling and Simulations Elective: 2:- Applied Digital Electronics	B-PH483T		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab	B-PH484P		--	--	4	2	4 - 6	60	40	50
4	RP	Research Project / Dissertation 1 (Core)	B-PH485P		--	--	8	4	--	--	200	100
		Research Project / Dissertation 2 (Core)	B-PH486P		--	--	8	4	--	--	200	100
Total					12	--	20	22		240	560	--

Total Credits:

1. Three-Year UG Degree Program: 132
2. Four-Year UG Degree Program: 176

B.SC.I, SEM I

DSC: Mechanics and Properties of Matter, B-PH111T Credit: 2

Objective: To provide the necessary information regarding mechanics and properties of matter.

Course Outcomes: After completing this course, students should be able to

1. Distinguish inertial, non-inertial and rotational frames of reference
2. Explain the concept of fictitious and Coriolis forces
3. Solve collision problems and determine motion regular/irregular bodies
4. Determine mechanical properties of solids
5. Solve problems based on surface tension and viscosity of liquids

Syllabus

Unit I: (7.5 Hrs)

Mechanics: Newton's law of motion, motion in a plane, components of velocity and acceleration in different coordinate system, Centripetal acceleration, Coriolis force and its applications. System of particles, Center of mass, Equation of motion, Conservation of linear and angular momentum, Conservation of energy, Elastic and inelastic collisions, Moments of inertia and their products, Moment of inertia of cylinder and sphere, Principal moments and axes.

Unit-II (7.5 Hrs)

Elasticity: Introduction, Hooke's law, Elastic constants (Y, K, η) and relation between them, Poisson's ratio, Elastic limit, Work done in stretching a wire, Twisting couple on a solid cylinder, Work done in twisting solid cylinder (wire), Bending of beam, Bending moment, External and internal bending moment, Cantilever supported at one end and at both end, Torsional pendulum, and Maxwell needle.

Unit III: (7.5 Hrs)

Viscosity: Streamline and turbulent flow, Coefficient of viscosity, Equation of continuity, Euler's equation, Bernoulli's theorem and its applications (Lift of an Airplane, Atomizer) , Poiseuilli's formula, Reynolds number, Terminal velocity, Stokes law by the method of dimension, Variation of viscosity with temperature.

Unit IV: (7.5 Hrs)

Surface tension: Introduction, Relation between radius of curvature, pressure and surface tension. Angle of contact and wetting, Surface energy, Pressure difference across a liquid surface: Excess pressure inside a spherical liquid drop, Excess pressure inside a soap bubble. Surface tension by Jaeger's, Quincke's and Capillary rise methods

References & Text books:

1. Applied Fluid Mechanics, by Mott Robert, Pearson Benjamin Cummir, VI Edition, Pearson Education/Prentice Hall International, New Delhi
2. Properties of Matter, by D. S. Mathur, Shamlal Chritable Trust New Delhi
3. Properties of Matter, by Brijlal
4. Physics for Degree Students B.Sc.-Part-I, by- C. L. Arora, Dr. P. S. Hemne, S Chand & Company.

5. General Properties of matter, by J. C. Upadhyay, Ram Prasad & Sons
6. Mechanics, by D. S. Mathur, S Chand.
7. Mechanics, by B. M. Roy, Das Ganu Publications.
8. A text book of properties of Matter, by N. S. Khare& S. Kumar.
9. Mechanics & Properties of Matter, by J. C. Upadhyaya.

B.SC.I, SEM I
DSC: LAB, B-PH112P Credit: 2

Objective: To provide the practical skill of mechanics, properties of matter and thermodynamics
Course Outcomes: After completing this course, students should be able to

1. Handle and use the basic measurement tools in laboratory
2. Determine mechanical properties of matter by various methods
3. Demonstrate thermal properties of matter and related the concepts
4. Analyse and compare the results obtained by various methods

List of the experiments:

1. Range and least count of Instruments, measurements using various instruments and error analysis (vernier callipers, screw gauge, traveling microscope, spectrometer etc.)

1. Acceleration due to gravity by bar pendulum
2. Young's modulus by cantilever.
3. Young's modulus by bending of beam.
4. Young's modulus by vibrational method.
5. Modulus of rigidity by Torsional pendulum.
6. Modulus of rigidity by Maxwell's needle.
7. Determination of η by statical method.
8. To determine Coefficient of Viscosity of water by Poiseulle's method.
9. Surface tension of a liquid by Quincke's method.
10. Surface tension of a liquid by Capillary rise method.
11. To determine the moment of inertia of a body using torsion pendulum.
12. To determine the moment of inertia of a fly-wheel.

References:

1. B. Sc. Physics practical by C. L. Arora
2. B. Sc. Physics practical by H. Singh, P.S. Hemne
3. B. Sc. Physics practical by Gita Sanon

B.SC.I, SEM I

GE: Everyday Physics: B-PH113T Credit: 2

Objective: To provide day to day life physics information or phenomena

Course Outcomes: After completing this course, students should be able to

1. Handle and use the basic knowledge of optical phenomena
2. Understand the phenomena about the motion of the bodies.
3. Handle the electric gadgets.
4. Understand the phenomena about the solar devices and thermal equipments.

Unit-I **(7.5 Hrs)**

Reflection, refraction, diffraction, interference, scattering (elementary ideas only) – examples from daily life – apparent depth, blue color of sky, twinkling of stars, Concave and convex mirrors, Lenses – focal length, power of a lens, refractive index, prism, dispersion. Human eye, defects of the eye – myopia, hypermetropia, presbyopia and astigmatism and their correction by lens.

Unit II **(7.5 Hrs)**

Velocity, acceleration, momentum, Inertia, force - laws of motion. Newton's law of gravitation, acceleration due to gravity, mass and weight, apparent weight, weightlessness Rotational motion, Moment of inertia, torque, centripetal and centrifugal acceleration examples- banking of curves, centrifugal pump, and roller coasters.

Unit III: **(7.5 Hrs)**

Ohms law, current measurements, voltage measurements, AC and DC voltages, battery eliminators, Dry cell battery, Working of Heater, Electric iron, water heating rod, Fuse, refrigerates, coolers and fans, precautions while handling household electric and electronic equipment,

Unit IV: **(7.5 Hrs)**

Laws of thermodynamics, heat engine, Pressure cooker working, gas Geezers, basic knowledge of surface tension, capillary action, viscosity, elasticity, Solar cell, solar battery, solar heater

References:

1. Physics of Everyday phenomena, by Griffith, Mc-Graw Hill
2. The physics of Everyday things by James Kakalios, Hachette UK publication.

B.SC.I, SEM I

GE: Storytelling Physics: B-PH114T Credit: 2

Objective: To provide the necessary information regarding development of physics via different happenings.

Course Outcomes:

After completing this course, students should be able to

1. Understand the motion of earth and related laws
2. To understand the nature of smallest part the elements
3. To understand the discovery of high energy electromagnetic radiations
4. Understand the possible origin of universe

Unit I: The History of The Earth's Rotation

Aristotle's concept about the universe, Copernicus theory, Brahe's Model of the Universe, Kepler's laws of planetary motion, Fundamental forces: Gravitational force, Electromagnetic force, Weak nuclear force, Strong nuclear force

Unit II: Story of Atomic Models

Structure of atom, Atomic number, Mass number, Atomic models: John Dalton's atomic model, Plum pudding model, Rutherford's model of the atom, Bohr's model of the atom, Electron Cloud Model/Quantum Mechanics Model of Atom

Unit III: Discovery of X-rays and Radioactivity

An introduction to Electromagnetic spectrum, Wavelength and frequency relationship, Discovery of X-rays, X-ray properties, X-ray uses

Radioactivity process, Discovery of Radioactivity, Alpha decay, Beta decay, Gamma Decay, Law of radioactive decay, Applications of radioactivity

Unit IV: Discovery of Big-Bang and Gamma Ray Bursts

Big Bang hypothesis, Accidental discovery of Big-Bang, Experiments supporting the existence of Big-Bang, Timeline of Big-Bang: Singularity, Inflation epoch, Cooling Epoch, Structure epoch

Gamma Ray Bursts: Concept of Supernova Explosion, Origin of GRBs, Discovery of GRBs, Importance of GRBs

References:

1. Concept of Physics by H. C. Verma

2. The physical universe: An introduction to Astronomy by Frank shu; University Science book publication

3. Kimayagar by Achyut Godbole, Rajhans Publication

4. NCERT books 11th and 12th Physics

B.SC.I, SEM I

VSEC: Physical Measurement Techniques, (B-PH115P) Credits:2

Objective: To provide the knowledge of day to day measuring instruments

Course Outcomes:

After completing this course, students should be able to

1. to measure parameters by suitable instruments.
2. calibrate the measuring tools.
3. understand the accuracy in the measurements.

Experiments

1. Use of ruler, thermometer, stopwatch, digital balance, measuring cylinder for measurement of different physical quantities
2. To Measure the diameter of a coin using Vernier callipers
3. To measure the inner diameter of a cylinder using Vernier callipers
4. To measure the diameter of a pin using micrometre screw gauge
5. To measure the thickness of a given sheet using micrometre screw gauge
6. To measure the diameter of a capillary tube using travelling microscope
7. To find the Refractive Index of a Glass Slab using a travelling microscope
8. To measure the radius of curvature of a convex lens using spherometer
9. To measure the angle of prism using spectrometer
10. Measurement of joint's range of motion using goniometer

References

1. B. Sc. Physics practical by C. L. Arora
2. B. Sc. Physics practical by H. Singh, P.S. Hemne
3. B. Sc. Physics practical by Gita Sanon

B.SC.I, SEM I

VSEC: Designing Power Supply, (B-PH116P) Credits:2

Objective: To provide the knowledge of power supply and batteries.

Course Outcomes:

After completing this course, students should be able to

1. design power supply of various output current and voltage.
2. Understand the selectivity of battery for various electronic devices.
3. Understand the precautions to avoid the electronics instruments to get damage.

Experiments Based On:

1. To study the voltage versus time graph of dry cell and step down transformer using CRO
2. To study the circuit of half wave rectifier
3. To study the circuit of full wave rectifier
4. To study the circuit of bridge rectifier
5. To study different types of filters
6. To prepare a Zener regulated power supply
7. To prepare an IC regulated power supply using 78xx series
8. To prepare an IC regulated power supply using 79xx series
9. To prepare a dc dual power supply of $\pm$ 5 volts
10. To prepare a variable voltage regulated power supply using IC LM 317

References:

1. Basic electronics by V. K. Mehata
2. B. Sc. Practical Physics by C. L. Arora

1. Basic Electronics (Solid State), by B. C. Theraja.
2. Electronic Principles by A. Malvino and D. J. Bates (Mc Graw Hill Education, India)

B.SC.I, SEM I

IKS: Introduction to Metaphysics, B-PH117T, Credit: 2

Objective: To introduce the concepts in metaphysics and classical Indian philosophy

Course Outcomes: After completing this course, students should be able to

1. Elaborate the metaphysical theories held by the different schools of classical Indian philosophy.
2. Compare the metaphysical theories held by the different schools of classical Indian philosophy.
3. Formulate the salient features of Indian metaphysics and epistemology.
4. Communicate the different views of reality and knowledge in Indian philosophy.

Unit I **7.5hrs**

What is Metaphysics? Metaphysics and physics, Nature and scope of metaphysics, Concepts in Metaphysics: Mind and body, Existence, Universals and particulars, Causation, Substance, Identity, Persistence through time, Modality.

Unit II **7.5hrs**

Types of metaphysical theory, Platonism, Aristotelianism, Kantianism, Idealism, Materialism, Naturalism, The epistemology of metaphysics,

Unit III **7.5hrs**

Classical Indian Metaphysics, Orthodox Schools: Sankhya, Yoga, Nyaya, Vaisesika, Purva-Mimansa, Vedanata.

Unit IV **7.5hrs**

Heterodox Schools: Jainism, Buddhism, Charvaka. Contemporary metaphysics, Analytic metaphysics in the 20th century.

References:

1. Metaphysics: A Very Short Introduction By Stephen Mumford · 2012
2. Metaphysics: The Key Concepts
3. By Nikk Effingham, Helen Beebee, Philip Goff · 2010
4. Roy W Perret. An Introduction to Indian Philosophy. UK: Cambridge University Press, 2016.
5. P. K. Mukhopadhyaya. Indian Realism. Calcutta: Lexington Books,1984.

END of SEM I

BSc Physics SEM-II

DSC: Thermodynamics and Statistical Physics, B-PH121T Credit: 2

Objective: To provide the knowledge regarding thermodynamics and statistical physics.

Course Outcomes: After completing this course, students should be able to

1. Explain the laws of thermodynamics and establish the limit on efficiency of Cornot's cycle
2. Derive the Maxwell's general relation and explain its applications
3. Analyse the experimental results using concepts in statistical mechanics
4. Develop framework for solving thermodynamic problems using statistical mechanics

Syllabus

Unit I: 7.5 hrs.

Thermodynamics I: Thermodynamic variables, Thermal equilibrium and temperature, Zeroth law of thermodynamics, Thermodynamic scales of temperature, Thermodynamic processes (Reversible and Irreversible), Indicator diagram, First law of thermodynamics, Carnot's cycle and it's efficiency, Carnot's theorem

Unit II: 7.5 hrs.

Thermodynamics II: Entropy, Second and third law of thermodynamics, Maxwell general relationship [$\delta(T, S)/ \delta(x, y) = \delta(P,V)/ \delta(x, y)$] and it's applications, Joules coefficient, Porous plug experiment, Liquefaction of gases- Boyle's temperature and inversion temperature, Liquefaction of Helium, Air conditioning (Concept only).

Unit III: 7.5 hrs.

Statistical physics I: Probability and frequency, Joint and Conditional probability, Mean value, variance, probability distribution, thermodynamic probability, Principle of a priori probability, Binomial distribution: mean values, fluctuations

Unit IV: 7.5 hrs.

Statistical physics II: Maxwell velocity distribution: Mean values and applications (1D, 2D and 3D) of Maxwell velocity distributions, μ- space, Gamma space, Phase space, accessible and inaccessible states, macro and micro states, Concept of Ensembles and their types.

References and Text books:

1. Heat, Thermodynamics and Statistical Physics, by Pragati Prakashan , Singhal, Agrawal.
2. Heat and Thermodynamics, by Brijlal, Subramanyam.
3. Heat, thermodynamics and statistical physics, by Brijlal, Subramayam and Hemne.
4. Heat and thermodynamics, by C. L. Arora.

BSc Physics SEM-II

DSC: LAB, B-PH122P

Objective: To provide the practical knowledge of thermodynamics

Course Outcomes: After completing this course, students should be able to

List of Experiments

1. To determine the pressure coefficient of air by constant volume air thermometer.
1. To verify the Stefan's law of radiation by using an incandescent lamp.
2. Thermal conductivity of a metal rod using Forbes method.
3. Thermal conductivity of a bad conductor by Lee's disc method.
4. To determine the critical temperature and critical pressure of a gas.
5. To determine the coefficient of thermal conductivity of glass in the form of a tube.
6. To determine specific heat of a given liquid by method of cooling.
7. To determine the mechanical equivalent of heat (J) with the help of Joule's calorimeter.
8. To determine temperature coefficient of resistance of platinum using platinum resistance thermometer
9. Study of heating efficiency of electrical kettle with varying voltages.
10. To determine the coefficient of thermal conductivity of rubber in the form of a tube.
11. To verify the laws of probability distribution throwing one coin, two coin.
12. To show that the deviation of probability of an event from theoretical value decreases with increase in number of events
13. Study of statistical distribution from the given data and to find (a) most probable value (Mp), (b) average

References:

4. B. Sc. Physics practical by C. L. Arora
5. B. Sc. Physics practical by H. Singh, P.S. Hemne
6. B. Sc. Physics practical by Gita Sanon

BSc Physics SEM-II

GE: BASIC CONCEPTS IN PHYSICS B-PH123T Credits: 2

Objective:

1. To introduce the basic concepts of electrostatics
2. To inculcate a scientific awareness about optics and modern physics
3. To understand the atomic structure, radioactive nucleus and thermodynamics

Course Outcomes:

After completing this course, the learner will be able to

1. understand the electrostatics
2. understand optics and modern physics laws
3. understand the atomic structure, radioactive nucleus and thermodynamics

Unit I **7.5 Hrs**

Electric charges, Electric field, Electric flux, Electric potential, Electric current, drift velocity, mobility, electrical resistivity and conductivity, Kirchhoff's rules, Biot – Savart law, Ampere's law and its applications, Faraday's laws, induced EMF and current, Lenz's Law, Self and mutual induction.

Unit II **7.5 Hrs**

Reflection, Refraction, total internal reflection and optical fibers, Diffraction, Microscopes and astronomical telescopes and their magnifying powers, interference, Young's double slit experiment, coherent sources, Dual nature of radiation, Photoelectric effect, Matter waves.

Unit III **7.5 Hrs**

Structure of atom, Alpha-particle scattering experiment; Rutherford's model of atom, Bohr model of hydrogen atom, hydrogen line spectra, Composition of nucleus, nuclear force, Mass-energy relation, mass defect, nuclear fission, nuclear fusion.

Unit IV **7.5 Hrs**

Heat, Zeroth law of thermodynamics, First law of thermodynamics, Second law of thermodynamics, isothermal, adiabatic, reversible, irreversible, and cyclic processes, perfect gas, degrees of freedom, specific heat capacities of gases, mean free path, Avogadro, number, heat, work and internal energy.

References :

1. Concept of Physics by H. C. Verma
2. Heat and thermodynamics, by C. L. Arora
3. Optics, by Ajay Ghatak.
4. Atomic and Nuclear Physics, by N. Subramanyam, Brijlal.

BSc Physics SEM-II

GE: Physics of Solar System B-PH124T Credits: 2

Course objectives:

1. To introduce the learners to an exciting topic of Solar system
2. To inculcate a scientific awareness about the Solar system
3. To understand the origin and the structure of the Sun and the planets
4. To explore the properties of the planets in Solar system

Course outcomes:

After completing this course, the learner will be able to

4. explain the origin of the solar system
5. explain the various components of the Solar system
6. explain the origin and the types of planets
7. compare and contrast the terrestrial planets and the Jovian planets
8. describe, in a scientific way, the mechanism of energy production in the Sun

Unit I: Basics of the Solar system 7.5 hrs.

Invention of Solar system, components of solar system: planets and their satellites, minor planets (meteoroids, meteors and mereorites) comets, age determination of solar system

Unit II: Origin of the Solar system 7.5 hrs.

The nebular hypothesis, the condensation theory, formation of terrestrial planets and Jovian planets, formation of moons, rings and comets

Unit III: The Sun as a star 7.5 hrs.

Position of the Sun on H-R diagram, the atmosphere of the Sun, interior structure of the sun, chromospehere and corona of the Sun

Unit IV: Energy production in the Sun 7.5 hrs.

Structure of an atom, nuclear fission and fusion process, thermonuclear reaction, proton-proron chain reaction, CNO cycle, Solar neutrino experiment

References:

1. Seven Wonders of the Sky by Jayant Vishnu Narlikar,Cambridge University Press
2. Astrophysics for Physicists by Arnab Rai Chaudhari, Cambridge University Press
3. “Aakashashi jadale nate” by Jayant Vishnu Narlikar, Rajhans Publication
4. An Introduction to astrophysics by Baidyanath Basu, PHI Learning Pvt. Ltd.
5. The Physical Universe by Frank H. Shu, University of California, Berkeley

BSc Physics SEM-II
VSEC: Maintenance of household appliances, B-PH125P

Objectives: To understand handling and maintenance of household appliance based on electrical and thermo dynamical concepts.

Outcomes: Students will be able:

1. To understand refrigerator working and maintenance
2. To test the components household gadgets
3. To repair the same as above
4. To repair the concept of electrical and electronic gadgets
5. To able to perform the periodic maintenance

Experiments:

1. To repair the refrigerator having problems like poor cooling, not defrosting, faulty thermistor, door does not close well
2. To repair the refrigerator having problems like: condensation or formation of ice inside the unit, food in the refrigerator is frozen, bad odour
3. To inspect and clean filter, coils, blowers and fan of air conditioner
4. To lubricate motor, bearings and adjust or replace fan belt of air conditioner
5. To service the gas stove for regular maintenance
6. To change the broken induction glass top and to replace faulty induction coil in the induction stove
7. To repair mixer/ grinder for problems like: broken coupler, leakage from jar, tripping problem, blunt blades problem, motor is not rotating, jammed jar blades, spark and burning smell inside mixer grinder
8. To fix the problems of washing machine like: machine is leaking, noisy machine, machine moves around, spin problem, machine won't fill with water, Door opening problem, clogged machine/ won't drain, smelly (bad odour) problem, machine ruining clothing, switching on problem
9. To troubleshoot water purifier with problems like : unusual water taste or smell from the water purifier, slow water flow from the water purifier, water purifier's faucet is making unusual noises, water leakage from faucet or filter/ membrane, R/O water tank does not fill up
10. To repair vacuum cleaner for problems like: Loss of suction, clogged filter, jammed cleaning head, stick vacuum cleaner batteries

References:

1. Service manuals of household appliances from google

BSc Physics SEM-II

Electrical and Electronic measurement techniques: B-PH126P

Objectives: To study some electrical and electronics parameters, physical quantities or Properties

Outcomes: Students will be able:

To use DMM and CRO for electrical measurements

To test the components consisting of p-n junctions

To perform experiments using simulator

To understand the concept of electrical and electronic physical quantities

1. Study of digital multi-meter (DMM)
2. Study of cathode ray oscilloscope (CRO)
3. Testing of diode and transistor using DMM
4. Calibration of CRO for measurement of frequencies
5. To find the unknown frequency of a source using Lissajous figures
6. To find the Zener breakdown voltage
7. To find the knee voltage of a diode
8. Measurement of inductance using Maxwell bridge (using simulator link from virtual lab of IIT Kharagpur)
9. Measurement of capacitance by Schering bridge method (using simulator link from virtual lab of IIT Kharagpur)
10. Measurement of resistance using Wheatstone bridge (using simulator link from virtual lab of IIT Kharagpur)

References:

1. DMM and CRO manuals
2. BSc Physics practical by C L Arora
3. Virtual lab of IIT Kharagpur

BSc Physics SEM-II

IKS: Indian Contribution to Astronomy, B-PH127T Credits: 2

Course objectives:

- To introduce the learner to the exciting branch of astronomy
- To introduce the learner about the rise of astronomy in India
- To introduce the learner to the great ancient astronomers and their work
- To introduce the learner to the scientific concept of telescopes

Course outcomes:

After completing the course, the learner will be able to

1. explain the rise of astronomy India
2. understand the contribution of great scientist in the field of astronomy
3. explain the basic concept of astronomical telescope
4. elaborate the history of few ancient observatories in India

Unit I: Roots of Indian astronomy 7.5 Hrs

Worldwide rise of astronomy, rise of astronomy in India, Vedic astronomy, siddhantic astronomy, Zij astronomy, modern astronomy

Unit II: Contribution of Aryabhatta to Astronomy 7.5 Hrs

Motion of earth and other planets arround earth, motion of the Earth around itself, concept of day and night, solar and sidereal time, heliocentric and geocentric universe, theory be hinding the shing of moon

Unit III: Siddhantic era of indian astronomy 7.5 Hrs

Concept of longitude and latitude, concept of astrolabe, uses of astrolabe made by Mahendra Suri, Contribution of Bramhagupta and Varahamihira, Properties of gravitational force, motion of moon around earth, phases of moon,

Unit IV: Modern astronomy 7.5 Hrs

Discovery of astronomical telescope, types of astronomical telescopes, establishment of Madras observatory, establishment of Kodaikanal observatory, establishment of Nizamiah Observatory, U.P. state observatory in Nainital

References:

1. Astronomy in India- A perspective by Rajesh Kochhar & Jayant Narlikar, Indian National Science Academy
2. Astronomy in India: Past, Present, and Future by Rajesh Kochhar & Jayant Narlikar, Inter-University Centre for Astronomy & Astrophysics, 1993
3. Astronomy in India: A Historical Perspective, edited by Thanu Padmnabham, Springer Nature
4. Modern Astronomy in India by K.D. Abhaynkar, Journal of the Royal Astronomical Society of Canada, Vol. 58, p.218
5. The Story of Astronomy in India BY Chander Mohan

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

DSC: BPH231T : PAPER- I (Waves and Oscillations)

Marks- 40 **Time- 30 hours**

Objective: To provide the knowledge of wave and oscillations and acoustics

Course Outcomes: After completing this course, students should be able to

1. Compare the behaviours of free, damped and forced oscillations
2. Apply the concepts based on CO1 in laboratory
3. Explain the propagation of mechanical waves and its applications
4. Define ultrasonic and acoustic waves and explain their applications

Unit I: **7.5 hrs.**

Free oscillations: Introduction to linear and angular S.H.M., Differential equation of S.H.M. and its solution, Composition of two perpendicular linear S.H.M.s for 1:1 and 1:2 (analytical method), Lissajous's figures

Damped oscillations: Differential equation of damped harmonic oscillator and its solution, Energy equation of damped oscillations, Power dissipation and quality factor.

Unit II: **7.5 hrs.**

Forced oscillations: Forced oscillation with one degree of freedom, Differential equation of forced oscillation and its solution, Resonance (Amplitude), Sharpness of resonance, Power dissipation, Quality factor and bandwidth

Waves in media: Speed of wave on a string, Standing waves, principle of superposition of waves, Phase velocity and group velocity, Harmonics, Quality of sound, Human ear and its response (Diagrammatic introduction only), Limit of human audibility, Intensity and loudness, bel and decibel, the musical scale, Temperaments and musical instruments

Unit III: **7.5 hrs.**

Applied acoustics: Transducers and their characteristics (Crystal microphone, Moving coil loud speaker), Recording and reproduction of sound (Magnetic tape, Cine film, Compact disc), Acoustic of building, Reverberation and reverberation period, Sabine's formula, Factors affecting the acoustics of building, Requirements for good acoustics

Unit IV: **7.5 hrs.**

Ultrasonics: Introduction, Properties and production of ultrasonic waves, piezoelectric effect, piezoelectric generator, Magneto-striction effect and oscillators, Frequency of ultrasonic waves, Application of ultrasonic waves (measurement of depth of sea, SONAR system and Medical science).

References and Text books:

1. Waves and Oscillations, by Stephenson.
2. A Text Book of Oscillations, waves and Acoustic, by Dr. M. Ghosh, Dr. D. Bhattacharya.
3. Oscillation, waves and sound, by Sharma and Saxena.
4. Waves and oscillation, by N. Subrahmanyam and Brijlal.
5. The Physics of waves and oscillation, by N. K. Bajaj, Tata McGraw-Hill, publishing co. ltd.
6. A Text Book of sound, by Khanna , Bedi

7. A Text Book of sound, by L. P. Sharma, Saxena (S. Chand)
8. Properties of Matter and Acoustics, by R. Murugeshan, Kiruthign Sivaprakash.
9. Fundamental of Acoustics 4th Edition, by Kinsler , John Wiley and Sons.
10. Basic Acoustics, by D. E. Hall, Oxford University Press.
11. A Text Book of Oscillations, Waves and Acoustics, by Dr. M. Ghosh, Dr. D. Bhattacharya (S. Chand)
12. Oscillation, Waves and Sound, by Sharma and Saxena.
13. Science and Technology of Ultrasonics, by Baldevraj, Narosa.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

DSC: BPH232T : PAPER- II (Electrostatics and Magneto-statics)

Marks- 40 **Time- 30 hours**

OBJECTIVES:

1. To disseminate the knowledge of electric field and dielectrics
2. To disseminate the fundamental knowledge of magnetism and magnetostatics
3. Provide opportunities for scientific study and creativity

OUTCOMES:

1. Students gain knowledge of electric field and dielectrics
2. They gain knowledge of magnetism and magnetostatics
3. Apply the knowledge to solve problems based on above properties to strengthen their concepts

Unit I: **7.5 hrs.**

Electrostatics: Coulombs law in vacuum in vector form, Force between two charges, Electric field intensity, Electric potential, Electric field intensity due to a point charge, Electric dipole, Electric dipole moment, Electric field intensity due to an electric dipole, Electric field as a negative gradient of potential, Conservative nature of the electric field.

Unit II: **7.5 hrs.**

Dielectric: Introduction, definition of polar and non polar molecules, Polarization of charges in a dielectric, Clausius - Mossotti equation, Three electric vectors D, E and P and relation between them, Concept of capacitance, Parallel plate capacitor without and with dielectric, application of Gauss's law to parallel plate capacitor.

Unit III: **7.5 hrs.**

Magnetism: Introduction, Magnetic materials, Langevin's theory of diamagnetism, its application as superconductor, Critical magnetic field and Meissner effect, Langevin's theory of para magnetism, Ferromagnetism, Ferromagnetic domain, Curie temperature, Ferrimagnetism, Ferrites and its applications, Antiferromagnetism, Neel temperature.

Unit IV **7.5 hrs.**

Magnetostatics: Concept of magnetic field, Lorentz force equation, Magnetic dipole moment, angular momentum and gyromagnetic ratio, Biot- Savart's law, It's applications (B due to steady current in a long straight wire, B along the axis of circular coil), Ampere's law, It's applications(B for a solenoid, A Toroid), Magnetization current, Magnetic vectors, Gauss law of magnetization.

References and Text books:

1. Electricity and Magnetism, by D. C. Tayal
2. Electricity and Magnetism, by Rakshit, Chottopadhay
3. Electricity and Magnetism, by S. S. Atwood.
4. Electricity and Magnetism, by K. K. Tewari.
5. University physics, by J. C. Upadhyay, Himalaya publications.
6. Foundation of Electrodynamics, by Theory, Rietz and Millford.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

DSC: BPH233P: Practical

1. Frequency of A.C. Mains by **Sonometer.**
2. Study of **Lissajous's** figures using CRO
3. To determine the dielectric constant of capacitor.
4. Finding the frequency of tuning fork using **Meldes experiment**
5. Study of oscillations of a spring.
6. To determine unknown frequency and to verify the law of inverse variation of frequency and volume of air by **Helmholtz resonator.**
7. To determine the velocity of sound wave in air (gas) with Kundt's tube.
8. Measuring the output voltage of a **microphone** over a range of audio frequencies to plot its frequency response.
9. Plotting the impedance of a **loudspeake**r as a function of frequency to determine its resonant frequency
10. Determination of **velocity of sound** using **volume resonator**
11. To determine the horizontal component of Earth's magnetic field and magnetic moment of the magnet.
12. To study the variation of magnetic field along the axis of a current carrying circular coil.
13. Study of magnetic field by vibration magnetometer.
14. Study the speed of waves on stretched string.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

PH234T

Minor: Physics of waves and Oscillations

Unit I:

7.5 hrs.

Free oscillations: Introduction to linear and angular S.H.M., Differential equation of S.H.M. and its solution, Composition of two perpendicular linear S.H.M.s for 1:1 and 1:2 (analytical method), Lissajous's figures

Damped oscillations: Differential equation of damped harmonic oscillator and its solution, Energy equation of damped oscillations, Power dissipation and quality factor.

Unit II:

7.5 hrs.

Forced oscillations: Forced oscillation with one degree of freedom, Differential equation of forced oscillation and its solution, Resonance (Amplitude), Sharpness of resonance, Power dissipation, Quality factor and bandwidth

Waves in media: Speed of wave on a string, Standing waves, principle of superposition of waves, Phase velocity and group velocity, Harmonics, Quality of sound, Human ear and its response (Diagrammatic introduction only), Limit of human audibility, Intensity and loudness, bel and decibel, the musical scale, Temperaments and musical instruments

Unit III:

7.5 hrs.

Applied acoustics: Transducers and their characteristics (Crystal microphone, Moving coil loud speaker), Recording and reproduction of sound (Magnetic tape, Cine film, Compact disc), Acoustic of building, Reverberation and reverberation period, Sabine's formula, Factors affecting the acoustics of building, Requirements for good acoustics

Unit IV:

7.5 hrs.

Ultrasonics: Introduction, Properties and production of ultrasonic waves, piezoelectric effect, piezoelectric generator, Magneto-striction effect and oscillators, Frequency of ultrasonic waves, Application of ultrasonic waves (measurement of depth of sea, SONAR system and Medical science).

References and Text books:

14. Waves and Oscillations, by Stephenson.
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16. Oscillation, waves and sound, by Sharma and Saxena.
17. Waves and oscillation, by N. Subrahmanyam and Brijlal.
18. The Physics of waves and oscillation, by N. K. Bajaj, Tata McGraw-Hill, publishing co. ltd.
19. A Text Book of sound, by Khanna , Bedi
20. A Text Book of sound, by L. P. Sharma, Saxena (S. Chand)
21. Properties of Matter and Acoustics, by R. Murugeshan, Kiruthign Sivaprakash.
22. Fundamental of Acoustics 4th Edition, by Kinsler , John Wiley and Sons.
23. Basic Acoustics, by D. E. Hall, Oxford University Press.
24. A Text Book of Oscillations, Waves and Acoustics, by Dr. M. Ghosh, Dr. D. Bhattacharya (S. Chand)
25. Oscillation, Waves and Sound, by Sharma and Saxena.

Science and Technology of Ultrasonics, by Baldevraj, Narosa.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

MINOR: BPH235T : (Static electricity and Magnetism)

Marks- 40 **Time- 30 hours**

OBJECTIVES:

1.To disseminate the knowledge of electric field and dielectrics

2.To disseminate the fundamental knowledge of magnetism and magnetostatics

3.Provide opportunities for scientific study and creativity

OUTCOMES:

1.Students gain knowledge of electric field and dielectrics

2.They gain knowledge of magnetism and magnetostatics

3.Apply the knowledge to solve problems based on above properties to strengthen their concepts

Unit I: **7.5 hrs.**

Electrostatics: Coulombs law in vacuum in vector form, Force between two charges, Electric field intensity, Electric potential, Electric field intensity due to a point charge, Electric dipole, Electric dipole moment, Electric field intensity due to an electric dipole, Electric field as a negative gradient of potential, Conservative nature of the electric field.

Unit II: **7.5 hrs.**

Dielectric: Introduction, definition of polar and non polar molecules, Polarization of charges in a dielectric, Clausius - Mossotti equation, Three electric vectors D, E and P and relation between them, Concept of capacitance, Parallel plate capacitor without and with dielectric, application of Gauss's law to parallel plate capacitor.

Unit III: **7.5 hrs.**

Magnetism: Introduction, Magnetic materials, Langevin's theory of diamagnetism, its application as superconductor, Critical magnetic field and Meissner effect, Langevin's theory of para magnetism, Ferromagnetism, Ferromagnetic domain, Curie temperature, Ferrimagnetism, Ferrites and its applications, Antiferromagnetism, Neel temperature.

Unit IV **7.5 hrs.**

Magnetostatics: Concept of magnetic field, Lorentz force equation, Magnetic dipole moment, angular momentum and gyromagnetic ratio, Biot- Savart's law, It's applications (B due to steady current in a long straight wire, B along the axis of circular coil), Ampere's law, It's applications(B for a solenoid, A Toroid), Magnetization current, Magnetic vectors, Gauss law of magnetization.

References and Text books:

7. Electricity and Magnetism, by D. C. Tayal
8. Electricity and Magnetism, by Rakshit, Chottopadhay
9. Electricity and Magnetism, by S. S. Atwood.
10. Electricity and Magnetism, by K. K. Tewari.
11. University physics, by J. C. Upadhyay, Himalaya publications.
12. Foundation of Electrodynamics, by Theory, Rietz and Millford.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

Minor : BPH236P : Practical

1. Frequency of A.C. Mains by **Sonometer.**
2. Study of **Lissajous's** figures using CRO
3. To determine the dielectric constant of capacitor.
4. Finding the frequency of tuning fork using **Meldes experiment**
5. Study of oscillations of a spring.
6. To determine unknown frequency and to verify the law of inverse variation of frequency and volume of air by **Helmholtz resonator.**
7. To determine the velocity of sound wave in air (gas) with Kundt's tube.
8. Measuring the output voltage of a **microphone** over a range of audio frequencies to plot its frequency response.
9. Plotting the impedance of a **loudspeake**r as a function of frequency to determine its resonant frequency
10. Determination of **velocity of sound** using **volume resonator**
11. To determine the horizontal component of Earth's magnetic field and magnetic moment of the magnet.
12. To study the variation of magnetic field along the axis of a current carrying circular coil.
13. Study of magnetic field by vibration magnetometer.
14. Study the speed of waves on stretched string.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

GE: BPH237T: PAPER- V (Physics of Planet earth)

Marks- 40 **Time- 30 hours**

Course objectives:

- To inculcate the learner about the scientific knowledge of planet Earth
- To introduce the learner to the concept of origin and evolution of Earth
- To introduce the learner about the interior and the atmosphere of Earth
- To introduce the learner about the magnetic as well as thermal properties of planet Earth

Course outcomes:

After completing the course, the learner will be able to

- explain the origin, evolution and dynamics of planet Earth
- explain the interior and the atmosphere of Earth
- explain the magnetic as well as thermal properties of planet Earth

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Unit I: Origin And Evolution Of Earth **7.5 Hrs**

Origin of Solar system, nebular hypothesis, condensation theory, terrestrial planets and jovian planets, the melting of solid Earth, Keplers laws of planetary motion, dynamic evolution of Solar system, speed and momentum of Earth, Gravitational potential of a nearly spherical body, Rotation, ellipticity and gravity

Unit II: Interior And Atmosphere of Earth **7.5 Hrs**

Formation of Earth's atmosphere, formation of the oscens, formation of Ozon layer, continental drift, sea floor spreading. Internal constitution of the earth, characteristics of lithosphere, and asthenosphere, causes of geodynamical process, geodynamic models, continental drift, Ocean floor spreading, plate tectonics and its geological implications, oceanic ridges, trenches and island arcs.

Unit III: Magnetic Properties Of Earth **7.5 Hrs**

Origin of geomagnetic field, theory of Earth's magnetism, Components of Earth's magnetic field, angle of dip, reversals of geomagnetic field, secular variations and westward drift, geomagnetic storms, polar wandering, geologic time, Palaeomagnetic studies of rock samples and their applications.

Unit IV: Thermal Proeprties of Earth **7.5 Hrs**

Importance of heat flow, thermal history of the earth, sources of heat generation and temperature distribution inside the earth, Jacob's hypothesis for liquid nature of the outer core, Radiogenic heat, Thermal contraction, gravitational energy and the heat capacity, Energy balance of the core, Thermodynamic efficiency, buoyancy forces and convective power.

References:

- An Introduction to astrophysics by Baidyanath Basu, PHI Learning Pvt. Ltd.
- The Physical Universe by Frank H. Shu, University of California, Berkeley
- Seven Wonders of the Sky by Jayant Vishnu Narlikar,Cambridge University Press
- Astrophysics for Physicists by Arnab Rai Chaudhari, Cambridge University Press
- Howell: Introduction to Geophysics
- Stacey: Physics of the Earth
- Lowrie: Fundamentals of Geophysics

- Chapman: Earth's Magnetism
  Activities
- Experience the Zero shadow day. What will be the physics behind it?
- Think about the thermal properties of three phases of water found on earth.
  Observe the orientation of freely suspended magnetic niddle. Is there any relation with Earth’s magnetic field?

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - III

VSEC C ProgrammingB-PH238P

2 Credits

1. C program to display “Hello World”
2. C program to sum 2 integers from user
3. C program to calculate simple interest
4. C program to multiply float numbers
5. C program to sort numbers (ascending or descending)
6. C program to calculate area of circle
7. C program to detect a Leap Year
8. C program to calculate volume of Sphere
9. C program to Calculate HCF and LCM
10. C program to sum Array Elements

References

1. Let Us C: Authentic guide to C programming language - 19th Edition, by Yashavant Kanetkar
2. Learn C Programming from Scratch: A step-by-step methodology with problem solving approach, by Mohammad Saleem Mir
3. The C Programming Language 2e by Brian W. Kernighan / Dennis Ritchie

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

DSC: BPH241T: PAPER- I (Introduction to Quantum Mechanics)

Marks- 40 **Time- 30 hours**

OBJECTIVES: 1. To disseminate the knowledge of quantum mechanics
2. Provide opportunities for scientific study and creativity

OUTCOMES: 1. Students gain knowledge of quantum mechanics
2. Apply the knowledge to solve problems based on above properties to strengthen their concepts

UNIT I : **7.5 hrs**.

Failure of classical physics to explain: black body radiations, wiens theory, Rayleigh-Jeans law, Planck's radiation law, photoelectric effect, characteristic of photoelectric effect, Einstein's explanation of photoelectric effect. Numerical problems.

UNIT II: **7.5 hrs**.

Compton Effect, Rutherford's model of atom, Bohr's postulates, Wave particle duality, de Broglie's hypothesis. Superposition principle, construction of wave packet, Concept of wave velocity and group velocity, Davisson and Germer experiment, Heisenberg's uncertainty principle and Heisenberg's gamma ray microscope. Numerical problems.

UNIT III : **7.5 hrs**

Schrodinger's equation (Time dependent and time independent equations), Physical significance of wave function Ψ, normalization of wave function, Probability current density, Operators, Expectation values of a dynamical quantities, Ehrenfest's theorem. Numerical problems

UNIT IV: **7.5 hrs.**

Linear operators, Eigen value and Eigen functions. One-dimensional applications of Schrodinger equations: free particle, step potential, Particle in a one dimensional potential box, Particle in a one dimensional well, rectangular potential barrier. Numerical Problems.

References:

1. Quantum Mechanics, Statistical Mechanics and SSP, by D. Chattopadhay, P. C. Rakshit.
2. Fundamentals of Quantum Mechanics, by P. R. Waghmare
3. Quantum Mechanics, by John L. Powel, Bernd Crasemann.
4. Quantum Mechanics, by Mathews and Venketesan.
5. Quantum Mechanics, by A. K. Ghatak, S. lokanathan.
6. Quantum Mechanics, by S. P. Singh, M. K. Bagde and Kamal Singh.
7. Quantum Mechanics, by Chatwal, Anand, Himalaya publications.
8. Advanced Quantum Mechanics, by- Satya Prakash, Pragati Publications.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

DSC: BPH242T: PAPER- II (Concept in electricity)

Marks- 40 **Time- 30 hours**

Objective: To provide the knowledge of various Ac circuits, power supply with their quality factors and solar energy devices

Course Outcomes: After completing this course, students should be able to

1. Explain the time dependent properties of electric fields and its applications
2. Mathematically model AC and DC Circuits and explain related concepts
3. Explain the required components and their roles in power supply
4. Explain the photovoltaic effect and determine the characteristics of PV systems

Unit I: **7.5 hrs.**

Time varying fields: Electromagnetic induction, Faradays laws in differential and integral form, Lenz's law, self and mutual induction, **Transformer**: Construction, working and its parameters, Energy losses.

Electric Currents: Current density, Equation of continuity, Kirchhoff's law, Rise and decay of current in LR and CR circuits, Decay of charge in LCR circuits

Unit II: A C Circuits **7.5 hrs.**

Application of complex number in solving an a. c. circuit: j- operator method, A.C. applied to pure resistive, pure inductive and pure capacitive circuit, application of j- operator in LR, CR and LCR circuit, Resonance, Sharpness of resonance, Series resonance circuit (Calculate I, Z, Φ and f_r),Q factor, Power in an a. c. circuit, Power factor.

Unit III: **7.5 hrs.**

Power supply- Diode characteristics (Forward and reverse), Rectification using half wave and full wave rectifiers (Find I_{dc}, V_{dc}, I_{rms}, η and ripple factor), Working of Full wave bridge rectifier, Filters, regulated and unregulated power supply, line and load regulation.

Unit IV: **7.5 hrs.**

Solar Electricity: Potential of solar energy, solar radiation and measurements, types of solar energy collectors and their advantages and disadvantages, Solar thermal electric power generation, Need and characteristics of photovoltaic system (PV), PV models and equivalent circuits.

References

1. Electricity and Magnetism, by Brijlal,Subramanyam.
2. Fundamental of Magnetism and Electricity, by D.N.Vasudiva.
3. Electricity and Magnetism with Electronics, by K.K.Tewari.
4. Electricity and Magnetism, by K.K.Tewari.
5. Elements of Electronics, by M.K.Bagde,S.P.Singh, KSingh (S.Chand.)
6. Solid state Electronic Devices II Edition, by B.G. Streetman
7. Electronic devices & circuit theory by Boylestad & Nashelsky, PHI

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

DSC: BPH243P: Practical

1. To study the characteristics of Transformer
2. Study of frequency response of series LCR circuit and determination of Q- factor.
3. Verification of Kirchhoff's laws, using electrical network.
4. To study growth/decay of current in LR circuit.
5. Study of growth of current in CR Circuit using microammeter.
6. Measurement of Inductance by phasor diagram method.
7. Measurement of Capacitance by phasor diagram method.
8. To study charging and discharging of a condenser through a resistor R.
9. To study the forward and reverse characteristics of diode
10. Study of Half wave rectifier
11. Study of full wave rectifier
12. To study regulated Power supply using zener diode
13. To study characteristics of Solar cell
14. To study the characteristics of Photovoltaic system

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

Minor: BPH244T: PAPER- I (Concepts in Quantum Mechanics)

Marks- 40 **Time- 30 hours**

OBJECTIVES: 1. To disseminate the knowledge of quantum mechanics
2. Provide opportunities for scientific study and creativity

OUTCOMES: 1. Students gain knowledge of quantum mechanics
2. Apply the knowledge to solve problems based on above properties to strengthen their concepts

UNIT I : **7.5 hrs.**

Failure of classical physics to explain: black body radiations, wiens theory, Rayleigh-Jeans law, Planck's radiation law, photoelectric effect, characteristic of photoelectric effect, Einstein's explanation of photoelectric effect. Numerical problems.

UNIT II: **7.5 hrs.**

Compton Effect, Rutherford's model of atom, Bohr's postulates, Wave particle duality, de Broglie's hypothesis. Superposition principle, construction of wave packet, Concept of wave velocity and group velocity, Davisson and Germer experiment, Heisenberg's uncertainty principle and Heisenberg's gamma ray microscope. Numerical problems.

UNIT III : **7.5 hrs**

Schrodinger's equation (Time dependent and time independent equations), Physical significance of wave function Ψ, normalization of wave function, Probability current density, Operators, Expectation values of a dynamical quantities, Ehrenfest's theorem. Numerical problems

UNIT IV: **7.5 hrs.**

Linear operators, Eigen value and Eigen functions. One-dimensional applications of Schrodinger equations: free particle, step potential, Particle in a one dimensional potential box, Particle in a one dimensional well, rectangular potential barrier. Numerical Problems.

References:

1. Quantum Mechanics, Statistical Mechanics and SSP, by D. Chattopadhay, P. C. Rakshit.
2. Fundamentals of Quantum Mechanics, by P. R. Waghmare
3. Quantum Mechanics, by John L. Powel, Bernd Crasemann.
4. Quantum Mechanics, by Mathews and Venketesan.
5. Quantum Mechanics, by A. K. Ghatak, S. lokanathan.
6. Quantum Mechanics, by S. P. Singh, M. K. Bagde and Kamal Singh.
7. Quantum Mechanics, by Chatwal, Anand, Himalaya publications.
8. Advanced Quantum Mechanics, by- Satya Prakash, Pragati Publications.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

Minor: BPH245T: PAPER- II (Basic Concept in electricity)

Marks- 40 **Time- 30 hours**

Objective: To provide the knowledge of various Ac circuits, power supply with their quality factors and solar energy devices

Course Outcomes: After completing this course, students should be able to

5. Explain the time dependent properties of electric fields and its applications
6. Mathematically model AC and DC Circuits and explain related concepts
7. Explain the required components and their roles in power supply
8. Explain the photovoltaic effect and determine the characteristics of PV systems

Unit I: **7.5 hrs.**

Time varying fields: Electromagnetic induction, Faradays laws in differential and integral form, Lenz's law, self and mutual induction, **Transformer**: Construction, working and its parameters, Energy losses.

Electric Currents: Current density, Equation of continuity, Kirchhoff's law, Rise and decay of current in LR and CR circuits, Decay of charge in LCR circuits

Unit II: A C Circuits **7.5 hrs.**

Application of complex number in solving an a. c. circuit: j- operator method, A.C. applied to pure resistive, pure inductive and pure capacitive circuit, application of j- operator in LR, CR and LCR circuit, Resonance, Sharpness of resonance, Series resonance circuit (Calculate I, Z, Φ and f_r),Q factor, Power in an a. c. circuit, Power factor.

Unit III: **7.5 hrs.**

Power supply- Diode characteristics (Forward and reverse), Rectification using half wave and full wave rectifiers (Find I_{dc}, V_{dc}, I_{rms}, η and ripple factor), Working of Full wave bridge rectifier, Filters, regulated and unregulated power supply, line and load regulation.

Unit IV: **7.5 hrs.**

Solar Electricity: Potential of solar energy, solar radiation and measurements, types of solar energy collectors and their advantages and disadvantages, Solar thermal electric power generation, Need and characteristics of photovoltaic system (PV), PV models and equivalent circuits.

References

1. Electricity and Magnetism, by Brijlal,Subramanyam.
2. Fundamental of Magnetism and Electricity, by D.N.Vasudiva.
3. Electricity and Magnetism with Electronics, by K.K.Tewari.
4. Electricity and Magnetism, by K.K.Tewari.
5. Elements of Electronics, by M.K.Bagde,S.P.Singh, KSingh (S.Chand.)
6. Solid state Electronic Devices II Edition, by B.G. Streetman
7. Electronic devices & circuit theory by Boylestad & Nashelsky, PHI

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

MINOR : BPH246P : Practical

1. To study the characteristics of Transformer
2. Study of frequency response of series LCR circuit and determination of Q- factor.
3. Verification of Kirchhoff's laws, using electrical network.
4. To study growth/decay of current in LR circuit.
5. Study of growth of current in CR Circuit using microammeter.
6. Measurement of Inductance by phasor diagram method.
7. Measurement of Capacitance by phasor diagram method.
8. To study charging and discharging of a condenser through a resistor R.
9. To study the forward and reverse characteristics of diode
10. Study of Half wave rectifier
11. Study of full wave rectifier
12. To study regulated Power supply using zener diode
13. To study characteristics of Solar cell
14. To study the characteristics of Photovoltaic system

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

GE: BPH247T: PAPER- II (Introduction to astronomy)

Marks- 40 **Time- 30 hours**

Course objectives:

- To inculcate a scientific awareness about the vastness of the space
- To introduce the learners to the exciting world of astronomy
- To explore and compare properties of the planets in solar system
- To understand the structure of the Universe and our position in it

Course outcomes:

After completing the course, the students are enable to

- identify the objects visible to the unaided eye in the night sky
- explain the phenomenon like seasons on the Earth, solar and lunar eclipses
- explain the dynamics of planets in solar system, use the orbital properties to estimate mass of the Sun
- compare and contrast the terrestrial planets and the Jovian planets
- derive the scientific understanding and explain the observed properties of stars and estimate
- their temperature, mass, size, etc.
- describe the scale of the Universe and the relative sizes of the different objects within the Universe
- describe the Earth's place in the Solar System, Galaxy, and Universe

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Unit 1: Observational Astronomy 7.5 Hrs

Contribution of Ptolemy, Copernicus, Tycho Brahe, Johannes Kepler, Galileo Galilei Concepts of Positional Astronomy: the Celestial Sphere, the cardinal points and circles on the celestial sphere, the alt-azimuth, equatorial coordinate systems, Sidereal, Apparent and Mean solar time and their relations , Constellations and nomenclature of stars: Aries, Pisces, Orion, Canis major, Taurus, Leo, Summer Triangle and Big Dipper (Saptarsi)

Unit 2: The Solar System 7.5 Hrs

The Sun and its atmosphere, planetary system, elliptical orbits of planets and Kepler's laws Terrestrial planets, Jovian Planets, characteristics of terrestrial and Jovian planets, asteroids, meteors and meteorites, comets, Phases and motion of the Moon, solar and lunar eclipses, Seasons, origin of the solar system – the nebular model

Unit 3: Astronomical Measurements 7.5 Hrs

Concept of Astronomical Unit, light year, Parcsec, Distance measurement techniques: Radar ranging, parallax method, Luminosity, flux, surface brightness of a star, apparent and absolute magnitude, Distance-modulus relationship and it's application

Unit 4: Physics of Stars 7.5 Hrs

classification of stars, H-R Diagram and its salient features, Color index and temperatures of stars, Population I and Population II stars, Life cycle of a star, White dwarf, Neutron Stars, Black hole.

Reference:

- An Introduction to astrophysics by Baidyanath Basu, PHI Learning Pvt. Ltd.
- The Physical Universe by Frank H. Shu, University of California, Berkeley
- Seven Wonders of the Sky by Jayant Vishnu Narlikar,Cambridge University Press
- Astrophysics for Physicists by Arnab Rai Chaudhari, Cambridge University Press
- V. B. Bhatia , Textbook of Astronomy and Astrophysics with Elements of
- Cosmology, Narosa Publishing House, New Delhi.
- Astrophysics: Stars and Galaxies, K. D. Abhyankar, Tata McGraw Hill
- Publication
    - An Introduction to astrophysics, Baidyanath Basu, PHI Learning Pvt. Ltd.

SUBJECT: PHYSICS

B.Sc. –II SEMESTER - IV

GE: BPH248P: (Computer hardware and maintenance**)**

Marks- 40 **Time- 30 hours**

1. Demonstrate testing and troubleshooting for power supplies in I/O devices and trace circuit of PC SMPS.
2. Identify, change settings and secure BIOS and UEFI. Update firmware, CPU, Motherboard, Storage Devices and Peripheral components. Installation of Application Software
3. Preventive maintenance of Storage devices, motherboard, power supplies, CPU, memory and display unit. Use of Multimeter and a Power Supply Tester to troubleshoot hardware problems.
4. Assemble and repair of Desktop Computer with all its hardware components.
5. Install different Operating System and all other application software.
6. Customize Operating System and maintenance of system application software.
7. Install Printer, Scanner and troubleshoot their faults.

SUBJECT: PHYSICS

B.Sc. –III SEMESTER - V

DSC: BPH351T: PAPER- I (Atomic and Nuclear Physics)

Marks: 75 **Time: 45 Hrs** **Credits: 03**

Course objectives:

1. To disseminate the knowledge of atom and related properties
2. To disseminate the fundamental knowledge of working of nuclear detectors and nuclear accelerators
3. Provide opportunities for scientific study and creativity

Learning Outcomes:

1. Students gain knowledge of various nuclear properties, decay processes
2. They gain knowledge of nuclear particle detectors and nuclear accelerators
3. Students gain the knowledge of fission -fusion reactions
3. They can apply the knowledge to solve problems to strengthen their concepts

Unit I: **12 Hrs**

Bohr's atomic model, Sommerfeld atom model, Bohr magnetron, Vector atom model, Concept of spin quantization and spin of electron, Quantum numbers associated with an atoms, Stern-Gerlach experiment, Selection rules for L, S, J, L-S coupling, J-J coupling.

Unit II: **11 Hr**

Pauli's exclusion principle, concept of shell and subshell, selection rules, Zeemen effect, Normal and Anamolous Zeemen effect, Lorentz theory of normal Zeemen effect, Quantum mechanical treatment for Zeemen effect, Lande g factor, Stark effect, experiment of Stark effect, Applications

Unit III: **11 Hrs**

Nomenclature, General properties of Nucleus, nuclear mass, concept of isotope, isobar, isomer, isotone, mass defect and binding energy, binding energy curve, packing fraction, nuclear forces, Nuclear reactions, alpha and beta decay, Neutrino, nuclear reactions.

Unit IV: **11 Hrs**

Interaction of charged particles and neutrons with matter, principle of detector, proportional counter, G-M counter, Scintillation detector, Wilson cloud chamber, Accelerators: Linear accelerator, Cyclotron, Fission-fusion reactions: Nuclear fission, nuclear fusion.

References:

1. Atomic and Nuclear Physics, S. N. Ghoshal, S. Chand
2. Atomic Physics, J. B. Rajam.
3. Modern atomic physics, Vasant Natarajan.
4. Elements of spectroscopy, Gupta, Kumar , Sharma.
5. Atomic physics, S. N. Ghoshal
6. Nuclear Physics, D. C. Tayal, (Himalaya Publishing House, Mumbai)
7. Concept of Nuclear Physics, B.L. Cohen, McGraw-Hill, 2003.
8. Nuclear & Particle Physics: An Introduction, B. Martin, Willey, 2006.

Activity:

1. **Build and Present Atomic Models**: Students prepare 3D models or digital presentations of Thomson, Rutherford, Bohr, and Quantum Mechanical models, highlighting their limitations and applications.

2. **Cloud Chamber Demonstration (Virtual/Experimental)**: Observe and interpret particle tracks using a cloud chamber or virtual simulation to understand radioactive emissions.

B.Sc. –III SEMESTER - V

DSC: BPH352T: PAPER- II (Modern Optics)

Marks: 75 **Time: 45 Hrs** **Credits: 03**

Course objectives:

1. To disseminate the knowledge of optical phenomenon
2. To disseminate the fundamental knowledge of electromagnetic waves
3. Provide opportunities for scientific study and creativity

Learning Outcomes:

1. Students gain knowledge of interference, diffraction and polarization
2. They gain knowledge of e.m. wave
3. Apply the knowledge to solve problems based on above properties to strengthen their concepts

Unit I: **12 hrs.**

Interference of light: Introduction, Interference in equal thickness thin film, Phase change on reflection, refraction and transmitted system. Newton's ring and its application to determine the wavelength and refractive index, Michelson Interferometer and its application to wavelength determination and wavelength difference, Fabry- Parrot Interferometer and its application.

Unit II: **11 hrs.**

Diffraction of light: Introduction, Fresnel's diffraction: Half period zones, Zone plates, Diffraction due to straight edge and due to narrow slit.

Fraunhoffer diffraction: Fraunhoffer diffraction at a single slit, at circular aperture, Plane diffraction grating and its application, Resolving power of grating, Rayleigh's criterion for resolution.

Unit III: **11 hrs.**

Polarization: Introduction, Brewster's law, Polarization by scattering (concept only), Blue colour of the sky (only idea), Uniaxial and biaxial crystal, positive and negative crystal, ordinary and extraordinary rays, Nicol prism, its application as an analyzer and polarizer, Double refraction in uniaxial crystal, phase retardation plate (Half and Quarter wave), Double prism.

Unit IV: **11 hrs.**

EM Waves: Introduction to EM spectrum related to wavelength, origin and characteristics of EM waves, Physical significance of Maxwell's equations, EM wave equations (in conducting medium and in free space), It's transverse nature, Plane polarized EM wave $\left(\frac{E_o}{H_o} = \sqrt{\frac{\mu}{\epsilon}}\right)$, Characteristics impedance of dielectric, Poynting vector, Poynting theorem.

References and Text books:

1. Physics for Degree students for B. Sc. Second year, by C. L. Arora, Dr. P. S. Hemne.
2. Optics and Spectroscopy, by R. Murugeshan , Kiruthign Sivaprakash.
3. Optics, by Brijlal and Subramayam.
4. Optics, by Ajay Ghatak.
5. A text book of optics, by Dr. Subrahmanyam, Brijlal and M. N. Avadhanulu.
6. Optics, by- J. K. Sharma, K. K. Sarkar.
7. Fundamentals of optics, by Jenkins and white.
8. Optics, by D. P. Khandelwal.
9. Electromagnetic field and waves, by Paul Lorrain and Dale R. Corson.
10. Foundation of Electromagnetic theory, by John R. Retitz, Fredrick, J. Milford.
11. Electromagnetic, by B. B. Laud.
12. Electrodynamics, by Jordon

Activity:

Design a Periscope or Kaleidoscope: Construct a simple optical device using mirrors and explain the principles of reflection involved.

B.Sc. –III SEMESTER - V

DSC: BPH353P: (DSC Lab)

Marks: 150 **Time: 90 Hrs** **Credits: 03**

List of Practicals: [Atomic and Nuclear Physics, Optics]

1. Study of random decay of nuclear disintegration and determination of decay constant using one coloured face dices.
2. Characteristics of GM tube.
3. Analysis of random error, Poission distribution static's of nuclear counting (data may be provided)
4. To determine the radius of curvature of the lower surface of a plano-convex lens by using Newton's ring apparatus.
5. Study of wavelength of light using Newton's ring.
6. To study the variation of the Line width with colour of light.
7. To produce interference pattern using Lloyd's mirror and to determine the

wavelength of sodium light.

8. To determine the dispersive power of a prism.
9. Study of polarization of light by reflection (Brewster's law).
10. To find R.I. of glass by using Brewster's law.
11. To determine the resolving power of a grating.
12. To study diffraction at straight edge and to determine the wavelength of monochromatic light.
13. To determine the resolving power of a telescope.
14. Study of wavelength of light using plane diffraction grating.
15. To determine the wavelength of prominent lines of mercury by plane transmission grating.
16. To determine Hall coefficient and mobility of charge carriers in a semiconductor.
17. To determine electronic charge and work function of the cathode material using photocell.
18. To determine the plank's constant 'h' by vacuum type photocell using DPMS.
19. To determine Planck's constant by photo cell.
20. To determine Planck's constant by solar cell.
21. To determine the Rydberg constant for Hydrogen.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - V

DSC: BPH354T: PAPER- III (Basic Electronics)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

1. To disseminate the concepts of basic electronics
2. To disseminate the fundamental knowledge of different electronic components
3. Provide opportunities for scientific study and creativity within a global context that will stimulate and challenge the students.

Learning Outcomes:

1. Students gain knowledge of concepts of electronics
2. They the fundamental knowledge of different electronic components and their applications
3. Apply the knowledge to solve problems based on above properties to strengthen their basics

Unit I: **(8 Hrs)**

PN junction; Formation, depletion region, barrier potential, symbol, biasing modes, V-I characteristics, diode current equation, effect of temperature on diode current, ideal diode, basic diode ratings, Zener diode: Construction, working, V-I characteristics & application of Zener diode as voltage regulator

Unit II: **(8 Hrs)**

Transistor Basics: Formation of transistor: PNP and NPN, symbols, working principle, transistor current equation. Modes of operation; CB, CE and CC, input output and transfer characteristics in CB and CE configuration, definition of α, ß and relation between them, Regions of operation (active, cut off and saturation), load line and Q point, Transistor as an amplifier and switch in CE configuration, Leakage currents, Thermal Runaway, Stabilization, Stability factor, Bias stabilizing circuits.

Unit III: **(7 Hrs)**

Field Effect Transistors: Construction, working and characteristics of JFET, Parameters: drain resistance, transconductance, amplification factor and their relation. MOS Field Effect Transistors: Types of MOSFETs, their Construction, Working and Characteristic curves.

Unit IV: **(7 Hrs)**

Switching Devices:

i) UJT: Construction, Working principle, characteristic curves, symbol and Application as relaxation oscillator and sawtooth generator, SCR

Optoelectronic devices: Solar cells (Photovoltaic cell), Photodiodes, LED: Construction and working and their I-V characteristics

References:

1. Electronics by V. K. Mehata
2. Basic electronics by Malvino
3. Basic electronics by B.L. Theraja
4. Electronic devices and circuit theory by Boylestad, Pearson publication,

Activity: Breadboard Circuit Design: Construct basic logic gate circuits or LED-based electronic circuits using diodes, transistors; verify their operation.

B.Sc. –III SEMESTER - V

DSC: BPH355P: (DSC 3 Lab)

Marks: 50 **Time: 30 Hrs** **Credit: 01**

List of Practicals: [Basic Electronics]

1. To study the characteristics of PN junction diode.
2. To study the characteristics of Zener diode.
3. To study the Zener diode voltage regulating characteristics.
4. Study of characteristics of LED.
5. To study the characteristics of FET
6. To study the characteristics of photo diode and use as light sensor (LDR).
7. Study of Solar cell as a Photo voltaic cell.
8. Study of characteristics of transistor in common base mode.
9. Study of characteristics of transistor in common emitter mode.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - V

DSE: BPH356T: PAPER- (Astrophysics)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

- To inculcate a scientific awareness Physics of the universe
- To introduce basics of the astrophysics
- To understand the structure of the Universe

Learning Outcomes: After completing the course, the students will be able to,

- Explain the fundamental physical processes involved in the astrophysical measurements
- Relate the physical processes in Sun, Earth and Moon to the sky observations
- Derive the scientific understanding of Stellar Atmosphere

Unit I: Interaction of Radiation and Matter **8 Hrs**

Atomic Structure, Atomic Processes, Emission and Absorption Spectra, the Equation of Radiative Transfer, the Curve of Growth, Local Thermodynamic Equilibrium, Blackbody Radiation, radioactive dating

Unit II: Astronomical Detection of Light 8 **Hrs**

The Telescope as a Camera, Refracting and Reflecting Telescopes, Quality of Images, Astronomical Instruments and Detectors, Observations and Photon Counting, Observations at Other Wavelengths, Modern Telescopes,

Unit III: The Sun, Earth and Moon 7 **Hrs**

Observable Layers of the Sun, Solar Activity, Angular Momentum of the Sun, The Earth's Interior, The Earth's Atmosphere, The Earth's Magnetosphere, The Moon's Interior and Surface, The Origin of the Moon,

Unit IV: Stellar Atmospheres 7 **Hrs**

Hydrostatic Equilibrium, Spectral Classification, Luminosity Classes, Hertzsprung–Russell Diagrams, Equations of Stellar Structure (Energy Transport in Stars, Radiative Transport, Convective Transport) Energy Generation in Stars

References:

- Foundations of Astrophysics, Barbara Ryden and BradleyM.Peterson, Cambridge University Press (ebook: Foundations of Astrophysics)
- An Introduction to Astrophysics by Baidyanath Basu, PHI Learning Pvt. Ltd.
- The Physical Universe by Frank H. Shu, University of California, Berkeley
- Seven Wonders of the Sky by Jayant Vishnu Narlikar, Cambridge University Press
- Astrophysics for Physicists by Arnab Rai Chaudhari, Cambridge University Press
- V. B. Bhatia , Textbook of Astronomy and Astrophysics with Elements of Cosmology, Narosa Publishing House, New Delhi.
- Astrophysics: Stars and Galaxies, K. D. Abhyankar, Tata McGraw Hill Publication

Activity:

Night Sky Observation: Observe the Moon, planets, and prominent constellations using binoculars, a telescope, or astronomy apps; prepare an observation report**.**

B.Sc. –III SEMESTER - V

DSE: BPH356T: PAPER- (Acoustics)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

1. To understand the fundamental principles of wave motion, acoustics, and sound propagation, including wave velocity, harmonics, and the acoustic wave equation.
2. To develop knowledge of sound characteristics, human hearing, sound recording and reproduction, and the acoustics of buildings, including reverberation and its applications.
3. To explore the generation, properties, and applications of ultrasonic waves through piezoelectric and magnetostriction effects.

Learning Outcomes:

By the end of the Course Learners will be able to:

1. Analyze wave phenomena, determine wave parameters, and solve problems related to sound propagation, harmonics, and acoustic wave motion.
2. Evaluate the characteristics of sound, explain the principles of room acoustics and sound recording systems, and apply concepts of reverberation to practical situations.
3. Explain the production and applications of ultrasonic waves using piezoelectric and magnetostriction techniques, and perform related calculations for ultrasonic frequency and acoustic parameters.

Unit I: **(7.5 Hrs)**

Waves in media: Introduction to vibrations and waves, Waves propagation on strings and rods: 1-D wave equation, The Acoustic Wave Equation, Solutions to 1-D acoustic wave equation, The Kirchhoff Helmholtz Integral Equation (KHIE),Neumann and Dirichlet Green functions in spherical coordinates, Exterior sound fields, Sound radiation from an oscillating piston placed in a rigid baffle, Interior sound fields, Acoustic response inside a cylindrical enclosure and measures of sound, Measures of sound including frequency analysis and integral transforms

Unit II: **(7.5 Hrs)**

Branched systems, Helmholtz resonator, radiation impedance, special techniques for wave equation.
Group velocity and phase velocity and their relation and measurement, Standing waves, Harmonics, Quality of sound, Human ear and its response (Diagrammatic introduction only), Limit of human audibility, Intensity and loudness, bel and decibel, the musical scale, Temperaments and musical instruments.

Unit III: **(7.5 Hrs)**

Applied acoustics: Transducers and their characteristics (Crystal microphone, moving coil loud speaker), Recording and reproduction of sound (Magnetic tape, Cine film, Compact disc), Acoustics of building, Reverberation and reverberation period, Sabine’s formula, Factors affecting the acoustics of building, Requirements for good acoustics.

Unit IV: **(7.5 Hrs)**

Ultrasonics: Introduction, Properties and production of ultrasonic waves, piezoelectric effect, piezoelectric generator, Magnetostriction effect and oscillators, Frequency of ultrasonic waves, Application of ultrasonic waves (measurement of depth of sea, SONAR system and Medical science).

References and Text books:

1. A Text Book of sound, by Khanna, Bedi

2. A Text Book of sound, by L. P. Sharma, Saxena (S. Chand)

3. Properties of Matter and Acoustics, by R. Murugeshan, Kiruthign Sivaprakash.

4. Fundamental of Acoustics 4th Edition, by Lawrence Kinsler , Austin Frey, Alan Coppens and James Sanders. John Wiley and Sons.

5. Basic Acoustics, by D. E. Hall, Oxford University Press.

6. A Text Book of Oscillations, Waves and Acoustics by Dr. M.Ghosh, Dr.D.Bhattacharya

(S. Chand)

7. Oscillation, Waves and Sound, by Sharma and Saxena.

8. Science and Technology of Ultrasonics, by Baldevraj, Narosa.

9. Fourier Acoustics by Earl G. Williams.

Activity:
Room Acoustics Study: Estimate the reverberation characteristics of classrooms or auditoriums and suggest improvements for better acoustics.

B.Sc. –III SEMESTER - V

DSE: BPH357P: (DSE Lab)

Marks: 100 **Time: 60 Hrs** **Credits: 02**

List of Practicals: [Acoustics and Astrophysics]

1. To study the characteristics of micro phone.
2. Study of loudspeaker (woofer, squawker, tweeter) as a transducer.
3. Study the speed of waves on stretched string.
4. Determination of velocity of sound using volume resonator.
5. To determine frequency of A. C. Mains with a Sonometer using single/two magnetic wire.
6. To determine unknown frequency and to verify the law of inverse variation of frequency and volume of air by Helmholtz resonator.

7. To determine the velocity of sound wave in air (gas) with Kundt's tube.
8. To determine mass of the Jupiter by studying revolution of its moons using the CLEA software
9. To study radiation pattern of the Sun and hence estimate effective surface temperature and luminosity of the Sun.
10. Estimating first-order atmospheric extinction of starlight using given data
11. Measuring sky brightness using solid state photometer
12. Studying solar limb darkening effect
13. Temperature of an artificial star
14. Photoelectric photometry of stars using CLEA software
15. Measuring distance to Moon by parallax method.
16. Identifying and measuring diameters of Craters on the Moon surface.
17. Measurement of distance of star clusters by main sequence fit method
18. Observing Sun sun-spots and measuring their diameter.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - V

Minor: BPH358T: PAPER- I (Physics of Atoms and Nucleus)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

1. To disseminate the knowledge of atom and related properties
2. To disseminate the fundamental knowledge of working of nuclear detectors and nuclear accelerators
3. Provide opportunities for scientific study and creativity

Learning Outcomes:

1. Students gain knowledge of various nuclear properties, decay processes
2. They gain knowledge of nuclear particle detectors and nuclear accelerators
3. Students gain the knowledge of fission -fusion reactions
3. They can apply the knowledge to solve problems to strengthen their concepts

Unit I: **7.5 Hrs**

Bohr's atomic model, Sommerfeld atom model, Bohr magnetron, Vector atom model, Concept of spin quantization and spin of electron, Quantum numbers associated with an atoms, Stern-Gerlach experiment, Selection rules for L, S, J, L-S coupling, J-J coupling, Pauli's exclusion principle, concept of shell and subshell.

Unit II: **7.5 Hr**

Zeemen effect, Normal and Anamolous Zeemen effect, Lorentz theory of normal Zeemen effect, Quantum mechanical treatment for Zeemen effect, Lande g factor, Stark effect, experiment of Stark effect.

Unit III: **7.5 Hrs**

Nomenclature, charge, density and mass of nucleus, concept of isotope, isobar, isomer, isotone, binding energy, binding energy curve, packing fraction, nuclear forces, Radioactivity disintegration, Concept of natural and artificial radioactivity, Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Applications of radioactivity (Agricultural, Medical, Industrial, Archaeological)

Unit IV: **7.5 Hrs**

Nuclear detectors: Ionization chamber, G-M counter, Scintillation detector, Semiconductor detector; Accelerators: Linear accelerator, Cyclotron, Fission-fusion reactions: Nuclear fission, nuclear fusion, chain reaction and critical mass

References:

1. Atomic and Nuclear Physics, S. N. Ghoshal, S. Chand
2. Atomic Physics, J. B. Rajam.
3. Modern atomic physics, Vasant Natarajan.
4. Elements of spectroscopy, Gupta, Kumar , Sharma.
5. Atomic physics, S. N. Ghoshal
6. Nuclear Physics, D. C. Tayal, (Himalaya Publishing House, Mumbai)
7. Concept of Nuclear Physics, B.L. Cohen, McGraw-Hill, 2003.
8. Nuclear & Particle Physics: An Introduction, B. Martin, Willey, 2006.

B.Sc. –III SEMESTER - V

DSE: BPH359P: (Minor Lab)

Marks: 50 **Time: 30 Hrs** **Credit: 01**

List of Practicals: [Atomic and Nucleus Physics]

1. Study of random decay of nuclear disintegration and determination of decay constant using one coloured face dices.
2. Analysis of random error, Poission distribution static's of nuclear counting (data may be provided)
3. To determine electronic charge and work function of the cathode material using photocell.
4. To determine the Planck's constant 'h' by vacuum type photocell using DPMS.
5. To determine Planck's constant by photo cell.
6. To determine Planck's constant by solar cell.
7. To determine the Rydberg constant for Hydrogen.
8. Characteristics of GM tube.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - V

DSE: BPH3510P: (VSEC Lab)

Marks: 100 **Time: 60 Hrs** **Credits: 02**

List of Practicals: [Design of electronic Circuits]

1. Design and construct Diode Logic Gates (OR,AND)
2. Design and construct a NOT gate using NPN transistor.
3. Design and construct Diode as a Clipper and Clamper circuit.
4. Design and construct a half-wave rectifier and measure ripple voltage.
5. Design and construct Zener as a Voltage Regulator circuit.
6. Construct OR/AND/NOT gate using NAND gate
7. Construct OR/AND/NOT gate using NOR gate.

8. Design a circuit in which the LED glows only when both switches are ON.
9. Design a circuit in which the buzzer sounds if **any one** of three switches is pressed.
10. Design a circuit in which the LED remains OFF only when both switches are ON.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - V

DSE: BPH3511P: (CEP)

Marks: 50 **Time:30 Hrs** **Credit: 01**

Course objectives:

1. To apply fundamental concepts of physics to identify and address community-based problems related to energy, environment, health, and technology.
2. To develop scientific awareness and promote scientific temper among the community through demonstrations, outreach activities, and awareness campaigns.
3. To foster teamwork, leadership, and social responsibility by engaging students in community-oriented projects using scientific knowledge and practical skills.

Learning Outcomes: After successful completion of the Community Enhancement Program, students will be able to:

1. Analyze and propose simple physics-based solutions to real-life community issues such as energy conservation, waste management, water quality, and renewable energy utilization.
2. Plan and conduct science outreach activities that effectively communicate basic physics concepts and encourage scientific thinking among school students and the general public.
3. Demonstrate teamwork, leadership, communication, and ethical responsibility while working collaboratively with community members on science-based initiatives.

SUBJECT: PHYSICS

B.Sc. –III SEMESTER - VI

DSC: BPH361T: PAPER- I (Advances in Physics: Laser, Fibre optics)

Marks: 75 **Time: 45 Hrs** **Credits: 03**

Course objectives:

1. To disseminate the fundamental knowledge of LASER.
2. To disseminate the knowledge of Fiber optics.
3. Provide opportunities for scientific study and creativity within a global context that will stimulate and challenge the students.

Learning Outcomes:

1. Students will gain knowledge of LASER and fiber optics.
2. They will understand the design, principle and working of LASER.

3. They will understand the principle and working of fiber optics.
3. Students will apply the knowledge for solving problems based on above properties to strengthen their basics

Unit I: 12 **hrs.**

LASER: Introduction to LASER, spatial and temporal coherence, Theory of LASER action, components of LASER system, characteristics of LASER beam, absorption, spontaneous and stimulated emission, Population inversion, Optical pumping, characteristics of laser beam.

Unit II: 11 **hrs.**

Three level and four level LASER system, Ruby LASER, He-Ne LASER, Semiconductor LASER, Applications of LASER, Comparison of LASER system, Holography.

Unit III: 11 **hrs.**

Fiber optics: Introduction to Fiber optics, Importance of optical fiber, Snell's law, Total Internal Reflection, Transmission of light in optical fiber, Basic structure, Single mode fibers, Stepped index monomode fiber, Acceptance angle and acceptance cone, Numerical aperture , Relation between acceptance angle and refractive indices of the media (Numerical Aperture).

Unit IV: **11 hrs.**

Graded index fibers, Refractive index profiles, Ray transmission in graded index fibers, Mode volume or Guided modes in Graded index fibers, Fiber losses and their units (basic concept), Electrical and optical band width, bandwidth length product, Dispersion in optical fiber, Comparison of Intermodal dispersion in Graded index and Step index fibers, Applications.

References and Text books:

1. Lasers and Nonlinear optics. By B. B. Laud.
2. LASERS- Theory and Applications, by Thyagarajan and A. K. Ghatak.
3. Optics and LASER, by V. K. Sewane.
4. Introduction to Lasers, by Dr. Avadhanulu, Dr. P. S. Hemne.
5. Laser and Optical fiber communication, by P. Sarah.
6. An introduction to fiber optics, by R. Allen Shotwell.
7. Optical Fibers & Fiber Optical Communication Systems, S. K. Sarkar.
8. Introduction to fiber optics, R S Khairnar.

Activity: As per the classroom instructions

B.Sc. –III SEMESTER - VI

DSC: BPH362T: PAPER- II (Theory of Relativity)

Marks: 75 **Time: 45 Hrs** **Credits: 03**

Course objectives:

- Understand the postulates of Einstein's Special Relativity.
- Analyze time dilation, length contraction, and simultaneity.
- Apply Lorentz transformations to solve relativistic problems.

Learning Outcomes: After completion of the course the students will be able to:

- Explain core principles like constancy of light speed and relativity of motion.
- Derive and interpret relativistic equations for time, length, and mass.
- Solve problems involving high-speed particles and energy-momentum relations.

Unit-I **12 hrs.**

Inertial frame, Galilean principle of relativity Galilean transformation equations: Transformation of position, distance, velocity and acceleration. Conservation of Momentum and Energy ‘Non inertial frames, fictitious force.

Unit-II **11 hrs.**

Rotating frame of reference, concept of carioles forces, (derivation), Center of mass, motion of Center of mass, Center of mass as a frame reference.

Michelson Morely experiment. Postulates of special theory of relativity. Larentz transformation equation – Length contraction and time dilation

Unit-III **11 hrs.**

Relativity of simultaneity concept of proper frame, proper length, proper time .Relativistic velocity transformation equations.

Variation of mass with velocity. Einstein’s mass energy relation (with derivation) Energy momentum relationship.

Unit-IV **11 hrs.**

Tensor Calculus and Differential Geometry: Riemannian space, Curvilinear coordinates, Tensors Concept of four vectors, Minkowsky space. Relativistic Dynamics. The principle of equivalence, Principle of General covariance, General Theory of Relativity, historical developments.

References:

1. Theory of relativity: Goyal and Gupta
2. Introduction to special theory of Relativity: Shrivastava
3. Elements of special theory of Relativity: S. P. Singh and M. K. Bagde.
4. Introduction to theory of Relativity: P. G. Bergmann
5. An Introduction to Relativity: J. V. Narlikar, C ambridge University Press, 2010.
6. First course in general relativity: B. F. Schutz , Cambridge university press, 1985
7. Introduction to Special Relativity :Resnick, Robert.. New York, NY: Wiley, 1968.
8. Special Relativity :French, A. P.(Massachusetts Institute of Technology Education Research Center: MIT Introductory Physics Series. New York, NY: Norton, 1968.)
9. Exploring Black Holes: Introduction to General Relativity: Taylor, Edwin F., and John A. Wheeler. San Francisco, CA: Addison Wesley Longman, 2000. ISBN: 9780201384239.
10. Relativity: The Special and the General Theory: A. Einstein,

Activity: As per the classroom instructions

Relativity Simulation: Use interactive simulations (PhET or similar) to visualize time dilation, length contraction, and relativistic velocity addition; discuss observations.

B.Sc. –III SEMESTER - VI

DSC: BPH363P: Practical

Marks: 150 **Time: 90 Hrs** **Credits: 03**

List of Practicals: [LASER, OPTICAL FIBERS, RELATIVITY]

1. Determination of wavelength of He-Ne laser – Ruler method.
2. Determination of thickness of a wire using He-Ne laser.
3. Determination of wavelength of laser light using semiconductor laser diffraction.
4. Arc spectra – Aluminium and Brass
5. Determination of wavelength of He-Ne laser – Ruler method.
6. Determination of thickness of a wire using He-Ne laser.
7. Determination of Acceptance angle and Numerical Aperture using fiber optic cable.
8. Determination of angle of divergence of a laser beam using He-Ne laser.
9. Determination of e/m using Zeeman effect.
10. Measurement of thickness of a thin film using MBI technique.
11. Experiment on rotatory dispersion of quartz.
12. To draw the histogram of theoretical Gaussian curve.
13. Programming-Computer Simulation of Length Contraction, Relativity of mass etc.
14. Programming-Computer Simulation of Equations of Motion for a System of Particles.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - VI

DSC3: BPH364T: PAPER-III (Introduction to Solid State Physics)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

1. Study the crystal structure and bonding in solids.
2. Understand electron behaviour using band theory and Fermi energy.
3. Analyze properties like conductivity, magnetism, and semiconductivity.

Learning Outcomes: After completion of the course the students will be able to:

1. Classify materials based on crystal and electronic structure.
2. Explain the origin of electrical, thermal, and magnetic properties in solids.
3. Apply quantum models to interpret band structure and carrier behaviour.

Unit I: **8 Hrs**
Crystal structure: periodicity, lattices and basis, fundamental translation vector, unit cell and primitive cell, Miller indices, lattice planes, Bravais lattices in 2-D and 3-D, packing fraction, coordination number, Inter-planer distances, Crystal structures-NaCl, diamond, CsCl, ZnS.

Unit II: **8 Hrs**
Reciprocal lattice, Wigner Seitz cell, Geometrical relation between direct and reciprocal lattice, Laue's theory of X-ray diffraction, Bragg's law and Bragg's diffraction conditions in direct and reciprocal lattice, Laue's pattern, Bragg's spectrometer and its applications (wavelength determination and simple cubic structure determination).

Unit III: **7 Hrs**
Drude Lorentz model, Mean free path, Electrical and thermal conductivity, Wiedemann Franz law (Derivation), Density of states, Fermi energy, Fermi temperature. Band theory of solids: Bloch theorem (statement only), Kronig-Penny model.

Unit IV: **7 Hrs**
Concept of hole, Hall effect, Energy bands in solid, distinction between metal, semiconductor and insulator. Interatomic forces, Ionic Solids, Covalent bond, VanderWaal's bond, Expression for vander Waal's forces, Molecular bond, Metallic bond, Hydrogen bond.

References:

1. Solid State Physics, Charles Kittel, John Willey & Sons
2. Solid State Physics by Ashcroft ,Mermin.
3. Solid State Physics: S. O. Pillai (New Age International 2006)
4. Solid State Physics, by Abdul Ali Omar, Pearson Publication, Delhi
5. Solid State Physics, by Saxena, Gupta, Mandal, Pragati Prakashan
6. Introduction to solids by Azaroff, Wiley publication
7. Solid State Physics by Singhal
8. Solid State Physics by J.R.Hook. H.E.Hall(NYT).
9. Solid State Physics by J.S.Blackmore.
10. Solid State Physics by R.K.Puri,V.K.Babbar.(S.Chand.)
11. Materials Science and Engineering: V. Raghavan
12. Solid State Physics by J.P.Shrivastava(PHI).

Activity: As per the classroom instructions

Crystal Structure Model: Construct 3D models of SC, BCC, FCC, and HCP crystal structures using balls and sticks or 3D software; calculate packing efficiency.

B.Sc. –III SEMESTER - VI

DSC3 Lab.: BPH365P:

Marks: 50 **Time: 30 Hrs** **Credit: 01**

List of Practicals: [**Solid State Physics]**

1. Study the basic cubic crystal and determination of Coordination number ,no. of atoms per unit cell, lattice parameter and packing density.
2. Determination of average grain size of a particle from X-Ray diffraction spectra using Debye- Scherrer Formula.
3. Thermal Conductivity of poor conductor.
4. Dielectric constant of material by charging and discharging of Capacitor
5. To determine Hall coefficient and mobility of charge carriers in a semiconductor.

6. Study of particle size of nano particles by SEM /TEM method.

B.Sc. –III SEMESTER - VI

DSE: BPH366T: PAPER- (Complex Analysis)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

1. To disseminate the importance of statistical mechanics
2. To solve the problems in classical and quantum domains by using statistical mechanics
3. Provide opportunities for scientific study and creativity.

Learning Outcomes:

1. Students should be able to apply statistical tools to solve the problems in Physics
2. Students should be able identify the connection between statistical mechanics and thermodynamics
3. Students should be able to compare and apply Classical and quantum distributions

Unit I: **8 hrs.**

The Origin of Complex Numbers, The Algebra of Complex Numbers; division, multiplication, addition and subtraction, The Geometry of Complex Numbers, polar and trigonometric forms of complex numbers, Functions of a Complex Variable; exponential, logarithmic, trigonometric, power, Hyperbolic, Limits and Continuity

Unit II: **8 hrs**

Differentiable Functions, Cauchy-Rieman Conditions, Analytic functions, Harmonic functions, multiple connected regions, Cauchy Theorem, Cauchy Integration formula, Derivatives, problems, Contours and Contour Integrals

Unit III: **7 hrs**

Singularities- Poles, Laurent Series Representations, Branch Points, Calculus of Residues- Residues Theorem, Cauchy Principal value, Product expansion of entire Functions, problems

Unit IV: **7 hrs.**

Applications of complex numbers in AC circuit analysis: Inductance, capacitance and circuits, Quantum mechanics: Wave function, Schrodinger equation, operators, problems

Text and Reference Books:

1. R. V. Churchill, Complex variables and Applications, 7th Edition McGraw Hill

2. Mathematical Physics: H. K. Dass

Activity: As per the classroom instructions.

Argand Plane Visualization: Use GeoGebra, MATLAB, or Python to plot complex numbers and perform addition, subtraction, multiplication, and rotation graphically.

B.Sc. –III SEMESTER - VI

DSE: BPH366T: PAPER- (Communication electronics)

Marks: 50 **Time: 30 Hrs** **Credits: 02**

Course objectives:

1. To know basics of transmission and reception of signals.
2. To provide the necessary information regarding theory of communication.
3. To get an information regarding analogue modulation techniques.
4. To provide modern digital modulation techniques.
5. To get an idea about wireless communication.

Learning Outcomes:

1. Demonstrate a clear understanding of key communication concepts, including information, signals, noise, and bandwidth They can apply the knowledge to solve problems to strengthen their concepts.
2. Differentiate between Analog and digital communication systems, including their components like transmitters and receivers.
3. Explain and implement pulse amplitude modulation (PAM), pulse code modulation (PCM), and digital modulation techniques like ASK, FSK, and PSK.
4. To understand Signal Quality and impact of noise on Analog communication systems and compute signal-to-noise ratios and noise figures.
5. Familiarise Emerging Technologies: Analyse the applications and trends in wireless communication, including cellular networks, Wi-Fi, and 4G technologies.

Unit I: Introduction to Communication Electronics **8 Hrs**

Basic concepts of communication: Radio waves and its use for communication, Information, signal, noise, signal to noise ratio, noise figure, channel, Bandwidth. types of communication systems: Analog and digital, Receiver, transmitter, Antennas, Types of antenna.

Unit II: Analog Communication Electronics **8 Hrs**

Modulation and demodulation techniques, modulation index, Amplitude modulation (AM): SSB, DSB, generation, demodulation, Frequency modulation (FM): theory, generation, demodulation, Phase modulation (PM): theory, generation, demodulation, Noise in Analog communication systems.

Unit III: Digital Communication Electronics **7 Hrs**

Pulse amplitude modulation (PAM): theory, generation, demodulation, Pulse code modulation (PCM): theory, quantization, coding, Digital modulation techniques: amplitude-shift keying (ASK), frequency-shift keying (FSK), phase-shift keying (PSK) Noise in digital communication systems,

Unit IV: Applications of Communication Electronics **7 Hrs**

Wireless communication: Cellular networks, Wi-Fi, Bluetooth, Optical communication: fiber optics, laser communication, Satellite communication: satellite orbits, satellite links, Generation of communications 2G, 3G, and 4G Emerging trends in.

References:

1. Modern Digital and Analog Communication Systems" by B. P. Lathi
2. Communication Systems" by R. P. Singh and J. C. Gupta
3. Communication Theory: Analysis and Application" by Alan G. B. T. Davis
4. Wireless Communications: Principles and Practice" by Theodore S. Rappaport
5. Fundamentals of Digital Communication" by S. K. Gupta and S. C. Gupta

Activity: As per the classroom instructions

Wireless Communication Survey: Measure Wi-Fi or mobile network signal strength (RSSI) at different campus locations using smartphone applications and prepare a coverage map.

B.Sc. –III SEMESTER - VI

DSE Lab: BPH367P:

Marks: 100 **Time: 60 Hrs** **Credits: 02**

List of Practicals: [**Complex Analysis, Communication electronics]**

Course Objectives:

1. To understand the principles of analogue and digital communication systems, including signal generation, modulation, transmission, and reception.
2. To develop practical skills in the operation, testing, and analysis of communication electronics components such as antennas, modulators, demodulators, RF modules, and communication trainer kits.
3. To familiarize students with modern wireless communication technologies, including optical fiber communication, cellular networks (3G, 4G, and introductory 5G), software-defined radio, and IoT-based communication systems.

Learning Outcomes:

After successful completion of the laboratory course, students will be able to:

1. Generate, transmit, receive and analyze analogue and digital communication signals using laboratory instruments and communication trainer kits.
2. Evaluate the performance of antennas, modulation techniques, and wireless communication systems through experimental measurements and simulations.
3. Apply the concepts of communication electronics to investigate modern technologies such as optical fiber communication, cellular communication (3G/4G), software-defined radio, and wireless sensor networks.

List of Practicals:

1. Study of Communication System Block Diagram (Transmitter–Channel–Receiver)
2. Study of Different Types of Antennas (Dipole, Monopole, Yagi-Uda, Patch)
3.Measurement of Antenna Radiation Pattern Using Antenna Trainer Kit
4. Study of Analog and Digital Signals Using CRO/DSO
5. Amplitude Modulation (AM) Generation and Demodulation.
6. Frequency Modulation (FM) Generation and Demodulation.
7. Pulse Amplitude Modulation (PAM)
8. Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM)
9. Pulse Code Modulation (PCM) Using Communication Trainer.
10. Analog vs Digital Communication Comparison Compare bandwidth, noise immunity,

and transmission quality.
11. Study of ASK, FSK, and PSK Digital Modulation Techniques
12. Transmission and Reception of Audio Signals Using RF Modules
13. Study of Optical Fiber Communication Trainer .
14. Study of Mobile Communication Standards (2G, 3G, 4G, 5G).
15. Measurement of Signal Strength Using Smartphone Applications.
16. Spectrum Analysis of Radio Signals Using Software Defined Radio (SDR).
17. Design and Testing of a Simple RF Transmitter and Receiver
18. Study of Noise Effects in Communication Systems
19. Simulation of Communication Systems Using MATLAB/Simulink or GNU Radio Model AM, FM, PCM, ASK, FSK, and PSK systems.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. III SEMESTER - VI

VSEC Lab: BPH368P: Optical Components

Marks: 100 **Time: 60 Hrs** **Credits: 02**

List of Practicals: [Optical Components]

Course objectives:

1. To develop practical skills in the identification, handling, alignment, and characterization of common optical components used in experimental physics.
2. To understand the principles of image formation, reflection, refraction, polarization, and light transmission through hands-on laboratory investigations.
3. To strengthen experimental skills in measurement, data analysis, and error estimation while working with optical instruments and laser-based setups.

Learning Outcomes: After completing the Optical Components laboratory module, students will be able to:

1. Identify and operate various optical components such as lenses, mirrors, prisms, polarizers, optical filters, beam splitters, and optical fibers in laboratory experiments.
2. Design, align, and analyze simple optical systems while interpreting experimental observations using the principles of geometrical and physical optics.
3. Perform accurate optical measurements, analyze experimental data, estimate uncertainties, and communicate results effectively in laboratory reports.

List of Practicals:

1. Identification and Study of Optical Components (Lenses, Mirrors, Prisms, Filters, Beam Splitters)
2. Study of Plane, Concave, and Convex Mirrors
3. Determination of the Focal Length of Convex and Concave Lenses
4. Study of Optical Filters (Red, Green, Blue, Neutral Density)

5. Alignment of Laser Beam Using Mirrors and Beam Splitters
6. Study of Optical Fiber and Light Transmission.
7. Construction of a Simple Optical Imaging System.

Note: Additional Experiments may be suitable for incorporating blended learning and digital tools into the physics laboratory

B.Sc. –III SEMESTER - VI

OJT: BPH369P: Internship

Marks: 200 **Time: 120 Hrs** **Credits: 04**

Learning Objectives:

1. To provide hands-on exposure to the functioning of research laboratories, industries, educational institutions, or technology-based organizations by applying fundamental concepts of physics in real work environments.
2. To develop technical, analytical, and problem-solving skills through the use of scientific instruments, laboratory equipment, software tools, and standard operating procedures relevant to physics-based professions.
3. To enhance professional competencies, communication skills, teamwork, work ethics, and time management, thereby improving students' employability and career readiness.

Learning Outcomes: After successful completion of the Institution-Based On-the-Job Training, students will be able to:

1. Apply theoretical knowledge of physics to perform practical tasks, operate scientific instruments, and solve workplace-related technical problems effectively.
2. Demonstrate professional behaviour, effective communication, teamwork, documentation, and adherence to laboratory safety and ethical practices in a professional environment.
3. Analyze workplace experiences, prepare technical reports, and evaluate career opportunities in research, industry, education, healthcare, electronics, renewable energy, instrumentation, and related fields.

B.Sc. IV SEMESTER - VII

DSC: Paper-I: Course Code: B-PH471T

MATHEMATICAL METHODS FOR PHYSICS

Credit: 4

Marks- 60 (Credit 4, 4h/week) Time- 60 hours

OBJECTIVES:

1. To disseminate the concepts of mathematical physics regarding co-ordinate system.
2. To disseminate the concepts Laplace Transform, and Inverse transform.
3. To disseminate the fundamental knowledge of Linear vector space
4. Provide opportunities for scientific study and creativity within a global context that will stimulate and challenge the students.

OUTCOMES:

1. Students gain knowledge of co-ordinate system, tensors, vector space, Laplace Transform, and Inverse transform.
2. They understand the special functions, their polynomial, and applications.
3. They apply the knowledge to solve problems based on above properties to strengthen their basics.

Unit I 15 hrs.

Curvilinear co-ordinate Systems, Physical ideas about gradient, divergence, and Curl, Fourier Series: Definition, Dirichlet's condition, Convergence, Fourier Integral and Fourier transform, Convolution theorem, Parseval's identity, Applications to the solution of differential equations.

Unit II 15 hrs.

Laplace transform of elementary functions – Inverse Laplace transforms – Methods of finding Inverse Laplace transforms – Heaviside expansion formula – Solutions of simple differential equations.

Unit III 15 hrs.

Linear vector spaces - linear independent bases, Dimensionality, inner product, matrices, linear transformation, Matrices- Inverse, Orthogonal and Unitary matrices, Cayley Hamilton theorem, eigen vectors and eigen value problem, Diagonalization, Complete orthonormal sets of function.

Unit-IV 15 hrs.

Linear differential equations, Special Function- Laguerre, Hermite, Legendre polynomials, Special Bessel's function, Spherical harmonics, Generating Function and recursion relations, differential and integral form.

References:

1. Mathematical Physics: A.W.Joshi

2. Mathematical Physics: H.K.Dass

3. Vector analysis – Newell

B.Sc. –IV SEMESTER - VII
DSC: Paper II: Course Code: B-PH472T

ELECTRODYNAMICS

Credit: 4

Marks- 60 (Credit 4, 4h/week) **Time- 60 hours**

Course Objectives:

- To provide students with a solid understanding of the fundamental concepts and principles of electrostatics and magnetostatics.
- To introduce students to Maxwell's equations and their applications in time-varying fields.
- To develop students' ability to apply mathematical tools and techniques to solve problems in electrodynamics.
- To familiarize students with electromagnetic wave equations and the behavior of electromagnetic waves in different media.
- To explore the concepts of radiation emission and the interaction of electromagnetic fields with matter.
- To enable students to analyze and interpret electromagnetic phenomena and their practical applications in various fields.
- To cultivate critical thinking, problem-solving skills, and the ability to apply electrodynamics principles to real-world scenarios.

Program Outcomes:

By the end of the course, students should be able to:

- Understand and apply the principles of electrostatics and magnetostatics, including Gauss's law, Ampere's law, boundary conditions, and the Biot-Savart law.
- Solve boundary value problems and apply uniqueness theorems and the method of images in electrostatics and magnetostatics.
- Comprehend Maxwell's equations, including the differential form of Gauss's law and Ampere's law, and their applications in time-varying fields.
- Analyze and solve problems related to electromagnetic potentials, including scalar and vector potentials.
- Understand the energy, force, and momentum relations in electromagnetic systems and apply Poynting's theorem.
- Comprehend electromagnetic wave equations and analyze the behavior of electromagnetic waves in different media, including reflection, refraction, and the skin effect.
- Understand gauge transformations and apply them in different gauges.
- Analyze radiation emission phenomena, including the radiation of electric dipoles, magnetic dipoles, and moving charges.
- Apply electrodynamics principles to analyze the radiation and fields of oscillating sources and antennas.
- Interpret and evaluate electromagnetic phenomena and their practical applications in various fields, such as electrical engineering, telecommunications, and optics.

- The provided reference books offer additional resources and perspectives to further enhance students' understanding of electrodynamics, and they can be used as supplementary materials for the course.

Unit-I: Electrostatics and Magnetostatics: 15 hrs.

Dirac delta function, Gauss's law and applications, Differential form of Gauss's law, Poisson and Laplace's equations, Electrostatic potential energy, Boundary conditions, Uniqueness theorems, Method of images, Multipole expansion.

Biot-Savart law, Ampere's law, Differential form of Ampere's law, Vector potential, Magnetic field of a localized current distribution, Boundary conditions.

Unit-II: Time varying fields and Energy, force, momentum relations: 15 hrs.

Faraday's law, Maxwell's displacement current, Maxwell's equations, Maxwell's equations in matter, Scalar and vector potentials, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy.

Unit-III: Electromagnetic wave equations: 15 hrs.

Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Normal and Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth.

Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator.

Unit IV: Radiation emission: 15 hrs.

Electric dipole, electric quadrupole and magnetic dipole radiation, Retarded and advanced potential, Jefimenko's Equations, Radiation by a moving charge: Lienard-Wiechert potentials of a point charge, Fields of a moving point charge. Larmor's formula, Angular distribution of radiation.

Reference Books

1. Introduction to Electrodynamics: David Griffiths (PHI)
2. Electrodyanamics J. D. Jackson
3. Introduction to Electrodynamics, A. Z. Capri and P. V. Panat (Narosa)
4. Classical theory of fields, Landau &Lifshitz
5. Electrodynamics, W. Panofsky and M. Phillips
6. Electromagnetism and Classified Theory, A. D. Barut, Dover
7. Electromagnetic theory and Electrodynamics, by Satya Prakash, KedarNath and Co.Meerut.
8. Electromagnetics by B.B.Laud, Willey Eastern.
9. Electrodynamics by Kumar Gupta and Singh.

B.Sc. –IV SEMESTER - VII

DSE: Paper III: Course Code: B-PH473T

NUMERICAL METHODS

Credit: 4

Marks- 60 (4h/week) **Time- 60 hours**

OBJECTIVES:

1. To disseminate the knowledge of various computational methods and programming
2. To disseminate the knowledge of simple computer language and syntax
3. Provide opportunities for scientific study, experimentally.

OUTCOMES:

1. Students develop experimental skills in programming to execute computational methods.
2. They analyse experimental limitations and precautions.
3. They become skilful to design and perform experiments with good accuracy.

UNIT I **15 hrs.**

SCILAB for numerical computation and visualization. Basics of SCILAB: real numbers in double precision; arithmetics with SCILAB; how to use scripts and functions; vectors and matrices; line plots; and logical variables, conditional statements, loops.

UNIT II **15 hrs**.

Root finding technique to determine the roots, or zeros, of a given function. Root-finding methods: including the Bisection method, Newton's method, and the Secant method. Order of convergence for these methods. SCILAB code using Newton's method,

Fundamentals of quadrature, Trapezoidal rule and Simpson’s rule; use of the SCILAB. Linear Interpolation. Linear least squares.

UNIT III **15 hrs.**

Gaussian elimination with large matrices, The LU decomposition algorithm must then incorporate permutation matrices. Count the number of required operations for Gaussian elimination, forward substitution, and backward substitution, Power method for eigenvalues of a matrix, Gaussian elimination to solve a system of nonlinear differential equations using Newton's method.

UNIT IV **15 hrs.**

Numerical integration of ordinary differential equations (ODEs). Euler method, and the Runge-Kutta methods, solving systems of ODEs. We will show how to use the SCILAB functions, and how to solve a two-point boundary value ODE.

References:

1. Introductory Methods of Numerical Analysis: S S Sastry

2. Computer Oriented Numerical Methods: V Rajaraman

B.Sc. –IV SEMESTER - VII

DSE: Paper III: Course Code: B-PH473T

SOLID STATE ELECTRONICS

Credit: 4

Marks- 60 (Credit 4, 4h/week) **Time- 60 hours**

OBJECTIVES:

To provide the basic and advanced knowledge physics of electronics as various electronic devices and circuits are useful in the measurement of various physical parameters at master and research level**.**

OUTCOMES:

1. Students gain knowledge of Energy bands and charge carriers in semiconductor, diode, transistors, various rectifiers and integrated circuits.
2. They understand the importance of biasing of various circuits, to improve the efficiency and prevent the monitory losses.
3. They apply the knowledge to design small projects based on electronics helpful for the improvement in their depth of knowledge.

Unit I: **15hrs**

Energy bands and charge carriers in semiconductor: Formation of energy bands, Classification of solids on the basis of energy band structure, direct and indirect semiconductor, intrinsic and extrinsic materials, Fermi level and fermi distribution function applied to semiconductors, Electron and hole concentration at equilibrium.

Fabrication of p-n junction: grown junction, alloyed junction, diffused junction, ion implementation, contact potential, forward and reverse biased junction: qualitative description of current flow at a junction, reverse breakdown: Zener breakdown, avalanche breakdown, capacitance of p-n junction

Unit II: **15hrs**

Transistor biasing and thermal stabilization: Fabrication of transistor, Charge transport in BJT, Amplification with BJT and relation between α, β *and* γ, operating point, bias stability, self-bias, emitter bias, voltage divider bias, stabilization against variation in I_{CO}, V_{BE} and β i.e. S, S', S'', CB and CC configurations in brief and CE configuration: input and output characteristics, CE cutoff and saturation region, typical transistor junction voltage values, Ebers-Moll model, Switching operation: Cutoff, Saturation, switching cycle, frequency limitations of transistor

Unit III: **15hrs**

Semiconductor discrete devices - special types of diodes: Zener diode, varactor diode, Schottky, MOS diodes, tunnel diode, photodiode, solar cells, LED, diode laser, IR emitters, LCDs, thermistors,

Junction field effect transistor (JFET), Metal-oxide-Semiconductor field effect transistor (MOSFET), unijunction transistor (UJT) and silicon controlled rectifier (SCR), phototransistor

Unit IV: **15hrs**

Integrated circuits: fabrication and characteristics- Integrated circuit technology, basic monolithic IC, epitaxial growth, masking and etching, diffusion of impurities, transistor for monolithic circuits, monolithic diodes, integrated resistors, integrated capacitors and inductors, monolithic circuit layout, Isolation methods, wafer of monolithic circuit testing, wire bonding and packaging

Reference books:

1. Milliman, J. Halkias, "integrated elctronics", Tata McGraw Hill
2. Boylestad & Nashelsky, "Electronic devices & circuit theory", PHI
3. Ben G. Streetman, "Solid state electronics devices", PHI

B.Sc. –IV SEMESTER - VII

DSC/ DSE: Course Code: B-PH474P

PRACTICAL

Marks 150

OBJECTIVES:

1. Provide opportunities for scientific study, experimentally.
2. To disseminate the practical knowledge of various computational methods and programming
3. To disseminate the practical knowledge of simple computer language and syntax

OUTCOMES:

1. They become skillful to design and perform experiments with good accuracy.
2. Students develop experimental skills in programming to execute computational methods.
3. They analyse experimental limitations and precautions.
4. They become skilful to design and perform experiments with good accuracy.

List of Practical:

1. Introduction to SCILAB: Variables and syntax
2. Introduction to SCILAB: Loops, arrays, conditions
3. Largest and smallest numbers
4. Bisection Method
5. Newton-Raphson Method
6. Matrix multiplication
7. Lagrange Interpolation
8. Linear Least Squares Fit
9. Simpson's rule integration
10. Runge - Kutta Method
11. Design of a regulated power supply.
12. Characteristics and applications of silicon-controlled rectifier.
13. Design of common emitter Power transistor amplifier.
14. Experiments on bias stability.
15. BJT Characteristics
16. Characteristics of Tunnel diode.
17. Experiment on FET characterization and application as an amplifier.
18. SCR charcteristics
19. Experiment on Unijunction transistor and its application.
20. To measure magnetic fields produced by a current carrying wire
21. To study and verify Faraday's Law of Electromagnetic Induction
22. To measure magnetic susceptibility using Quinke's method/Gouy's Method

23. To study Biot-Savart's law
24. To study Hall effect
25. Solar cell Characterization
26. B-H Curve/ Magnetic Hysteresis curve experiment
27. To study Electrical/Dielectric Breakdown of air
28. To investigate the resonance and frequency response characteristics of an RLC circuit and verify its compatibility.
29. Designing of innovative experiments by students based on the laws of electrodynamics.
30. To study relationship between slit geometry and diffraction pattern.
31. To design and test photo detector circuit.
32. To measure numerical aperture (NA) of an optical fibre.
33. Determination of e/m by Thomson method.

B.Sc. –IV SEMESTER -VII

RM: Paper IV: Course Code: B-PH475T

RESEARCH METHODOLOGY

Marks- 60 (Credit 4, 4h/week) Time- 60 hours

Course Objective:

1. To provide necessary knowledge, skills, and understanding of the research process in physics.
2. To familiarize students with various research methodologies, techniques, and tools commonly used in physics research.
3. To foster critical thinking, scientific reasoning, and ethical conduct in physics research.

Course Outcomes:

By the end of the research methodology course for physics, students should be able to:

1. Understand the nature and significance of research in physics, and appreciate its role in advancing scientific knowledge and technological advancements.
2. Design research studies, experiments, simulations, or theoretical models appropriate for addressing research questions in physics.
3. Develop skills in scientific writing, including writing research proposals, reports, and scientific papers following accepted standards and formats.
4. Understand the ethical considerations and responsible conduct of research in physics, including principles of intellectual property, authorship, and collaboration.

By achieving these course outcomes, students will be well-prepared to engage in independent research projects, pursue advanced studies in physics, or contribute to the scientific community through their research endeavours.

Syllabus

Unit I 15 Hours

Scientific methods and their applications in physics research, Types of research in physics: experimental, theoretical, and computational, Formulation of Research Problem, Recognizing research questions and objectives, Review of literature and identifying gaps in knowledge, Developing hypotheses and research proposals, Research Design and Planning.

Unit II **15 Hours**

Selecting appropriate research methodologies and techniques, Designing experiments, simulations, or/and theoretical models, Identifying data collection methods and instruments.

Data Collection and Analysis: Techniques for collecting experimental, observational, or simulation data, Data processing, reduction, and analysis, Statistical methods and tools for analysing data in physics research, Data visualization and plotting techniques.

Experimental Techniques and Instrumentation: Principles of experimental physics, Laboratory safety and ethics, Handling and calibration of experimental equipment, Propagation of Errors.

Unit III **15 Hours**

Scientific Writing and Communication: Writing research proposals, reports, and scientific papers, scientific ethics and plagiarism, Policy for use of AI in paper writing, Presentation skills and effective communication of research findings.

Unit IV **15 Hours**

Research Presentation and Evaluation: Preparing and delivering effective research presentations, Peer review process and scientific evaluation, critically evaluating scientific literature and research findings.

Research Ethics and Responsible Conduct: Ethical considerations in physics research, Intellectual property and patents, Professional conduct, responsible authorship, and collaboration Research.

Reference Books

1. "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar
2. "Research Methodology: Methods and Techniques" by C.R. Kothari
3. Simplifying Physics Mathematics Research Methodology, Rajan Iyer
4. Research Methods for Science, M. P. Marder, Cambridge University Press, 2011
5. Research Methodology Techniques and Trends, Y. K. Singh and R. B. Bajpai, APH Publishing Corporation House, 2008.
6. Data Reduction and Error Analysis for the Physical Sciences 3rd Ed. by Philip R Bevington& D Keith Robinson, McGraw – Hill (2003)
7. Numerical Methods by Balagurusamy, Tata McGraw – Hill (2000)
8. "Computational Physics: Problem Solving with Python" by Rubin H. Landau, Manuel J. Paez, and Cristian C. Bordeianu
9. "Statistical Data Analysis for the Physical Sciences" by Adrian Bevan
10. LATEX for Engineers and Scientists by David J Buerger, McGraw Hill Pub. Co., NY, 1990.

B.Sc. –IV SEMESTER - VIII

DSC: Paper I: Course Code: B-PH481T

QUANTUM MECHANICS-I

Credit: 4

Marks- 60 **Time- 60 hours.**

OBJECTIVES:

1. To disseminate the concepts of quantum mechanics with respect to initial development and various representations
2. To disseminate the fundamental knowledge of angular and generalized angular momenta.
3. Provide opportunities for scientific study and creativity within a global context that will stimulate and challenge the students.

OUTCOMES:

1. Students gain knowledge of quantum mechanics with respect to initial development and various representations.
2. They the fundamental knowledge of angular and generalized angular momenta.
3. Apply the knowledge to solve problems based on above properties to strengthen their basics.

Unit- I: **15 hrs.**

Time dependent and time-independent Schrodinger equation, continuity equation, wave packet, admissible wave functions, and stationary states. Formalism of wave mechanics, expectation values, quantum mechanical operators for position and momentum in the coordinate representation, Construction of quantum mechanical operators for other dynamical variables from those of position and momentum, Ehrenfest's theorem, momentum eigen functions in the coordinate Representation, box normalization and Dirac delta function. Coordinate and momentum representations, Schrodinger equation in momentum representation,

Unit-II: **15 hrs.**

Brief revision of linear vector spaces, inner or scalar product, Schwarz inequality, state vectors, general formalism of operator mechanics vector, operator algebra, commutation relations, eigen values and eigen vectors, Hermitian operators degeneracy, orthogonality eigenvectors of Hermitian operators, noncommutativity of two operators and uncertainty in the simultaneous measurements of the corresponding dynamical variables, the fundamental expansion postulate, representation of state vector, Dirac's bra-ket notations. Matrix representation of operators, change of basis, unitary transformations, quantum dynamics, Schrodinger, Heisenberg, and interaction picture.

Unit-III: **15 hrs.**

Solution of Schrodinger equation for simple problems, 1-D Square well, step and barrier potentials, 1-D harmonic oscillator, zero-point energy. harmonic oscillator problem by operator method.

Angular momentum operator, commutation relations, expression for L^2 operator in spherical polar coordinates, Role of L^2 operators in central force problem, eigen value problem for L^2 , separation of Schrodinger equation in radial and angular parts, solution of radial equation for hydrogen atom, 3-d square well potential, parity of wave function, parity operator.

Unit-IV: **15 hrs.**

Generalized angular momentum, raising, and lowering operators, matrices for J2, Jx, Jy, Jz operators, Pauli spin matrices, Addition of angular momenta, Clebich-Gordon Coefficient, spin angular momentum, spin momentum functions.

References:

1. Quantum mechanics: L.I.Schiff
2. Quantum mechanics: Mathews and Venkatesan
3. Quantum mechanics :Ghatak and Loknathan
4. Quantum mechanics: B.Craseman and J.D.Powell
5. Modern quantum mechanics: J.J.Sakurai
6. Quantum Theory D. Bohm, (Asia Publishing House)

B.Sc. –IV SEMESTER - VIII

DSC: Paper II: Course Code: B-PH482T

CLASSICAL MECHANICS

Credit: 4

Marks- 60 **Time- 60 hours.**

OBJECTIVES:

1. To disseminate the deep knowledge of Newtonian, Lagrangian and Hamiltonian of the classical particles
2. To disseminate the fundamental knowledge of rigid dynamics and central force motion
3. Provide opportunities for scientific study and creativity within a global context that will stimulate and challenge the students.

OUTCOMES:

1. Students understand the Newtonian, Lagrangian and Hamiltonian equations of the classical particles.
2. They understand the basics of rigid dynamics and central force motion.
3. Apply the knowledge to solve problems based on above properties to strengthen their basics.

Unit-1 (15 Hours)

Review of Newtonian mechanics, Dynamical systems, Phase space dynamics, stability analysis, generalized coordinates, degree of freedom, principle of virtual work, constraints & their classifications with examples, D'Alembert's Principle, Variational Principle, Lagrange's equation.

Unit-II (15 Hours)

Hamilton's Principle, Euler Lagrange equation of motion, Conservation laws and cyclic coordinates, Symmetry properties of space and time, Hamilton's canonical equation of motion, Hamilton-Jacobi equation and its solution.

Unit-III (15 Hours)

Central force problems, Lagrangian and Hamiltonian for central forces, Centre of mass and laboratory systems, Kepler problems, classification of orbits, scattering in central force field, Principle of least action, Canonical Variables, Poisson's bracket, Canonical transformation, generating function

Unit-IV (15 Hours)

Rigid body dynamics, moment of inertia tensor, Euler's angle, Non-inertial frames and pseudo-forces, Periodic motion: small oscillations, normal modes, Special theory of relativity, Lorentz transformations, relativistic kinematics and mass–energy equivalence.

Text and Reference books:

1. Classical Mechanics: H. Goldstein
2. Classical Mechanics: J. W. Muller-Kirsten, World Scientific 2008
3. Classical Mechanics: N.C. Rana and P.S. Joag
4. Classical Mechanics : J. C. Upadhyaya (Himalaya Publishing House)

B.Sc. –IV SEMESTER - VIII

DSE: Paper III: Course Code: B-PH483T
MOLECULAR MODELLING AND SIMULATIONS

Credit: 4

OBJECTIVES:

1. To disseminate the knowledge of Modelling and Simulation
2. To disseminate the practical knowledge of Modelling and simulation tools
3. Provide opportunities for scientific study of molecular systems

OUTCOMES: After the course completion student will be able to,

1. Preform classical molecular simulations
2. Preform quantum mechanical simulations
3. Determine electronic and mechanical properties of molecules

Part I: Particle and Continuum Methods

Unit I **15hrs**

1 Introduction, Continuum modelling and solution approaches
2 Statistical mechanics,
3 Basics of molecular dynamics and Monte Carlo
4 Visualization and data analysis
5 Applications

Unit –II **15hrs**

1 Multi-scale modelling paradigm
2 Modelling chemical interactions
3 Applications: Adsorption and absorption
4 Reactive potentials
5 Applications: Fracture

Part II: Quantum Mechanical Methods

Unit III **15hrs**

1. Basics of quantum mechanics
2. The Many-Body Problem
3. From many-body to single-particle
4. Quantum modelling of molecules
5. Applications: Hydrogen Storage

Unit IV **15hrs**

1. Atoms to Molecules
2. From atoms to solids
3. Quantum modelling of solids
4. Applications: Solar Photovoltaics

References

1. Daan Frenkel_ Berend Smit - Understanding molecular simulation from algorithms to applications (2002, Academic Press) - libgen.lc
2. Tamar Schlick, Molecular Modeling and Simulation An Interdisciplinary Guide. Springer
3. Herma Cuppen, Introduction in Molecular Modeling (dictaat.pdf (ru.nl)
4. Alan Hinchliffe, Molecular Modelling for Beginners UMIST, Manchester, Willey

5. DAVID S. SHOLL and JANICE A. STECKEL DENSITY FUNCTIONAL THEORY A Practical Introduction Willey
6. Wolfram Koch, Max C. Holthausen, A Chemist's Guide to Density Functional Theory

B.Sc. –IV SEMESTER - VIII
DSE: Paper III: Course Code: B-PH483T
APPLIED DIGITAL ELECTRONICS

Credit: 4

OBJECTIVES:

1. To disseminate the knowledge of Logic circuits
2. To disseminate the practical knowledge of Binary counters
3. Provide opportunities for scientific study, memory devices

OUTCOMES:

After the course completion student understand

1. How to design logic gates and circuits Logic circuits
2. Construction and working of Binary counters
3. Memory devices, their working and design.

Unit I **15 hrs.**

Binary and decimal number systems, NOT, OR, AND gates using transistor, truth tables and Boolean equations of NAND, NOR & EXOR gates, Binary addition and subtraction, 2's compliment representation, Representing decimal numbers as 2's complements, Binary addition and subtraction, multiplication and division using 2's compliments. De Morgan's theorems, Duality theorem, SOP and POS methods, Karnaugh maps upto 4 variables, Multiplexers (4:1 and 8:1) and Demultiplexers (1:4 and 1:8), half adder and full adder

Unit II **15 hrs.**

Flip-flops: RS ff using NOR and NAND gates, Clocked RS ff, D-ff, JK-ff, JKMS-ff, Clock waveform, IC 555 and its application as astable and monostable multivibrator, Shift registers: SISO (4 bit using D-ff), SIPO, PISO, PIPO (4 bit using RS ff), Ring counter (4 bit using D-ff), Asynchronous counters, UP/DOWN counters, Synchronous counters, MOD-3, MOD-5 and MOD-7 counters

Unit III **15 hrs.**

D/A converters: variable resistor network, binary ladder, A/D converters: counter type, Single slope-pulse width or voltage to time, Dual slope
Semiconductor memories: ROM, RAM, EPROM, EEPROM, Flash memory, DRAM, SRAM, SDRAM, F-RAM and MRAM

Unit IV **15 hrs.**

Integrated circuit technologies: TTL: Two input TTL NAND, Two input TTL NOR gates, Inverter, TTL input and output profile, concept of open collector gates, Need of three state TTL devices, three state buffer
CMOS: Two input TTL NAND, Two input TTL NOR gates, Inverter
Comparison of TTL and CMOS technologies (advantages and disadvantages)
Introduction to PLDs: Simple Programmable Logic Devices (SPLDs), Complex Programmable Logic Devices (CPLDs) and Field-Programmable Gate Arrays (FPGAs).

Reference books:

Digital Principles and Applications by Malvino & Leach: Mc Graw Hill publication
Digital Fundamentals by Thomas Floyd and R. P. Jain: PEARSON education
Digital Electronics by Kale, Gokhale and Dharmadhikari: Das Ganu Publication

B.Sc. –IV SEMESTER - VIII

DSC/DSE: Course Code: B-PH484P

PRACTICAL

Credit: 6

1. Determination of e/m by Busch's helical beam method.
2. Study of paramagnetic to ferromagnetic phase transition.
3. Study of Paramagnetic salt by Guoy's balance
4. Differential scanning Calorimetry
5. Determination of Plank's constant.
6. Determination of Stephan's constant.
7. Michelson Interferometer.
8. Resistivity of Ge at various temperature by Four Probe method and determination of band gap.
9. Susceptibility, Gauy's method.
10. Ionic Conductivity of NaCl.
11. Skin depth in Al using electromagnetic radiation.
12. Determination of Boltzmann Constant using diode
13. End point energy and Absorption coefficient using G.M.tube.
14. Electron Spin Resonance. (ESR)
15. Fabry-Parot Interferometer.
16. Electron Diffraction.
17. Thermionic Emission.
18. Franck – Hertz Experiment.
19. Determination of Planck's constant using different color filters
20. Stefan's constant – Black body radiation.
21. Clausius – Mossottiequation using sugar solution (Determination of Polarisation.)
22. To study absorption spectra of Iodine molecule and to determine its dissociation energy using spectrometer.
23. Determination of skin depth of aluminium and iron through the measurement of amplitude and phase changes of transmitted low frequency electromagnetic waves.
24. Investigation of propagation of electromagnetic wave through a transmission lineand determination of propagation constant under boundary conditions.
25. Determination of Hall Coefficient and carrier concentration in given sample.
26. Study of Magneto resistance in semiconductors.

Modelling and Simulations

OBJECTIVES:

1. To disseminate the knowledge of Modelling and Simulation
2. To disseminate the practical knowledge of Modelling and simulation tools
3. Provide opportunities for practical scientific study of molecular systems

OUTCOMES:

After the course completion student will be able to,

1. Preform classical molecular simulations
2. Preform quantum mechanical simulations
3. Determine electronic and mechanical properties of molecules

Practical

Molecular Modelling

1 Simulation of Random walk problem
2 Introduction to PDB files
3 Introduction to VMD and Visualization and data analysis
4 Introduction to GROMACS
5 Basic Monte Carlo Method
6 Basic Molecular Mechanics
7 Basic Molecular dynamics
8 Introduction to Burai
9 Introduction to Quantum Espresso
10 Electronic Properties of molecules
11 Analysis of Molecular Orbitals

References

1. Daan Frenkel_ Berend Smit - Understanding molecular simulation _ from algorithms to applications (2002, Academic Press) - libgen.lc
2. Tamar Schlick, Molecular Modeling and Simulation an Interdisciplinary Guide. Springer
3. Herma Cuppen, Introduction in Molecular Modeling (dictaat.pdf (ru.nl)
4. Alan Hinchliffe, Molecular Modelling for Beginners UMIST, Manchester, Willey
5. DAVID S. SHOLL and JANICE A. STECKEL DENSITY FUNCTIONAL THEORY A Practical Introduction Willey
6. Wolfram Koch, Max C. Holthausen, A Chemist’s Guide to Density Functional Theory

Practical on Digital Electronics

1. Study of various multivibrators using IC 555
2. Study of RS Flip-flops and D- flip-flop
3. Study of JKMS flip flop
4. Study of binary counters 3 bit asynchronous and MOD 5 counter
5. Study of 3 bit serial in serial out shift registrar
6. Study of 3 bit serial in parallel out shift register
7. Study of R-2R binary ladder A/D convertors
8. Study of counter type D/A convertors

B.Sc. – SEMESTER - VIII

Course Code: B-PH526P

Internship / Apprenticeship/Field Project (Related to DSC)

Credit: 4

OBJECTIVES:

1. To disseminate the Internship experience
2. Provide opportunities for scientific projects

OUTCOMES:

1. Students develop experimental skills in research
2. They analyze experimental limitations, precautions and future scope

Internship

Each student has to take a part time internship in the field of science and technology.

END of SEM VIII