DEPARTMENT OF PHYSICS

SYLLABUS FOR FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP)

(FIRST– SIXTH SEMESTER)

Approved by Academic Council vide Resolution no. AC – 03/2024/05 Dated: 04 – 05 – 24

ARYA VIDYAPEETH COLLEGE (AUTONOMOUS)

ARYA NAGAR, GUWAHATI – 16

CONTENT

PREFACE

"Education is not preparation for life; education is life itself." —John Dewey

The aim of imparting education is not only to increase the knowledge but also to create the possibilities for a student to invent and discover. The purpose of this syllabus is to establish minimum basic concepts for each course to meet the needs of all our students. All the elements in this syllabus amalgamate to bring out the best in every student and enable them to be on the path of continuous progress.

The syllabus is framed based on Learning Outcome Based Education (LOCF) - the spirit of NEP, 2020. The programmes offered by the college are :

i. Bachelor Degree in Arts
ii. Bachelor Degree in Science
iii. Bachelor Degree in Commerce

Under the above programme, the following courses are offered by the college:

i. Core Course
ii. Minor Course
iii. Skill Enhancement Course
iv. Interdisciplinary Course
v. Ability Enhancement Course
vi. Value Added Course
vii. Internship

Programme outcome of each programme and Programme Specific Outcomes of each discipline/subject offered by the college is mapped with course learning outcome of each course. Graduate attributes of students obtaining Undergraduate Degree from the college are also incorporated in the syllabus.

The syllabus includes eight semesters where there will be 23 Core Courses, 8 Minor Courses, 2 Value Added Courses, 3 SEC Courses, 3 IDC Courses, 4 AEC courses and internship. The total credit offered for eight semesters is 160.

The syllabus framed takes into account the different styles of learning – audio, visual and experiential. The syllabus correlates academics to real life situations balancing social and emotional stimulation among the students and imbibe human values. Also the syllabus gives the opportunity for the theoretical knowledge to be pursued ensuring maximum application of it.

Structure of Four Year Undergraduate Course

Semester	Type	Core	Minor	SEC	IDC	AEC	VAC/FC	IN
	Credit	4	4	3	3	2	4(2 + 2)	2
I		CE-1114	MN-1114	SE-1113	ID-1113	AE-1112	VL-1112 (Two Courses)	-
II		CE-2114	MN-2114	SE-2113	ID-2113	AE-2112	VL-2112 (Two Courses)	-
III		CE-3214	MN-3214	SE-3213	ID-3213	AE-3212	-	-
		CE-3224						
IV		CE-4214	MN-4214	-	-	AE-4212	-	IN-4212
		CE-4224						
		CE-4234						
V		CE-5314	MN-5214	-	-	-	-	-
		CE-5324						
		CE-5334						
		CE-5344						
VI		CE-6314	MN-6214	-	-	-	-	-
		CE-6324						
		CE-6334						
		CE-6344						
VII		CE-7414	MN-7314	-	-	-	-	-
		CE-7424						
		CE-7434						
		CE-7444						
VIII		CE-8414	MN-8314	-	-	-	-	-
		CE-8424**						
		CE-8434**						
		CE-8444**						

****Students who secure more than 7.5 CGPA at the end of third year (6th semester) may opt for a research dissertation of 12 credits instead of the three core courses.**

Course code: **First two letters is the abbreviation of course component**

First digit implies semester number

Second digit implies course level

Third digit implies course number

Fourth digit implies credit points per course.

Digit	Course Level
1	100 - 199
2	200 - 299
3	300 - 399
4	400 - 499

Semester Wise Credit Distribution

Semester	CREDIT DISTRIBUTION							
	CORE	MINOR	SEC	AEC	IDC	VAC/FC	IN	TOTAL
FIRST	1 x 4	1 x 4	1 x 3	1 x 2	1 x 3	2 x 2	--	20
SECOND	1 x 4	1 x 4	1 x 3	1 x 2	1 x 3	2 x 2	--	20
THIRD	2 x 4	1 x 4	1 x 3	1 x 2	1 x 3	--	--	20
FOURTH	3 x 4	1 x 4	--	1 x 2	--	--	1 x 2	20
FIFTH	4 x 4	1 x 4	--	--	--	--	--	20
SIXTH	4 x 4	1 x 4	--	--	--	--	--	20
SEVENTH	4 x 4	1 x 4	--	--	--	--	--	20
EIGHT	4 x 4	1 x 4	--	--	--	--	--	20

SEC: SKILL ENHANCEMENT COURSE

AEC: ABILITY ENHANCEMENT COURSE

IDC: INTERDISCIPLINARY COURSE

VAC/FC: VALUE ADDED COURSE

IN: INTERNSHIP

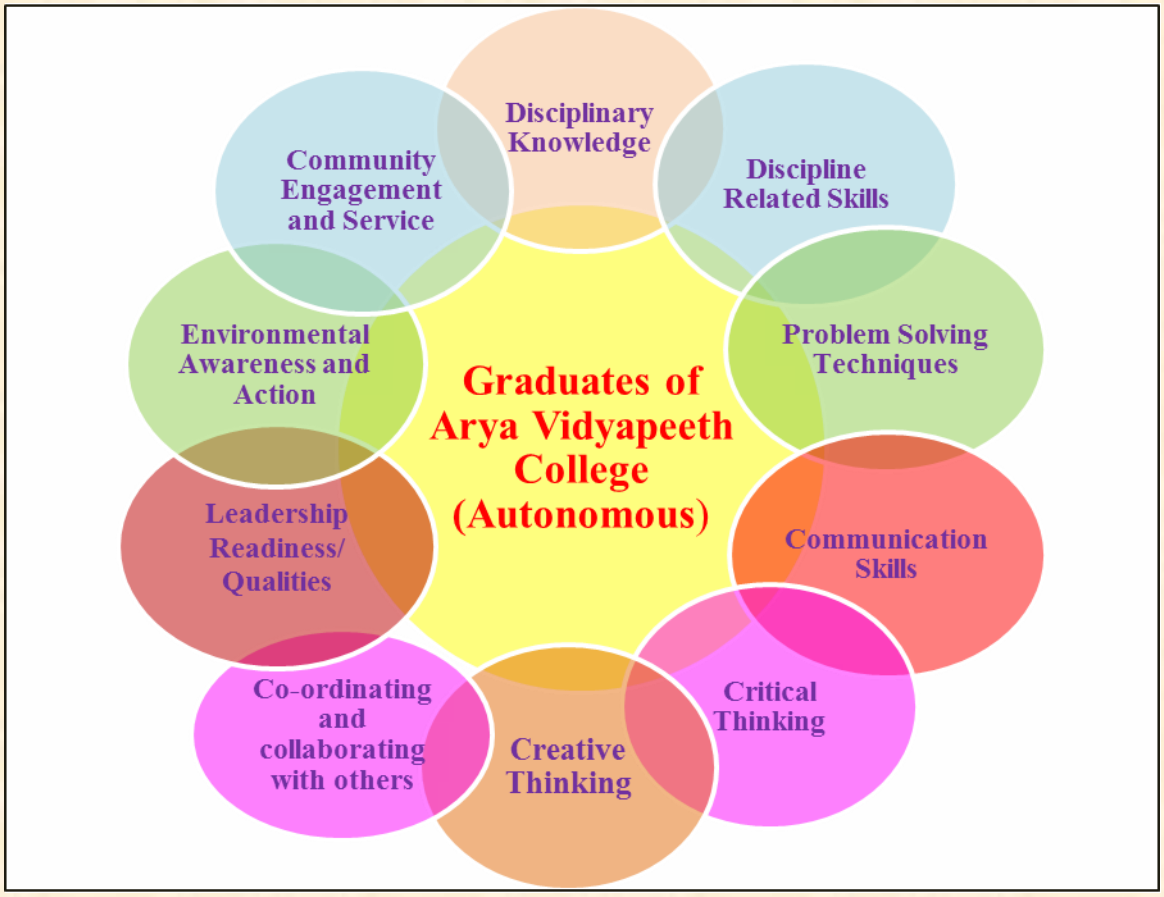
Abbreviation of Course Components:

CE (Core), MN (Minor), SE(Skill Enhancement Course), AE (Ability Enhancement Course), VL (Value added Course), ID (Interdisciplinary Course), IN (Internship)

GRADUATE ATTRIBUTES

Graduate Attributes:

Graduate Attributes are the qualities, skills and understandings that the students should develop during their time with the college. These attributes consequently shape the contribution they are able to make to their profession and society. They are the qualities that also prepare graduates as agents of social good in an unknown future. These attributes sets them apart from those without a degree. The graduate attributes of Arya Vidyapeeth College (Autonomous) are:



Model of Graduate Attributes

1. **Disciplinary knowledge:** Graduates shall acquire comprehensive knowledge and understanding of their subject area, the ability to engage with different traditions of thought, and the ability to apply their knowledge in practice including in multi-disciplinary or multi-professional contexts.
2. **Discipline related skills:** Skills in areas related to specialization in the chosen disciplinary/interdisciplinary/major/minor area(s) of learning in a broad multidisciplinary context. In addition create, select, and apply appropriate modern techniques, resources and IT tools.
3. **Problem solving skills:** A capacity for problem identification, the collection of evidence, synthesis and dispassionate analysis and apply one's learning in real – life situations.

4. **Communication Skills:** Ability to recognize and value communication as the tool for negotiating and creating new understanding, collaborating with others, and furthering their own learning.
5. **Critical thinking:** Graduates acquire the capacity for problem identification, collection of evidence, synthesis and dispassionate analysis. They also acquire the capacity for attentive exchange, informed argument and reasoning.
6. **Creative Thinking:** The graduates acquire an ability to create, perform or think in different and diverse ways about the same objects or scenarios and also the ability to communicate effectively for different purposes and in different contexts. They should also be able to work independently and as part of a team.
7. **Co-ordinating and collaborating with others:** The graduates need to possess the ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. They should also be able to work productively with others, no matter their culture, perspective or background, and complete joint projects and also to work in partnership.
8. **Leadership readiness/qualities:** The graduates should be able to lead and support others by inspiring them with a clear vision and motivating them to achieve goals. They also need to acquire ability to map out the tasks of a team or an organization and setting directions.
9. **Environmental Awareness and action:** The graduates shall earn the capacity to realize the individual's responsibility in protecting and conserving the environment. They need to gain the capacity to understand the impact of the professional solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
10. **Community engagement and service:** The graduates need to develop an understanding of social and civic responsibilities, and of the rights of individuals and groups. The graduates should be able to demonstrate the capability to participate in community-engaged services/ activities for promoting the wellbeing of the society which includes participation in NSS,NCC, adult literacy etc

UNDERGRADUATE PROGRAMME OUTCOME (PO)

BACHELOR DEGREE INSCIENCE: (B.Sc)

1. **SPO-1 Knowledge:** Learners are encouraged to apply the knowledge of mathematics and science fundamentals to various solutions of complex problems. As such, knowledge of the subject is the sole objective of any student learner. A student is exposed to a wide range of topics in various subjects and is given intensive training in each of the courses that have laboratory related work. The learner is encouraged to use various mathematical methods (analytical and numerical) and experimental methods as an application to the acquired concepts and principles that help in studying various branches of sciences. At the end of the program, students are able to gain thorough knowledge in key areas in the subjects offered.
2. **SPO-2 Problem Analyses**: Well equipped with an understanding of the analytical methods involved, they are in a position to interpret and analyze results so obtained from experiments and draw suitable conclusions against their supported data acquired. At the end of the program, students will be able to identify, formulate and analyze scientific problems and reach concrete solutions using various principles of mathematics and sciences.
3. **SPO-3 Designing Solutions**: Having acquired knowledge of subjects, students are trained to think out of the box, design and conduct an experiment or a series of experiments that demonstrate their understanding of the methods and processes involved.
4. **SPO-4 Modern tool usage**: Learners are trained to create, select, and apply appropriate techniques, resources and IT tools in the analysis and synthesis of data within limitations. (Outcome of final year project).
5. **SPO-5 Effective Communication**: Proficiency in speaking, reading, writing and listening in English and one Indian language and find meaning of the world by connecting people, ideas, books, media and technology.
6. **SPO-6 Employability**: This programme enables the learners to perform the jobs in diverse fields such as science, engineering, industries, survey, education, banking, development-planning, business, public service, self business etc. efficiently.They will also be able to appear for competitive examinations
7. **SPO-7 Ethics:** While it is necessary to instil the spirit of competitiveness among students in a world of increasing competition, it is equally vital to develop a strong sense of ethics among learners that will help them develop some positive attitudes and values. This includes appreciation of the various principles and theories that evolved in science, the impact that science

has on social, economical and environmental issues. One of the main objectives of any academic exercise, therefore, should be to produce well-groomed individuals who understand the significance of ethical values and abide by them even in the most pressing circumstances. In this programme, this process is enabled through courses and facilitators who integrate the teaching of ethics in everyday pedagogy. As such, at the end of this programme students will be able to develop, internalise and exercise ethics in their professional as well as personal practices.

8. **SPO-8 Environment and Sustainability**: 'Environmental sustainability' has become the watchword of the 21st century. An increased engagement with environment related concerns is appearing tangibly on global fronts; academics cannot and should not remain quarantined from this massive development. Through classroom discussions and research projects, this programme facilitates active dialogues with factors which influence human-ecology interactions. As such, at the end of this programme students will be able to identify and analyze socio-political, cultural and economic problems which act as deterrents to environmental sustainability and provide creative solutions towards the same.

9. **SPO-9 Soft-Skill Development**: Apart from the attainment of knowledge and hands on skills in practical applicability of the subject, learners need to be equipped with soft-skills and values which will help them function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary groups. These soft skills include leadership, teamwork, project-management, positive outlook, innovative approaches and effective articulation. Several soft skill programs are organized for learners through various agencies that tie up with the state government. As such, at the end of this programme, students will be able to hone the soft-skills required in positively enhancing their academic, professional and personal pursuits towards self and societal advancement.

10. **SPO-10 Science and Society**: The learners are encouraged to apply logical reasoning based on the knowledge, skills, designing solutions to assess societal, health, safety issues and the responsibilities that go along with the scientific practice. As an extension activity to society, learners are encouraged to take up specific projects such as impact of salinity on fresh water wells in an adopted village, and provide effective solutions.

11. **SPO-11 Life-long learning**: With the pursuit of knowledge for either personal or professional reasons, learners are also encouraged to volunteer and be self motivated that not only enhances society values, active participation and personality development, but also enhances self-sustainability, competiveness and employability. As such, learners will be able to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in every broad context of technological changes.

CORE

LIST OF COURSES:

Semester	COURSE Name & Code	Contents
1	MATHEMATICAL PHYSICS-I & MECHANICS-I PY-CE-1114	Vectors and scalars
		Vector differentiation
		Vector differential operator
		Vector Integration
		Work energy principle
		Rigid body dynamics
		Gravitation
		Special theory of relativity.
2	MATHEMATICAL PHYSICS-II & PROPERTIES OF MATTER PY-CE-2114	Ordinary Differential Equation
		Partial Differential Equation
		Elasticity
		Surface Tension
		Viscosity.
3	MATHEMATICAL PHYSICS-III PY-CE-3214	Orthogonal Curvilinear Coordinate
		Matrix Algebra
		Dirac Delta Function
		Some Special Integrals
		Theory of Probability and Errors
	OPTICS PY-CE-3224	Ray Optics
		Wave Optics.
4	MATHEMATICAL PHYSICS-IV PY-CE-4214	Series Solution of Differential Equation
		Fourier Series
		Tensor Analysis
		Solution of Linear and Non-linear Equations
		Numerical Integration
	WAVES & APPLIED OPTICS PY-CE-4224	Harmonic Motion
		Wave Motion
		Sound Wave
		Superposition of Two Harmonic Waves
		Applied Optics

4	ELECTRICITY AND MAGNETISM PY-CE-4234	Electrostatics
		Current Electricity
		Magnetostatics
5	MATHEMATICAL PHYSICS-V PY-CE-5314	Complex Analysis
		Complex Integration
		Fourier Transformation
		Laplace Transformation
		Numerical Solution of Ordinary Differential Equation and Partial differential Equation
	CLASSICAL MECHANICS PY-CE-5324	D'Alembert's Principle and Lagrangian Equation
		Hamiltonian Dynamics and Poisson Bracket
		Motion under Central Force and theory of Scattering
		Relativistic Mechanics
	THERMAL PHYSICS PY-CE-5334	Zeroth and First Law of Thermodynamics
		Second Law of Thermodynamics
		Entropy
		Thermodynamic Potentials
		Maxwell's Thermodynamic Relations
		Distribution of Velocities
		Molecular Collisions
		Real Gases.
	ANALOG ELECTRONICS PY – CE – 5344	Semiconductor devices
		Network Theorem
		Bipolar Junction Transistors
		Two-terminal Devices and their Applications
		Sinusoidal Oscillators
		Operational Amplifiers (Black Box approach)
	QUANTUM MECHANICS PY-CE-6314	Origin of Quantum Theory
		Schrödinger Equation
		Postulates of Quantum Mechanics
		Application of Schrödinger Equation .

6	CONDENSED MATTER PHYSICS PY-CE-6324	Crystal Structure
		Crystal Bonding
		Free electron theory of metals
		Specific Heat of Solids
		Dielectric and Ferroelectric Properties of materials
	ATOMIC AND NUCLEAR PHYSICS PY-CE-6334	Discovery of charged particles
		X-Rays
		Atoms in Electric and Magnetic Fields
		General properties of atomic nuclei and its stability
		Radioactive Decay
	DIGITAL ELECTRONICS PY-CE-6344	Integrated Circuits
		Digital Circuits
		Boolean Algebra
		Arithmetic Circuits
		Sequential Circuits
		Timer Circuits
		Shift Registers (up to 4-bits only)
		Counters (up to 4-bits only)
		Computer Organization

Programme Specific Outcome of Bachelor of Science-Physics Core (PSO)

PSO No.	Name	Outcome
PSO–1	Basic Knowledge	The learner will acquire knowledge regarding the fundamental principles of Physics through the study of Mechanics, Optics, Waves and Oscillation, Heat and Thermodynamics, Electricity and Magnetism, Classical Mechanics, Quantum Mechanics, Atomic and Nuclear Physics, Electronics, Statistical Mechanics, and Electromagnetic Theory.
PSO–2	Research Level Competency & Critical Thinking	The learner will be familiar with the state of the art of the appropriate level of technology for (a) experimental design and implementation, (b) analysis of experimental data, (c) numerical and mathematical methods in solving problems, (d) different computational techniques and apply them for experimental data analysis and solving theoretical problems.
PSO–3	Skill Enhancement through ICT	The learner will acquire a fair amount of computational skills using open-source software packages such as Python, Numpy, Scipy, Matplot lib, Matlab, and LaTex. This will not only prepare them for higher studies or research in any branch of Physics but also make them ready for various kinds of jobs in the IT sector and other industries.
PSO–4	Communication Skill	The learner will learn effective communication skills to present their knowledge of physics from basic to advanced levels in the form of preparation of laboratory notebooks, project work, seminar presentations, poster presentations ,wall magazines, models and other modes.
PSO–5	Digitally Efficient	The learner will learn using computers for computational and simulation studies in Physics. Proficiency will be earned in appropriate soft-ware for numerical and statistical analysis of data, ability to search in-formation related to Physics from internet.
PSO–6	Team Work	The learner will learn to work either independently or in a group during laboratory sessions, projects and student seminar.
PSO–7	R & D Jobs	The learner can pursue a career in R& D jobs related to Physics and allied fields like Space Physics, Atmospheric Physics, Instrumentation, Oceanography and lots more.
PSO–8	Competency for Competitive Examinations	The learner will be competent to face national/international level examinations like UGC-CSIR NET, GATE, JAM, JEST, GRE, TOEFL and UPSC Civil Service Examinations.

Course Learning Outcome (CLO) – Core

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	MATHEMATICAL PHYSICS–I & MECHANICS-I PY-CE-1114	CLO-01	After completing the course a student will be able to understand vector and their applications in various fields.
		CLO-02	Further, a student will be able to understand and solve a real-life problem that needs an understanding of the laws of mechanics, gravitation, and relativity.
2	MATHEMATICAL PHYSICS-II & PROPERTIES OF MATTER PY-CE-2114	CLO-01	After completing the course, a student will be able to solve ordinary as well as partial differential equations. They can apply the knowledge in various fields of science and engineering .fields.
		CLO-02	Further, a student will be able to understand and solve a real-life problem that needs an understanding of the elasticity, surface tension and viscosity.
3	MATHEMATICAL PHYSICS-III PY-CE-3214	CLO - 01	After successful completion of the course, the learner will learn about generalized coordinate system and its transformation to other coordinate system like Cartesian, polar, cylindrical, and spherical polar coordinate system; Matrix algebra, determination of eigen values and eigen vectors, etc.; Randomness of event and theory of probability; The method of error calculation and its minimisation.
		CLO-02	The learner can apply the knowledge of coordinate system and its transformation in different field of science and engineering. The application of matrix is wide not only in Physics but also indifferent branches of science and technology. The knowledge of matrix will help in understanding and solving problems. The knowledge of error calculation and its minimisation, and also, fitting of experimental data by the method of least square can be applied indifferent experimental procedure.

3	MATHEMATICAL PHYSICS-III PY-CE-3214	CLO-03	Any real life problem can be analyzed and may be given a matrix representation which is a most common procedure in science and technology. The learner can apply the knowledge of matrix in solving a real life problem. Similar is the case with knowledge of error theory and probability
	OPTICS PY-CE-3224	CLO-01	After successful completion of the course, a learner will learn about formation of image due to a system of lenses, different types of magnifications, defects of images of different types, and matrix method of studying geometrical optics.
		CLO-02	Also, the learner will learn about detailed theory of wave like behavior of light through the phenomena interference, diffraction, and polarisation as well as associated phenomena - colour of thin film, Newton's ring etc.
		CLO-03	Biprism experiment, Newton's ring experiment, Michelson Interferometer, Grating experiment, experiment with polarimeter will give better insight into the subject.
4	MATHEMATICAL PHYSICS-IV PY-CE-4214	CLO-1	After successful completion of the course, a learner will receive broad overview of solving differential equation by series method. Similarly, they will be acquainted with other mathematical tools like Dirac-Delta function, Beta-Gamma function and Tensor analysis
		CLO-02	These mathematical tools have extensive applications in the field of Quantum Mechanics, General Theory of Relativity and many more.
		CLO-03	These knowledge will help a learner in solving problems related to Quantum Mechanics, General Theory of Relativity etc.
	WAVES & APPLIED OPTICS PY-CE-4224	CLO-01	This course will acquaint the learner with the oscillatory motion of simple harmonic type and its classification under different physical conditions; phenomenon like resonance. They will learn about wave motion in an elastic medium and its mathematical analysis
		CLO-02	Also, they will learn about propagation of sound in an elastic medium, Newton's formula to determine the velocity of sound and Laplace correction. Fourier analysis of sound wave will also be learned in this course

4	WAVES & APPLIED OPTICS PY-CE-4224	CLO-03	After the course, the student will learn to handle practical instruments with laser, learn holography and fibre optics.
		CLO-04	This course will help in understanding musical notes and working of the musical instruments; necessary criteria for constructing an auditorium etc
	ELECTRICITY AND MAGNETISM PY-CE-4234	CLO-01	One will learn the fundamental properties of charged particles and electric fields in this course.
		CLO-02	This course will give learners an understanding of the phenomena of electricity, magnetism, electromagnetic Induction and electrical circuits which are essential for higher studies in physics and also important for various engineering applications.
		CLO-03	This course builds the basis for studying more advanced topics in electromagnetic theory.
5	MATHEMATICAL PHYSICS-V PY-CE-5314	CLO-01	After successful completion of the course, the learner will learn about Complex Analysis and Complex Integration. They will also learn Fourier and Laplace transformation.
		CLO-02	These mathematical tools will help the learner to study various branches of science and engineering. This knowledge will help the future study as well
	CLASSICAL MECHANICS PY-CE-5324	CLO-01	Understand the fundamental concepts of analytical mechanics such as generalized coordinates and velocity, the Lagrange and Hamilton functions.
		CLO-02	Ability to use the Lagrange and Hamilton equations to solve complex mechanical problems.
		CLO-03	Knowledge of relativistic mechanics will help learning advanced topics in Quantum Mechanics, Nuclear Physics, General Theory of Relativity etc.
	THERMAL PHYSICS PY-CE-5334	CLO-01	The basic laws of nature associated with heat and thermodynamics, the conversion of heat into work and vice-versa, principle of working of machine – carnot engine, concept of entropy, thermodynamic potentials, etc. Also, they will learn about kinetic theory of gases.
		CLO-02	They will learn to apply the concept of kinetic theory of gases to explain the real life physical phenomena like thermal conductivity, diffusion of gases in a medium, phenomenon like Brownian motion,etc.

5	ANALOG ELECTRONICS PY-CE-5344	CLO-01	This course forms the basis of electronics which is responsible for the technological advances of the present-day world.
		CLO-02	The learner will understand the basic concepts of semi-conductor physics and its application.
		CLO-03	They will learn about the operation, characteristics, and various applications of different types of diodes, transistors, field effect transistors, OPAMP, and oscillators.
		CLO-04	They will also have an idea about the working of amplifier and regulated power supply.
6	QUANTUM MECHANICS PY-CE-6314	CLO-01	The learner will receive a broad overview of the history of quantum mechanics and its gradual development. Schrödinger equation which is one of the important equation for studying quantum mechanical systems will be learned along with other aspects like operator formulism of quantum mechanics, principle of uncertainty and complementary etc
		CLO-02	He will learn to apply the formulism learned so far to investigate quantum mechanical systems like simple harmonic oscillator hydrogen atom etc.
		CLO-03	This knowledge will help in understanding other branches in Physics like Solid State Physics, Nuclear Physics, Spectroscopy etc.
	CONDENSED MATTER PHYSICS PY-CE-6324	CLO-01	One will learn the main features of crystal lattices and understand the elementary lattice dynamics
		CLO-02	One learns about the mechanical, magnetic, and electrical properties of the substance as well as the forces that bind the units into the solid state.
		CLO-03	One also learns the main features of the physics of electrons in a solid.
		CLO-04	Till now, the most important sub-field of solid state physics in the 20^{th} century is the study of semiconductors and solid state electronics. This course promises to give background knowledge in pursuing advanced-level studies in semiconductor and solid state electronics.
	ATOMIC AND NUCLEAR PHYSICS PY-CE-6334	CLO-01	The learner will learn about the structure of atom and its behavior in electric and magnetic field.

6	ATOMIC AND NUCLEAR PHYSICS PY-CE-6334	CLO-02	The learner will learn the constituents of nucleus and the force which binds them together. They will learn about binding energy and understand the concept of stability of nucleus and the cause of radioactivity.
		CLO-03	The knowledge will help them in future study and doing R&D jobs. The knowledge of nuclear physics will make them competent to pursue a career in radiological physics, nuclear power plant etc.
	DIGITAL ELECTRONICS PY-CE-6344	CLO-01	At the end of the course, a learner will have a broad exposure of different types of digital circuits and their applications.
		CLO-02	A learner will know the basic knowledge of integrated circuit and its types and working process of computers.

MAPPING OF PROGRAME OUTCOME (PO) AND COURSE LEARNING OUTCOME (CLO)

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Course Code	CLO	Programme Outcome (PO)										
		SPO-1	SPO-2	SPO-3	SPO-4	SPO-5	SPO-6	SPO-7	SPO-8	SPO-9	SPO-10	SPO-11
PY-CE-1114	CLO-1	3	1	1	2	2	1	2	1	1	1	1
	CLO-2	2	1	1	2	2	1	2	1	1	1	1
PY-CE-2114	CLO-1	3	1	1	2	2	1	2	1	1	1	1
	CLO-2	2	1	1	2	2	1	2	1	1	1	1
PY-CE-3214	CLO-1	2	2	2	2	2	2	2	1	1	2	1
	CLO-2	3	2	2	2	2	2	2	1	1	2	1
PY-CE-3224	CLO-1	3	2	2	2	2	2	2	1	1	2	1
	CLO-2	3	2	2	2	2	2	2	1	1	2	1
PY-CE-4214	CLO-1	2	2	2	2	2	2	2	2	2	2	1
	CLO-2	3	2	2	2	2	2	2	2	2	2	1
PY-CE-4224	CLO-1	2	2	2	2	2	2	2	2	2	2	1
	CLO-2	3	2	2	2	2	2	2	2	2	2	1
PY-CE-4234	CLO-1	2	2	2	2	2	2	2	2	2	2	1
	CLO-2	3	2	2	2	2	2	2	2	2	2	1
PY-CE-5314	CLO-1	1	3	3	3	3	3	2	2	2	2	1
	CLO-2	2	3	3	3	3	3	2	2	2	2	1
PY-CE-5324	CLO-1	1	3	3	3	3	3	2	2	2	2	1
	CLO-2	1	3	3	3	3	3	2	2	2	2	1
PY-CE-5334	CLO-1	1	3	3	3	3	3	2	2	2	2	1
	CLO-2	2	3	3	3	3	3	2	2	2	2	1
PY-CE-5344	CLO - 1	1	3	3	3	3	3	2	2	2	2	1
	CLO - 2	1	3	3	3	3	3	2	2	2	2	1
	CLO - 3	2	3	3	3	3	3	2	2	2	2	1
	CLO - 4	1	3	3	3	3	3	2	2	2	2	1
PY-CE-6314	CLO-1	1	3	3	3	3	3	2	2	2	2	1
	CLO-2	2	3	3	3	3	3	2	2	2	2	1
PY-CE-6324	CLO-1	1	3	3	3	3	3	2	2	2	2	1
	CLO-2	1	3	3	3	3	3	2	2	2	2	1
PY-CE-6334	CLO - 1	2	3	3	3	3	3	2	2	2	2	1
	CLO - 2	1	3	3	3	3	3	2	2	2	2	1
PY-CE-6344	CLO - 1	1	3	3	3	3	3	2	2	2	2	1
	CLO - 2	1	3	3	3	3	3	2	2	2	2	1

MAPPING OF PROGRAME SPECIFIC OUTCOME (PSO) AND COURSE LEARNING OUTCOME (CLO)

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Course Code	CLO	Programme Specific Outcome (PSO)							
		PSO - 1	PSO - 2	PSO - 3	PSO - 4	PSO - 5	PSO – 6	PSO - 7	PSO - 8
PY-CE-1114	CLO - 1	3	1	2	1	1	1	1	1
	CLO - 2	3	1	2	1	1	1	1	1
PY-CE-2114	CLO - 1	2	3	2	1	1	1	1	1
	CLO - 2	3	1	2	1	1	1	1	1
PY-CE-3214	CLO - 1	2	2	2	1	2	1	1	1
	CLO - 2	2	2	2	1	2	1	1	1
PY-CE-3224	CLO - 1	2	3	2	1	2	1	1	1
	CLO - 2	2	2	2	1	2	1	1	1
PY-CE-4214	CLO - 1	2	3	2	1	2	1	1	1
	CLO - 2	2	2	2	1	2	1	1	1
PY-CE-4224	CLO - 1	1	2	2	1	2	1	1	1
	CLO - 2	2	2	2	1	2	1	1	1
PY-CE-4234	CLO - 1	2	3	2	1	2	1	1	1
	CLO - 2	2	2	2	1	2	1	1	1
PY-CE-5314	CLO - 1	1	3	2	1	2	1	2	2
	CLO - 2	2	3	2	1	2	1	2	2
PY-CE-5324	CLO - 1	1	2	2	1	2	1	2	2
	CLO - 2	1	3	2	1	2	1	2	2
PY-CE-5334	CLO - 1	1	3	2	1	2	1	2	2
	CLO - 2	2	3	2	1	2	1	2	2
PY-CE-5344	CLO - 1	1	3	2	1	2	1	2	2
	CLO - 2	1	3	2	1	2	1	2	2
	CLO - 3	2	3	2	1	2	1	2	2
	CLO - 4	1	2	2	1	2	1	2	2
PY-CE-6314	CLO - 1	1	3	2	1	2	1	2	2
	CLO - 2	2	3	2	1	2	1	2	2
PY-CE-6324	CLO - 1	2	3	2	1	2	1	2	2
	CLO - 2	1	3	2	1	2	1	2	2
PY-CE-6334	CLO - 1	1	2	2	1	2	1	2	2
	CLO - 2	2	3	2	1	2	1	2	2
PY-CE-6344	CLO - 1	1	3	2	1	2	1	2	2
	CLO - 2	2	3	2	1	2	1	2	2

COURSE NAME: Mathematical Physics - I And Mechanics - I

COURSE CODE: PY- CE - 1114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

- *To impart advanced concepts and methods in Mathematics which include the Calculus of vector-valued functions.*
- *To impart basic concepts of work-energy principle, rigid body dynamics, laws of gravitation, and a basic concept of relativity.*

Course Learning Outcome:

CLO-01: *After completing the course a student will be able to understand vector and their applications in various fields.*

CLO-02: *Further, a student will be able to understand and solve a real-life problem that needs an understanding of the laws of mechanics, gravitation, and relativity.*

Mathematical Physics - I (Credit - 1; No. of lectures - 15)

Unit I: Vector and scalars(Lectures 2)

Introduction, dot and cross products including triple products, their physical significance

Unit II: Vector differentiation (Lectures 3)

Ordinary derivative of vectors, continuity, and differentiability, the partial derivative of vectors, applications to problems in Physics.

Unit III: Vector differential operator(Lectures 5)

Gradient, divergence, and curl - definitions and physical meaning, formulas involving del and invariance

Unit IV: Vector Integration (Lectures 5)

Ordinary integrals of vectors - line integral, surface integral and volume integral, Gauss's theorem, Stoke's theorem and Green's theorem (no rigorous proof is required)

Mechanics – I (Credit - 2; No. of lectures - 30)

Unit V: Work energy principle (Lectures 8)

Laws of motion - Concepts of work, energy, and power, Conservative forces - conservative force as a negative gradient of potential, Conservation of linear and angular momentum, motion of a rocket.
Centre of mass - motion of the centre of mass, collision problem in the centre of mass frame of reference and laboratory frame of reference

Unit VI: Rigid body dynamics (Lectures 9)

Rotational motion - translation and rotational motion, torque, angular momentum. Moment of inertia - general theorem of the moment of inertia, moment of inertia calculation in particular cases - disk, cylinder, and sphere; flywheel, the kinetic energy of rotational motion.

Unit VII: Gravitation (Lectures 7)

Newton's law of gravitation, Gravitational field - the intensity of the field, gravitational potential, and gravitational potential energy; gravitational field and potential due to a solid sphere and spherical shell. Motion under the central force field, two body problems, and reduced mass.

Unit VIII: Special theory of relativity (Lectures 6)

Reference frame - inertial and non-inertial, Galilean Transformation, Galilean Invariance, Postulates of special theory of relativity, Lorentz Transformation equations - length contraction, time dilation and mass variation.

PRACTICAL

Total Lectures: 30

A minimum of five experiments to be done.

1. To measure the thickness of a piece of glass using a vernier calliper, screw gauge, and spherometer and compare their results.
2. To measure the diameter of a capillary tube using a traveling microscope.
3. To determine the height using a sextant.
4. To determine the Moment of Inertia of a Symmetrical body about an axis by the torsional oscillation method.
5. To determine the moment of inertia of a flywheel.
6. To find the angular acceleration and torque of a flywheel.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum
9. To determine the value of g using the motion of an oscillating spring.

BOOKS RECOMMENDED:

1. Vector Analysis, Murray R. Spiegel (Schaum Series)
2. Mathematical Methods for Engineers and Scientists, K. T. Tang
3. Higher Engineering Mathematics, H. K. Das.
4. An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw Hill.
5. Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. Physics, Resnick, Halliday, and Walker 8/e. 2008, Wiley.
8. B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
9. A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

COURSE NAME: Mathematical Physics - II And Properties Of Matter

COURSE CODE: PY- CE - 2114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

- *To impart advanced concepts and methods in Mathematics which include the Calculus of vector-valued functions.*
- *To impart basic concepts of work-energy principle, rigid body dynamics, laws of gravitation, and a basic concept of relativity.*

Course Learning Outcome:

CLO-01: *After completing the course a student will be able to understand application of differential equation in various fields.*

CLO-02: *Further, a student will be able to understand and solve a real-life problem that needs an understanding of elasticity, surface tension and viscosity.*

Mathematical Physics - II (Credit - 1, Lectures - 15)

Unit I: Ordinary Differential Equation (Lectures 8)

Order and degree of a differential equation, 1st order linear differential equation, 1st order and 2nd order homogenous differential equation. Radioactive decay, Newton's law of cooling, Free fall.

Unit II: Partial Differential Equation (Lectures 7)

Solution of Partial differential equation using separation of variables, exact and inexact differentials. Laplace's equation in the cartesian coordinate system, Wave equation.

Properties of Matter (Credit - 2, Lectures - 30)

Unit III: Elasticity (Lectures 10)

Hooke's law, Elastic behaviour of solids, Different types of elasticity, Elastic constants, Relation among different elastic constants, Poisson's ratio, determination of Poisson's ratio, Twisting couple of a cylinder. Bending moment, depression of a cantilever.

Unit IV: Surface Tension (Lectures 10)

Surface tension and surface energy, the Pressure difference across a liquid surface - drops and bubbles, Rise of liquid in a capillary tube - Jurin's law

Unit V: Viscosity (Lectures 10)

The flow of liquid, streamline flow, continuity equation - Bernoulli's theorem and its applications, Viscosity, coefficient of viscosity, Reynold's number, Poiseuille's equation, Effect of temperature and pressure on the viscosity of fluids.

PRACTICAL

Total Lectures: 30

A minimum of five experiments are to be done.

1. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
2. To determine the Modulus of Rigidity of a Wire Static method.
3. To determine the spring constant and rigidity modulus from the motion of a spring.
4. To determine the surface tension of water by Jaeger's method.
5. To determine the coefficient of viscosity of water by capillary flow method (Poiseuille's method).
6. To determine the surface tension of a liquid by the capillary rise method and verify Jurin's law
7. To determine the coefficient of viscosity of glycerine or mustard oil by Stoke's method.

BOOKS RECOMMENDED:

1. Mathematical Methods for Engineers and Scientists, K. T. Tang
2. Higher Engineering Mathematics, H. K. Das.
3. An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw Hill.
4. Properties of Matter by D. S. Mathur, S. Chand, and Company.
5. B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
6. A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

COURSE NAME: Mathematical Physics - III

COURSE CODE: PY- CE - 3214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

The objective of the course is to acquaint the learner with different mathematical tools that are necessary for doing any R&D job.

It also intended to introduce a few of the numerical recipes like solution of linear and transcendental equations and solving integration by numerical methods which is indispensable component solving problems by computer.

Emphasis will be put on explaining the concept with real-life problems.

Course Learning Outcome:

CLO–01: *After successful completion of the course, the learner will learn about generalised coordinate system and its transformation to other coordinate system like Cartesian, polar, cylindrical, and spherical polar coordinate system; Matrix algebra, determination of eigen values and eigen vectors, etc.; Randomness of event and theory of probability; The method of error calculation and its minimisation.*

CLO–02: *The learner can apply the knowledge of coordinate system and its transformation in different field of science and engineering. The application of matrix is wide not only in Physics but also in different branches of science and technology. The knowledge of matrix will help in understanding and solving problems. The knowledge of error calculation and its minimisation, and also, fitting of experimental data by the method of least square can be applied in different experimental procedure.*

CLO–03: *Any real life problem can be analyzed and may be given a matrix representation which is a most common procedure in science and technology. The learner can apply the knowledge of matrix in solving a real life problem. Similar is the case with knowledge of error theory and probability*.

Unit I - Orthogonal Curvilinear Coordinate (12 lectures)

Curvilinear coordinates - Unit vectors and scale factors in orthogonal curvilinear coordinates, plane polar coordinates, right circular cylindrical coordinates, and spherical polar coordinates. Arc length, area, and volume elements in each of these systems.

Gradient, Divergence, Curl, and Laplacian in plane polar coordinates, right circular cylindrical coordinates, and spherical polar coordinates.

Unit II - Matrix algebra (10 lectures)

Introduction to different types of matrices, Properties of matrices, Transpose of a matrix, complex conjugate matrix, Hermitian matrix, special square matrix, unit matrix, diagonal matrix, co-factor matrix, adjoint of a matrix, self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix.

Eigenvalue problems, Cayley-Hamilton Theorem, Diagonalization of matrices.

Unit III - Dirac Delta Function (7 lectures)

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

Unit IV - Some Special Integrals (8 lectures)

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Unit V - Theory of Probability and Errors (8 lectures)

Independent random variables, Probability distribution functions of Binomial, Gaussian, and Poisson, with examples. Mean and variance.

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least- squares fit.

PRACTICAL

Total Lectures: 30

Basics of Coding

• Basics of Scientific Computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, numerical errors of elementary floating point operations, round off and truncation errors with examples.

Introduction to Algorithms and Flow charts. Branching with examples of conditional statements, for and while loops.

• Basic Elements of Python: Variables and assignments, variable types, output and input statements, arithmetic oper- ations, comment statement.

• Control Statements: Logical statements- IF, IF-ELSE block, Looping Statements- WHILE, FOR loop, indentation, break and continue, List comprehension.

• Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules.

• Basics of Numpy: Importing Numpy, Difference between List and NumPy array, Adding, removing and sorting elements, creating arrays using ones(), zeros(), random(), arange(), linspace(). Basic array operations (sum, max, min, mean, variance), 2-d and 3-d arrays, matrix operations, reshaping and transposing arrays, random number generation using rand().

• Basics of Mat plotlib: Introduction to graphical analysis, the importance of visualization of computational data, mat plotlib. pyplot functions, simple plots.

List of Programs

1. To find a set of prime numbers between two given numbers.
2. To find the Fibonacci series up to 10 terms.
3. Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.
4. To transform a point from cartesian coordinate system to polar coordinate system and vice-versa.

5. Generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.
6. Generate random numbers and calculate area of circle, area of square, volume of sphere, value of π.

Matrix Algebra

Write a suitable code

1. To create a matrix with or without using numpy array/matrix.
2. To add, multiply two matrices.
3. To find determinant and inverse of a matrix.
4. To find eigen values and eigen vectors of a matrix.

Method of Least square Fitting of experimental data:

Write a suitable code to fit experimental data by the method of least squares, test goodness of fit, and standard deviation of

1. Voltage-Current data from Ohm's law experiment and hence to find the value of resistance.
2. Load-Elongation data taken from Young's law experiment and calculating the value of Young's modulus (Y) from the fitted data.

BOOKS RECOMMENDED:

1. Murray R Spiegel. Schaum's Outline of Theory and Problems of Vector Analysis. Schaum, 1959.
2. Richard Bronson. Theory and problems of matrix operations. The McGraw Hill Companies, 1989.
3. K.T. Tang. Mathematical Methods for Engineers and Scientists 1: Complex Analysis, Determinants and Matrices. Mathematical Methods for Engineers and Scientists. Springer Berlin Heidelberg, 2006. ISBN: 9783540302742.
   URL: https://books.google.co.in/books?id=orOTiguKIR4C.
4. HK Dass. Higher Engineering Mathematics. S. Chand Publishing, 2011.
5. John Robert Taylor and William Thompson. An introduction to error analysis: the study of uncertainties in physical measurements. Vol. 2. Springer, 1982.
6. Shankar S Sastry. Introductory methods of numerical analysis. PHI Learning Pvt. Ltd., 2012.
7. S.R.K. Iyengar and R.K. Jain. Numerical Methods (As Per Anna University). New Age International (P) Limited, 2009. ISBN: 9788122426106.
   URL: https://books.google.co.in/books?id=5p5jFxb16UEC.
8. D. Walker. Computational Physics: An Undergraduate's Guide. Pantaneto introductory physics series. Pantaneto Press, 2013. ISBN: 9780992636807.
   URL: https://books.google.co.in/books?id=KTzooAEACAAJ.
9. T. Pang. An Introduction to Computational Physics. Cambridge University Press, 2006. ISBN: 9780521825696. URL: https://books.google.co.in/books?id=zTO-jzbfD3wC.

10. M.E.J. Newman. Computational Physics. CreateSpace Independent Publishing Platform, 2013. ISBN: 9781480145511.
URL: https://books.google.co.in/books?id=SS6uNAEACAAJ.
11. Robert Johansson, Robert Johansson, and Suresh John. Numerical python. Vol. 1. Springer, 2019.
12. Jaan Kiusalaas. Numerical methods in engineering with Python 3. Cambridge university press, 2013.

COURSE NAME: Optics

COURSE CODE: PY- CE - 3224

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective

- *To impart knowledge regarding image formation due to a system of lenses.*
- *To impart knowledge about the matrix method of studying paraxial optics.*
- *To impart knowledge about wave like behaviour of light and related phenomena like interference, diffraction, and polarization.*

Course Learning Outcome

CLO–01: *After successful completion of the course, a learner will learn about formation of image due to a system of lenses, different types of magnifications, defects of images of different types, and matrix method of studying geometrical optics.*

CLO–02: *Also, the learner will learn about detailed theory of wave like behaviour of light through the phenomena - interference, diffraction, and polarisation as well as associated phenomena - colour of thin film, Newton's ring etc.*

CLO–03: *Biprism experiment, Newton's ring experiment, Michelson Interferometer, Grating experiment, experiment with polarimeter will give better insight into the subject.*

Unit I - Ray Optics (20 lectures)

Fermat's principle - its application to laws of reflection and refraction, Refraction of paraxial rays at a single spherical surface, thick lens, magnification of image, interrelation among lateral, longitudinal, and angular magnification, Lagrange's law, and Helmholtz equation.

Defects of image

Spherical aberration and its minimization, Qualitative idea about coma, astigmatism and distortion, Chromatic aberration.

Matrix method of paraxial optics

Translation matrix and Refraction Matrix, use of matrix method in refraction at a spherical surface and refraction through thin lens, zone matrix.

Unit II - Wave Optics (25 lectures)

Interference

Concept of light wave and its equation, Stokes' law, interference due to Fresnel's biprism, interference by a plane parallel film, colour of thin film, Newton's rings, Michelson interferometer and its application for finding difference in wavelengths.

Diffraction

Difference between Fresnel and Fraunhofer classes, half-period zones and strips, Zone plate and its lensing property, diffraction at a straight edge and a circular aperture, Fraunhofer diffraction due to a single slit, grating (its reduction to double slit), Resolving power and Dispersive power (derivation not

required).

Polarisation

Plane polarised light, polarisation on reflection, Brewster's law, double refraction, Nicol prism, rotation of plane of polarization by optically active substances, specific rotation, polarimeter.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum experiments to be performed is seven

1. To determine the refractive index of a liquid by using plane mirror and convex lens.
2. To determine the focal length of two lenses and their combination by displacement method.
3. Familiarization with Schuster's focusing, determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin sheet/paper by measuring the width of the interference fringes produced by a wedge- shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.
11. To verify the law of Malus for plane polarized light.
12. To determine the specific rotation of sugar solution using Polarimeter.
13. To analyze elliptically polarized Light by using a Babinet's compensator.
14. To find the difference in wavelength using Michelson Interferometer.

BOOKS RECOMMENDED:

1. B Ghosh and KG Mazumdar. "A Text Book on Light". In: Sreedhar Pub., Calcutta, (2003).
2. P Chakrabarti. Geometrical & Physical Optics. New Central Book Agency, 2010.
3. A. Ghatak. Optics. McGraw-Hill Education, 2009. ISBN: 9780073380483. URL: https://books.google.co. in/books?id=KTMHOQAACAAJ.
4. Eugene Hecht. Optics. Pearson Education India, 2012.
5. CL Arora. B. Sc. Practical Physics. S. Chand Publishing, 2001.
6. S.K. Ghosh. A Textbook of Practical Physics. New Central Book Agency (P) Limited, 2008. ISBN: 9788173811609. URL: https://books.google.co.in/books?id=L3ElrgEACAAJ.

7. D Chattopadhyay and PC Rakshit. An advanced course in practical physics. New Central Book Agency, 1990.

COURSE NAME: Mathematical Physics - IV

COURSE CODE: PY- CE - 4214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to acquaint the learner with the method of solving differential equation by series method (Frobenius method), and also to introduce with other types of differential equations - Legendre, Hermite and their properties. They also learn Dirac Delta Function, some special integrals - Beta and Gamma functions,Tensor analysis.

Course Learning Outcome

CLO – 01: *After successful completion of the course, a learner will receive broad overview of solving differential equation by series method. Similarly, they will be acquainted with other mathematical tools like Dirac-Delta function, Beta-Gamma function and Tensor analysis.*

CLO – 02: *These mathematical tools have extensive applications in the field of Quantum Mechanics, General Theory of Relativity and many more.*

CLO – 03: *So, these knowledge will help a learner in solving problems related to Quantum Mechanics, General Theory of Relativity, etc.*

Unit I - Series solution of differential equation (15 lectures)

Second order linear differential equations, series method of solutions (Frobenius), Legendre's differential equations, Legendre's polynomial, Hermite's differential equations, Hermite's polynomial, generating function, spherical harmonics, orthogonal properties & recurrence relations.

Unit II - Fourier Series (6 lectures)

Periodic functions. Orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series).

Unit III - Tensor Analysis (8 lectures)

Introduction to tensor - Transformation of coordinates, Einstein's summation convention. contravariant and covariant tensor, tensorial character of physical quantities, symmetric and antisymmetric tensors, Kronecker delta, Levi-Civita Tensor.

Rules for combination of tensors - addition, subtraction, outer multiplication, contraction, and inner multiplications. Quotient law of tensors

Unit IV - Solution of Linear and Non-linear Equations (10 lectures)

Simultaneous linear equations - Gauss elimination method, Gauss-Siedel method. Non-linear equations - Bisection method, Newton-Raphson method, Sectant method.

Unit V - Numerical Integration (6 lectures)

Numerical integration - trapezoidal rule, Simpson's 1/3 rd rule.

PRACTICAL

Total Lectures: 30

Solution of linear and non-linear equations

Using Bisection, Newton Raphson and Secant methods, find out roots of the equation.

1. To approximate nth root of a number up to a given number of significant digits.
2. Solve transcendental equations (a) $\alpha = \tan \alpha$, (b) $\sin \alpha = \sqrt{m}\alpha$.
3. Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.

Use Gauss elimination method, Iterative methods like Gauss Seidel method for solving system of linear equations.

1. Use Kirchhoff's laws to write down the set of mesh equations for a given linear electric circuit and solve the mesh equations (3 meshes).
2. Solve coupled spring mass system (3 masses).

Numerical Integration

Use Trapezoidal rule, Simpson's 1/3 rd Rule, to evaluate the following integration.

1. Given positions with equidistant time interval, find the velocity and acceleration of a particle in motion.
2. Evaluate:

$$\frac{1}{\sqrt{2\pi\sigma^2}} \int exp\left(\frac{(x-2)^2}{2\sigma^2}\right)(x+3)dx$$

   for $\sigma = 1, 0.1, 0.001$ and show that it tends to 5.

3. Evaluate:

$$\int_{-\infty}^{\infty} \frac{dx}{1+x^2}$$

4. Evaluate the Fourier coefficients of a given periodic functions (a) square wave, and (b) saw tooth wave and represent them graphically.
5. Verify the properties of Dirac Delta function using its representation as a sequence of functions - Gaussian functions and rectangular functions.
6. Plot (a) Legendre's polynomial, (b) Bessel's function.
7. Verify the Orthogonality of Legendre Polynomials.

BOOKS RECOMMENDED

1. K.T. Tang. Mathematical Methods for Engineers and Scientists 2: Vector Analysis, Ordinary Differential Equations and Laplace Transforms. Mathematical Methods for Engineers and Scientists. Springer Berlin Heidelberg, 2006. ISBN: 9783540302704. URL: https://books.google.co.in/books?id=r0zrNgOLurIC.
2. M.R. Spiegel. Schaum's Outline of Fourier Analysis with Applications to Boundary Value Problems. Schaum's Outline Series. McGraw Hill LLC, 1974. ISBN: 9780071783637. URL: https://books.google.co.in/books? id=WoK9OEOynSUC.
3. H K Dass. Higher Engineering Mathematics. S. Chand Publishing, 2011.

4. Shankar S Sastry. Introductory methods of numerical analysis. PHI Learning Pvt. Ltd., 2012.
5. S.R.K. Iyengar and R.K. Jain. Numerical Methods (As Per Anna University). New Age International (P) Limited, 2009. ISBN: 9788122426106. URL: https://books.google.co.in/books?id=5p5jFxb16UEC.
6. D. Walker. Computational Physics: An Undergraduate's Guide. Pantaneto introductory physics series. Pantaneto Press, 2013. ISBN: 9780992636807. URL: https://books.google.co.in/books?id=KTzooAEACAAJ.
7. T. Pang. An Introduction to Computational Physics. Cambridge University Press, 2006. ISBN: 9780521825696. URL:https://books.google.co.in/books?id=zTO-jzbfD3wC.
8. M.E.J. Newman. Computational Physics. CreateSpace Independent Publishing Platform, 2013. ISBN: 9781480145511.
   URL: https://books.google.co.in/books?id=SS6uNAEACAAJ.
9. Robert Johansson, Robert Johansson, and Suresh John. Numerical python. Vol. 1. Springer, 2019.
10. Jaan Kiusalaas. Numerical methods in engineering with Python 3. Cambridge university press, 2013.

COURSE NAME: Waves & Applied Optics

COURSE CODE: PY- CE - 4224

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to acquaint the learner with the concept of oscillatory motion of simple harmonic type and its different characteristics. Also, a broad overview will be given about propagation of wave in an elastic medium and different aspects of sound wave. Also, Fourier analysis of sound wave will be done. Principles of Laser, Holography, and Fibre Optics will be discussed along with their applications.

Course Learning Outcome:

CLO – 01: *This course will acquaint the learner with the oscillatory motion of simple harmonic type and its classification under different physical conditions; phenomenon like resonance. They will learn about wave motion in an elastic medium and its mathematical analysis, superposition of waves, stationary waves.*

CLO – 02: *Also, they will learn about propagation of sound in an elastic medium, Newton's formula to determine the velocity of sound and Laplace correction. Fourier analysis of sound wave will also be learned in this course.*

CLO – 03: *This course will help in understanding musical notes and working of the musical instruments; necessary criteria for constructing an auditorium etc.*

CLO – 04: *After the course, the student will learn to handle practical instruments with laser, learn holography and fibre optics.*

Unit I - Harmonic Motion (8 lectures)

Simple Harmonic motion, Composition of two simple harmonic oscillations at right angles, Lissajous figures. Free, damped, and forced oscillations, resonance, and sharpness of resonance.

Unit II - Wave Motion (6 lectures)

Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of Wave Equation. Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave,Water Waves - Ripple and Gravity Waves.

Unit III - Sound Wave (8 lectures)

Velocity of Transverse Vibrations of Stretched Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction, Effect of temperature and pressure on velocity of sound in air, intensity level of sound and its unit (bel and decibel), Acoustics of auditorium, reverberation, Sabine's law.

Unit IV - Superposition of Two Harmonic Waves (8 lectures)

Standing (Stationary) Waves in a String - Fixed and Free Ends, Phase and Group Velocities, Changes w.r.t Position and Time. Energy of Vibrating String, Transfer of Energy, Normal Modes of Stretched Strings, Plucked and Struck Strings, Melde's Experiment, Longitudinal Standing Waves and Normal Modes, Open and Closed Pipes.

Unit V - Applied Optics **(15 lectures)**

Lasers - Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, Ruby laser, He-Ne laser, Basic ideas of Semiconductor lasers.

Holography - Basic principle and theory, coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.

Fibre Optics - Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Basic ideas about optical fibre communication system.

PRACTICAL

Total Lectures: 30

Minimum experiments to be performed is six.

1. Study the motion of a spring in different medium (a) air and (b) water/kerosene oil. Calculate the value of g in bothcases and compare the result.
2. Determine the frequency of an electric tuning fork by Melde's experiment and verify the $\lambda^2 - T$ law.
3. Study the Lissajous figure of two waves using a CRO and determine the value of unknown frequency of the wave.
4. Determine the velocity of sound wave in air at room temperature using a resonance tube at three different resonancepositions.
5. Study the relation between frequency and length/tension of a given wire under constant tension using a sonometerand also plot a graph between frequency and length/tension.
6. Study the diffraction of light due to the propagation of an ultrasonic wave in a given liquid and calculate the speedof sound in the given liquid.
7. Determine the grating radial spacing of the CD and DVD by using either reflection or refraction method with aHe-Ne or Solid State laser. Compare the experimental values with the theoretical one.
8. Find the width of the given wire using diffraction pattern obtained by a He-Ne or solid state laser and verify theresult using a screw gauge.
9. Study the V-I characteristics of a light dependent resistor (LDR). Show the relation between resistance and distanceof light source and calculate the dark resistance of the LDR.
10. Study the V-I characteristics of a photovoltaic cell and calculate the fill factor and efficiency of the cell.
11. Measure the numerical aperture and acceptance angle of an optical fibre.

BOOKS RECOMMENDED:

1. N.K. Bajaj. The physics of waves and oscillations. Tata McGraw-Hill, 1988. ISBN: 9780074516102. URL: https://books.google.co.in/books?id=lw1HzwEACAAJ.
2. M.G.D. Bhattacharya. A Textbook Of Oscillations, Waves And Acoustics, 5th Edition. S Chand & Company Lim-Ited, 2016. ISBN: 9789385676154. URL: Https://Books.Google.Co.In/Books?Id=Maordaaaqbaj.
3. H.J. Pain. Physics of Vibrations and Waves. John Wiley & Sons, Incorporated., 2005. URL: https://books.google.co.in/books?id=2zBN0AEACAAJ.
4. Anthony Philip French. Vibrations and waves. CRC press, 2017.
5. Francis A. Jenkins and Harvey E. White. Fundamentals of Optics. Tata McGraw-hill, 1981.
6. K.Thyagarajan and A.K.Ghatak. LASERS: Fundamentals & applications. Tata McGraw Hill, 2010.
7. M.R. Shenoy et al. Fiber Optics Through Experiments. MV Learning, 2015. ISBN: 9788130929835. URL: https://books.google.co.in/books?id=Z_VzjwEACAAJ.
8. S.C. Gupta. Optoelectronic Devices And Systems. PHI Learning, 2014. ISBN: 9788120350656. URL: https://books.google.co.in/books?id=zmfkBQAAQBAJ.
9. A. Lipson, S.G. Lipson, and H. Lipson. Optical Physics. Cambridge University Press, 2010. ISBN: 9781139492607. URL:https://books.google.co.in/books?id=aow3o0dhyjYC

COURSE NAME: Electricity And Magnetism

COURSE CODE: PY- CE - 4234

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to give the learners a broad overview of Electrostatics, Current Electricity and Magnetostatics which are essentially required for the pursuance of Higher Studies or doing R & D job.

Course Learning Outcome:

CLO – 01: *One will learn the fundamental properties of charged particles and electric fields in this course.*

CLO – 02: *This course will give learners an understanding of the phenomena of electricity, magnetism, electromagnetic induction, and electrical circuits which are essential for higher studies in physics and also important for various engineering applications.*

CLO – 03: *This course builds the basis for studying more advanced topics in electromagnetic theory*

Unit I – Electrostatics (15 lectures)

Electric field, Divergence of Electric field, Gauss's law of electric field in integral and differential form, Applications of Gauss's law for linear, surface and volume charge distribution. Curl of an electric field, Electric potential, electric potential due to a uniformly charged - (a) wire, (b) ring, and (c) disc. Electric dipole, Potential and field due to a dipole, dipole in a uniform external electric field, dipole-dipole interaction. Multipole expansion of electrostatic potential due to a volume distribution of charge.

Electrostatic boundary conditions

Electrostatic energy: Energy of (a) an assembly of point charges, (b) a uniformly charged sphere. Laplace's and Poisson's equations, boundary conditions and Uniqueness theorem, Solutions of Laplace's equation in one dimension: Electric potential and intensity (a) inside an infinite parallel plate capacitor, (b) inside spherical capacitor, and (c) due to a long and uniformly charged conducting wire.

Method of electrical image

Method of electrical image with examples of (a) infinite grounded conducting plane and (b) grounded conducting sphere.

Unit II - Current Electricity (15 lectures)

Electric current density, continuity equation, Ohm's law, Applications of Kirchoff's law to solve electrical network problem, Kelvin double bridge for low resistance measurement, moving coil ballistic galvanometer and its sensitivity.

Self and mutual induction, coefficient of coupling, reciprocity theorem, self induction of a long

solenoid, mutual induction of two solenoids, measurement of L and M using d.c. source and ballistic galvanometer.

Transient growth and decay of current in LR, CR and LCR circuits, oscillatory discharge. Thermo electricity: Coefficients of thermo-emf, thermoelectric power, basic ideas of Seeback and Peltier effects.

Generation of alternating current, Phasor (complex number method) method of analyzing a.c. circuits, current and potential across resistive, inductive and capacitive elements and their phase relationships, power factor, LR, CR and LCR (series and parallel) circuits, quality factor, resonance; Maxwell's LC bridge and Anderson's bridge.

Rotating magnetic field, a.c. motor, transformer, reflected impedance in transformer, use of transformer.

Unit III – Magnetostatics (15 lectures)

Magnetic field, Lorentz force, Cyclotron motion, cycloid motion, Biot-Savart law, Magnetic field due to a steady current in (a) straight conductor and (b) a circular coil. Divergence and Curl of a magnetic field. Ampere's circuital law: magnetic field due to a (a) long straight conductor and (b) an infinite solenoid carrying a steady current, Magnetic scalar and vector potential. Force and torque on a current loop in a uniform magnetic field, Current loop as a magnetic dipole.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum experiments to be performed is five

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and
   (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit and calculate the time constant..
3. To determine the value of an unknown low resistance using a Potentiometer.
4. To determine the value of an unknown low resistance using a Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength and its variation in a solenoid (determine $\frac{dB}{dx}$)
7. To determine self inductance of a coil by Anderson's bridge.
8. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at reso-nance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.
10. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
11. Determine a high resistance by leakage method using Ballistic Galvanometer.
12. To determine self-inductance of a coil by Rayleigh's method.

13. To determine the mutual inductance of two coils by Absolute method.

BOOKS RECOMMENDED:

1. D.J. Griffiths. Introduction to Electrodynamics. Cambridge University Press, 2017. ISBN: 9781108357142. URL: https://books.google.co.in/books?id=Kh4xDwAAQBAJ.
2. Vasudeva. D. N. Fundamentals of Magnetism and Electricity. S. Chand Limited, 2007. ISBN: 9788121909556. URL: https://books.google.co.in/books?id=DbucEAAAQBAJ.
3. D. Chattopadhyay. Electricity And Magnetism. New Central Book Agency (P) Limited, 2013. ISBN: 9788173812514. URL: https://books.google.co.in/books?id=0WWmcgeF1XQC.
4. Laud. B. B. Electromagnetics. Wiley Eastern, 1987. ISBN: 9780852264997. URL: https://books.google.co.in/books?id=XtgFvbd9F2UC.
5. K K Tewari. Electricity and Magnetism. S. Chand Limited, 1995. ISBN: 9788121906678. URL: https://books.google.co.in/books?id=wQsrDAAAQBAJ.

COURSE NAME: Mathematical Physics - V

COURSE CODE: PY- CE - 5314

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to acquaint the learner with Complex Analysis and Complex Integration, Fourier and Laplace Transformation.

Course Learning Outcome:

CLO – 01 : *After successful completion of the course, the learner will learn about Complex analysis and Complex Integration. They will also learn Fourier and Laplace transformation.*

CLO – 02: *These mathematical tools will help the learner to study various branches of science and engineering. This knowledge will help them in future study as well.*

Unit I - Complex Analysis (15 lectures)

Brief Revision of Complex Numbers and their Graphical Representation, Euler's formula, De Moivre's theorem, Roots ofComplex Numbers

Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions - poles and branch points, order of singularity, branch cuts.

Integration of a function of a complex variable, Cauchy's Inequality, Cauchy's formula, Simply and multiply connected region, Laurent and Taylor's expansion, Residues and Residue Theorem, Application in solving Definite Integrals

Unit II - Fourier Transform (10 lectures)

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian functions Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem (Statement only). Properties of Fourier transform (translation, change of scale, complex conjugation).

Unit III - Laplace Transform (8 lectures)

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem (Statement only). Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator.

Unit IV - Numerical Solution of Ordinary Differential Equation and Partial Differential Equation (12 lectures)

Euler's method, Modified Euler's method, Runge-Kutta method of order 2 and 4, finite difference method to solve PDE.

PRACTICAL

Total Lectures: 30

List of Experiments

Numerical Solution of Ordinary Differential Equation

First order ODE - Solution of 1st order ODE by Euler's method, Modified Euler method, Runge-Kutta method of order 2.

1. Classical equation of motion.
2. Radioactive decay.
3. Newton's law of cooling.
4. Current in RC, LC circuits with DC source.

Second order ODE - solving by Euler's method, modified Euler's method, RK2 method, and Finite difference method.

1. The motion of a simple harmonic oscillator without considering the effect of damping.
2. The motion of damped harmonic oscillator highlighting (a) overdamped, (b) critically damped, and (c) underdamped conditions.

Boundary value problem -

1. Solve $y''(x) + y(x) = 0$ with $y(0) = 1$, $y(\pi/2) = 1$ for $0 < x < \pi$.
2. Motion of a projectile in a resistive medium.

Numerical Solution of Partial Differential Equation-

The solution of partial differential equation numerically by finite difference method.

1. Solve heat equation, and
2. Solve the equation of sound wave.

Complex Analysis, Fourier Transformation, and Laplace Transformation-

1. Find the two square roots of $5 + 12j$.
2. Evaluate Fast Fourier Transformation (FFT) of e^{x^2}.
3. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

BOOKS RECOMMENDED:

1. M.R. Spiegel et al. *Schaum's Outline of Complex Variables, 2ed*. Schaum's Outline Series. McGraw Hill LLC, 2009. ISBN: 9780071615709. URL: https://books.google.co.in/books?id=EjT3fE2SgGwC.
2. K.T. Tang. Mathematical Methods for Engineers and Scientists 1: Complex Analysis, Determinants and Matrices. Mathematical Methods for Engineers and Scientists. Springer Berlin Heidelberg, 2006. ISBN: 9783540302742. URL: https://books.google.co.in/books?id=orOTiguKIR4C.
3. HK Dass. Higher Engineering Mathematics. S. Chand Publishing, 2011.

4. Shankar S Sastry. Introductory methods of numerical analysis. PHI Learning Pvt. Ltd., 2012.

5. S.R.K. Iyengar and R.K. Jain. Numerical Methods (As Per Anna University). New Age International (P) Limited,2009. ISBN: 9788122426106. URL: https://books.google.co.in/books?id=5p5jFxb16UEC.

6. D. Walker. Computational Physics: An Undergraduate's Guide. Pantane to introductory physics series. Pantane toPress, 2013. ISBN: 9780992636807. URL: https://books.google.co.in/books?id=KTzooAEACAAJ.

7. T. Pang. An Introduction to Computational Physics. Cambridge University Press, 2006. ISBN: 9780521825696. URL: https://books.google.co.in/books?id=zTO-jzbfD3wC.

8. R.H. Landau, M.J. Páez, and C.C. Bordeianu. Computational Physics: Problem Solving with Python. EBL-Schweitzer.Wiley, 2015. ISBN: 9783527413157.

   URL: https://books.google.co.in/books?id=gR6zCQAAQBAJ.

9. M.E.J. Newman. Computational Physics. Create Space Independent Publishing Platform, 2013. ISBN: 9781480145511. URL: https://books.google.co.in/books?id=SS6uNAEACAAJ.

10. Robert Johansson, Robert Johansson, and Suresh John. Numerical python. Vol. 1. Springer, 2019.

11. Jaan Kiusalaas. Numerical methods in engineering with Python 3. Cambridge university press, 2013

COURSE NAME: Classical Mechanics

COURSE CODE: PY- CE - 5324

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective :

Here, the objective is to provide the learner a broad overview of mechanics of a point particle. Apart from Newtonian approach, Lagrangian and Hamiltonian approach is introduced to study a dynamical system with reference to practical examples. Also broad overview of relativistic mechanics will be provided.

Course Learning Outcome :

CLO – 01: *After successful completion of the course, the learner will Understand the fundamental concepts of analytical mechanics such as generalized coordinates and velocity, the Lagrange and Hamilton functions.*

CLO – 02: *The learners will develop the ability to use the Lagrange and Hamilton equations to solve complex mechanical problems.*

CLO – 03: *Knowledge of relativistic mechanics will help learning advanced topics in Quantum Mechanics, Nuclear Physics, General Theory of Relativity, e*tc.

Unit I - Classical Mechanics (30 lectures)

D'Alembert's Principle and Lagrangian Equation

Co-ordinate system, constraints, Generalized co-ordinate and velocity, generalized force, principle of virtual work, D'Alembert's principle, Lagrange's equation of motion. Applications - one dimensional simple harmonic oscillator, freely falling body under gravity, coupled oscillators.

Hamiltonian Dynamics and Poisson Bracket

Legendre Transformation, Hamilton's Canonical Equation of Motion, Hamiltonian Applications - one dimensional simple harmonic oscillator, particle in a central force field- conservation of angular momentum and energy, planetary motion - Kepler's problem.

Motion under Central Force and theory of scattering

Central force motion, two body central force motion, Equation of the orbit under central force, Planetary motion - Kepler's laws. Scattering of a particle by a hard sphere, Center of mass and Laboratory System of Scattering - Rutherford Scattering.

Fluid Motion

Concept of viscosity and terminal velocity, Continuity equation and mass conservation, stream line and laminar mo- tion, Reynold's number, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation,

Unit - II Relativistic Mechanics (15 lectures)

Relativistic momentum and energy, Equivalence of mass and energy. Massless particles (i.e. photons). The geometry of spacetime and space-time interval. Four-vectors: spacelike, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

BOOKS RECOMMENDED:

1. H. Goldstein, C.P. Poole, and J.L. Safko. Classical Mechanics. Addison Wesley, 2002. ISBN: 9780201657029. URL: https://books.google.co.in/books?id=tJCuQgAACAAJ.
2. R.G. Takwale and P.S. Puranik. Introduction to Classical Mechanics. Tata McGraw-Hill, 1980. URL: https: //books.google.co.in/books?id=wDQWyAEACAAJ.
3. K.C. Gupta. Classical Mechanics of Particles and Rigid Bodies. Wiley, 1988. ISBN: 9788122400045. URL: https: //books.google.co.in/books?id=bK7vAAAAMAAJ.
4. N.C. Rana and J.P. Sharadchandra. Classical Mechanics. Tata Mac Graw Hill, 1991. URL: https://books.google.co.in/books?id=67NWPgAACAAJ.
5. S.N. Biswas. Classical Mechanics. Books & Allied Limited, 2014. ISBN: 9788187134183. URL: https://books.google.co.in/books?id=Y0H_zgEACAAJ.
6. L.D. Landau and E.M. Lifshitz. Mechanics: Volume 1. v. 1. Elsevier Science, 1982. ISBN: 9780080503479. URL: https://books.google.co.in/books?id=bE-9tUH2J2wC

COURSE NAME: Thermal Physics

COURSE CODE: PY- CE - 5334

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to provide a broad overview of thermodynamics covering the fundamental principles involved - First and Second law of thermodynamics, conversion of heat into work and vice-versa, Carnot engine, concept of entropy, importance of thermodynamic potentials etc.

Also, the kinetic theory of gases will be covered with an objective to learn the molecular motion of gaseous particles, phenomena like thermal conduction, diffusion, brownian motion, etc.

Course Learning Outcome

CLO – 01: *After successful completion of the course, the learner will Understand the basic laws of nature associated with heat and thermodynamics, the conversion of heat into work and vice-versa, principle of working of machine - carnot engine, concept of entropy, thermodynamic potentials, etc. Also, they will learn about kinetic theory of gases.*

CLO – 02: *They will learn to apply the concept of kinetic theory of gases to explain the real life physical phenomena like thermal conductivity, diffusion of gases in a medium, phenomenon like brownian motion, etc.*

Unit I - Introduction to Thermodynamics (30 lectures)

Zeroth and First Law of Thermodynamics:

Zeroth Law of Thermodynamics & Concept of Temperature, First Law of Thermodynamics and its differential form, Internal Energy, Applications of First Law: General Relation between CP and CV , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.

Second Law of Thermodynamics

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & effciency. Refrigerator & coeffcient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Ther- modynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy

Concept of Entropy, Clausius Theorem, Second Law of Thermodynamics, Entropy of a perfect gas, Entropy Changes in Reversible and Irreversible processes, Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Thermodynamic Potentials

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Maxwell's Thermodynamic Relations

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of CP - CV , (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Unit II - Kinetic Theory of Gases (15 lectures)

Distribution of Velocities

Pressure exerted by a gas using spherical polar coordinates, Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Molecular Collisions

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is four.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To determine the boiling point of a given liquid with the help of Platinum Resistance Thermometer (PRT).
7. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
8. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

BOOKS RECOMMENDED:

1. P.K. Chakrabarti. Theory and Experiments on Thermal Physics. New Central Book Agency (P) Limited, 2013. ISBN: 9788173815041. URL: https://books.google.co.in/books?id=JCNXhdvWCGkC.
2. J.P. Agarwal and S. Prakash. Thermodynamics and Statistical Physics. Pragati Prakashan, 1993. URL: https: //books.google.co.in/books?id=6UCcGwAACAAJ.
3. S.C. Garg, R.M. Bansal, and C.K. Ghosh. Thermal Physics: Kinetic Theory, Thermodynamics and Statistical Me- chanics. McGraw Hill Education (India) Private Limited, 2013. ISBN: 9781259097614. URL: https://books. google.co.in/books?id=VAbvjgEACAAJ.
4. F.W. Sears and G.L. Salinger. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics. Addison-Wesley principles of physics series. Addison-Wesley Publishing Company, 1975. ISBN: 9780201068948. URL: https://books.google.co.in/books?id=3gRRAAAAMAAJ

COURSE NAME: Analog Electronics

COURSE CODE: PY- CE - 5344

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

This course will give foundation of the semiconductor electronics so that one canwork in any industry or pursue higher studies or do R&D job in future.

Course Learning Outcome :

CLO – 01: *This course forms the basis of electronics which is responsible for the technological advances of the present-day world.*

CLO – 02: *The learner will understand the basic concepts of semiconductor physics and its application.*

CLO – 03: *They will learn about the operation, characteristics, and various applications of different types of diodes, transistors, field effect transistors, OPAMP, and oscillators.*

CLO – 04 : *They will also have an idea about the working of amplifier and regulated power supply.*

Unit I - Semiconductor Diodes (8 lectures)

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. Barrier Formation in PN Junction Diode. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current flow mechanism in Forward and Reverse Biased Diode. Static and Dynamic Resistance.

Unit II - Two-terminal Devices and their Applications (6 lectures)

(1) Rectifier Diode: Half- wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LED, (2) Photodiode, (3) Solar Cell, (4) Tunnel diode, and (5) Schoktty diode (no derivation).

Unit III - Network theorem (3 lectures)

Thevenin, Norton, Superposition, Reciprocity theorem and maximum power transfer theorem.

Unit IV - Bipolar Junction Transistors (6 lectures)

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β. Relations between α and β . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Unit V – Amplifiers (9 lectures)

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Two stage D-coupled amplifier and its frequency response. Effects of Positive and

Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Unit VI - Sinusoidal Oscillators (4 lectures)

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Unit VII - Operational Amplifiers (Black Box approach) (5 lectures)

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.
(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log ampli-fier, (7) Zero crossing detector (8) Wein bridge oscillator.

Unit - VIII Cathode Ray Oscilloscope (4 lectures)

Block diagram of CRO, various components of cathode ray tube, deflection sensitivity, generation of wave form, measurement of voltage, current, frequency, phase difference using CRO, basic idea of DSO (digital Storage Oscilloscope).

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is twelve.

1. To study V-I characteristics of PN junction diode both in forward and reverse bias conditions.
2. To study V-I characteristics of Light emitting diode in forward bias for two different colours.
3. To study the V-I characteristics of a Zener diode in reverse biased condition and its use as voltage regulator.
4. To study of V-I and power curves of solar cells, and find maximum power point and efficiency.
5. To verify Thevenin's and Norton's theorems.
6. To verify the superposition and maximum power transfer theorem.
7. To find the value of ripple factor and efficiency of a full wave rectifier.
8. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
9. To study the various biasing configurations of BJT for normal class A operation.
10. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
11. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
12. To design a Wien bridge oscillator for given frequency using an op-amp.
13. To design a phase shift oscillator of given specifications using BJT.
14. To study the Colpitt's oscillator.
15. To design a digital to analog converter (DAC) of given specifications.
16. To study the analog to digital convertor (ADC) IC.
17. To design an inverting amplifier using Op-amp (741/351) for dc voltage of given gain .

18. To design inverting amplifier using Op-amp (741/351) and study its frequency response.
19. To design non-inverting amplifier using Op-amp (741/351) and study its frequency response.
20. To study the zero-crossing detector and comparator.
21. To add two dc voltages using Op-amp in inverting and non-inverting mode.
22. To design a precision Differential amplifier of given I/O specification using Op-amp.
23. To investigate the use of an op-amp as an Integrator.
24. To investigate the use of an op-amp as a Differentiator.
25. To measure voltage and frequency of a periodic waveform using CRO.
26. To construct a series LR circuit. Display the two waveforms on the CRO and measure the phase differences betweenthe volatges across L and R.

BOOKS RECOMMENDED:

1. J. Millman. Integrated Electronics: Analog And Digital Circuits And Systems. Mcgraw-Hill Education (India) Pvt Limited, 2010. Isbn: 9780070151420. Url: Https://Books.Google.Co.In/Books?Id=R4x9zgeacaaj.
2. J.D. Ryder. Electronic Fundamentals And Applications: Integrated And Discrete Systems. A Pitman Interna-Tional Text. Prentice-Hall, 1976. Isbn: 9780132513715. Url: Https://Books.Google.Co.In/Books?Id=Ygftaaaamaaj.
3. B.G. Streetman And S. Banerjee. Solid State Electronic Devices. Pearson, 2015. Isbn: 9780133356038. Url: Https://Books.Google.Co.In/Books?Id=-Nnznqeacaaj.
4. S. Salivahanan And K. Vallavaraj. Electronic Devices And Circuits (For Jntu). Tata Mcgraw-Hill Publishing Com-Pany Limited, 2008. Isbn: 9780070606456. Url: Https://Books.Google.Co.In/Books?Id=4zxupgaacaaj.
5. W.D. Stanley. Operational Amplifiers With Linear Integrated Circuits. Pearson Education, 2002. Isbn: 9788131708453. Url: Https://Books.Google.Co.In/Books?Id=1eyh3gquh5kc.
6. A.S. Sedra Et Al. Microelectronic Circuits. Oxford Series In Electrical And Computer Engineering. Oxford UniversityPress, 2020. Isbn: 9780190853549. Url: Https://Books.Google.Co.In/Books?Id=Vlwhygeacaaj.
7. U. Tietze, C. Schenk, And E. Gamm. Electronic Circuits: Handbook For Design And Application. Electronic Circuits. Springer Berlin Heidelberg, 2015. Isbn: 9783540786559. Url: Https://Books.Google.Co.In/Books?Id=Clqvcwaaqbaj.
8. S.M. Sze. Semiconductor Devices: Physics And Technology, 2nd Ed. Wiley India Pvt. Limited, 2008. Isbn: 9788126516810. Url: Https://Books.Google.Co.In/Books?Id=D_J0znhjuvic.
9. M.H. Rashid. Microelectronic Circuits: Analysis And Design. Cengage Learning, 2016. Isbn: 9781305642805.Url: Https://Books.Google.Co.In/Books?Id=2tfqjgeacaaj.
10. T.L. Floyd. Electronic Devices (Conventional Current Version). Pearson Education, 2017. Isbn: 9780134414577. Url: Https://Books.Google.Co.In/Books?Id=Oep-Zqeacaaj.

COURSE NAME: Quantum Mechanics

COURSE CODE: PY- CE - 6314

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to impart broad overview of the history of quantum mechanics and its gradual development. Schrödinger equation has been discussed along with its applications.

Course Learning Outcome:

CLO – 01: *The learner will receive a broad overview of the history of quantum mechanics and its gradual development. Schrödinger equation which is one of the important equation for studying quantum mechanical systems will be learned along with other aspects like operator formulism of quantum mechanics, principle of uncertainity and complementarity, etc.*

CLO – 02: *He will learn to apply the formulism learned so far to investigate quantum mechanical systems like simple harmonic oscillator, hydrogen atom, etc.*

CLO – 03: *This knowledge will help in understanding other branches in Physics like Solid State Physics, Nuclear Physics, Spectroscopy, etc*

Unit I - Origin of Quantum Theory (15 lectures)

Origin of Quantum Theory - Inadequacy of classical physics, Planck's quantum hypothesis, Photo elecric effect, Compton effect, Wave-particle duality - de-Broglie hypothesis and genesis of Quantum Mechanics, Verification of matter wave - Davisson-Germer's experiment, G. P. Thomson's electron diffraction experiment (qualitative idea only).

Uncertainty and complementarity - Heisenberg's uncertainty principle and complementarity principle of Neil Bohr, limitations on experiment.

Unit II - Schrödinger's equation (12 lectures)

Development of the wave equation, time dependent Schrödinger's equation, Statistical interpretation wave function, probability current density, expectation value and operator, Ehrenfest's theorem, Time independent Schrödinger's equa- tion, stationary states, energy quantisation, properties of energy eigen function, General solution of time dependent Schrödinger's equation for time independent potential. Schrödinger's equation in momentum space.

Unit III - Postulates of Quantum Mechanics (5 lectures)

Postulates of quantum mechanics, observables, hermitian operators, eigenvalues and eigenfunction, uncertainty principle (including time and energy), commuting observables and compatibility.

Unit IV - Application of Schrödinger's equation in one dimensional potential well (13 lectures)

Schrödinger's equation in one dimensional step potential, potential barrier - reflection and transmission coefficients and tunneling effect, square well potential with infinite depth, one dimensional harmonic oscillator.

PRACTICAL

Total Lectures: 30

List of Experiments

1. Find the energy eigen values and corresponding normalized wave functions of a particle in a square well potentialof infinite depth.
2. Find the energy eigen values and corresponding normalized wave functions of a particle in a square well potentialof finite depth.
3. Find the energy eigen values and corresponding normalized wave functions of a simple harmonic oscillator.
4. Solve the s-wave Schrödinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2u}{dr^2} = A(r)u(r),$$

$$A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

$$where, \quad V(r) = -\frac{e^2}{r}$$

where, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ −13.6 eV. Take e = 3.795(eV), $\hbar c$ = 1973 (eV) and m = 0.511 × 106 eV/c^2.

5. Solve the s-wave Schrödinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2u}{dr^2} = A(r)u(r),$$

$$A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

$$where, \quad V(r) = -\frac{e^2}{r}e^{-r/a}$$

where, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ −13.6 eV. Take e = 3.795(eV), $\hbar c$ = 1973 (eV) and m = 0.511 × 106 eV/c^2.

6. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2u}{dr^2} = A(r)u(r),$$

$$A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

The anharmonic potential,

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m = 940MeV/c^2$, $k = 100MeV\,f\,m^{-2}$, $b = 0,\ 10,\ 30\ MeV\,fm^{-3}$. In these units, $c\hbar = 940MeV/c^2$, $k = 100MeV\,fm^{-3}$ for all three cases. The ground state energy is expected to lie in between 90 and 110 MeV for all three cases.

7. Solve the s-wave Schrodinger equation for the hydrogen molecule

$$\frac{d^2u}{dr^2} = A(r)u(r),$$

$$A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

where, μ is the reduced mass of the two-atom system for the Morse potential.

$$V(r) = D\left(1 - 2e^{-\alpha r'} + e^{-2\alpha r'}\right)$$

$$r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corressponding wave function. Take m = 940 × 10^6 eV/c^2, D = 0.755501, α = 1.44 and r_0 = 0.131349A◦

BOOKS RECOMMENDED:

1. S. Gasiorowicz. Quantum Physics, 3Rd Ed. Wiley India Pvt. Limited, 2007. ISBN: 9788126511174. URL: https://books.google.co.in/books?id=qFtQiVmjWUEC.
2. B.H. Bransden and C.J. Joachain. Quantum Mechanics. Prentice Hall, 2000. ISBN: 9780582356917. URL: https://books.google.co.in/books?id=e57kxQEACAAJ.
3. Nouredine Zettili. Quantum mechanics: concepts and applications. John Wiley & Sons, 2009.
4. David J Griffiths and Darrell F Schroeter. Introduction to quantum mechanics. Cambridge university press, 2018.
5. A.K. Ghatak and S. Lokanathan. Quantum Mechanics: Theory and Applications. Macmillan Publishers India Limited, 2004. ISBN: 9781403923417. URL: https://books.google.co.in/books?id=PlZKUT3veHUC.
6. G Arul dhas. Quantum mechanics. PHI Learning Pvt. Ltd., 2008.
7. Joshua Izaac and Jingbo Wang. Computational quantum mechanics. Springer, 2018.

COURSE NAME: Condensed Matter Physics

COURSE CODE: PY- CE - 6324

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

Here, the objective is to give learners a broad overview of matter in solid state withdifferent aspects like mechanical, electrical and dielectric properties as well as the forces that bind them together.

Course Learning Outcome:

CLO – 01: *One will learn the main features of crystal lattices and their bondings, classificationsof materials in terms of their electric properties.*

CLO – 02 : *One learns to apply the concept material properties to measure conductivity, Hall coefficient, and carrier concentration in a material.*

CLO – 03 : *The knowledge of material properties will help in developing computer codes to further study wide variety of materials.*

CLO – 04 : *Till now, the most important subfield of solid state physics in the 20th century isthe study of semiconductors and solid state electronics. This course promises to give background knowledge in pursuing advanced-level studies in semiconductor and solid state electronics.*

Unit I - Crystal Structure (10 lectures)

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

Unit II - Crystal bonding (5 lectures)

Ionic, covalent, metallic, Van der Waal and hydrogen bondings, cohesive energy of ionic crystal, Madelung constant.

Unit III - Free Electron Theory of Metals (12 lectures)

Electrical and thermal conductivity of metals, Wiedemann-Franz law. Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (4-probe method) & Hall coefficient.

Unit IV - Specific Heat of Solids (6 lectures)

Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.

Unit V - Dielectric and Ferroelectric Properties of Materials (12 lectures)

Polarisation, Depolarisation field, Electric susceptibility, Polarisability, Clausius-Mosotti equation, Langevin-Debye equation, Dielectric constant and dielectric loss, Normal and anomalous dispersion, Basic idea about piezoelectric, pyro- electric, ferrorelectric and electrstrictive effects, Curie-Weiss law, Ferroelectric domains and PE hysteris loop. Plasma oscillations and frequency.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is four

1. To study a powder X-Ray diffraction data and to determine the lattice parameters, crystalline size, and inter plannnerdistance. (XRD data needs to be arranged by the Department)
2. To determine the Coupling Coefficient of a Piezoelectric crystal.
3. To measure the Dielectric Constant of a dielectric Materials.
4. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance(SPR).
5. To determine the refractive index of a dielectric layer using SPR.
6. To study the PE Hysteresis loop of a Ferroelectric Crystal.
7. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method and to determine itsband gap energy.
8. To determine the Hall coefficient and carrier concentration of a semiconductor sample.

BOOKS RECOMMENDED:

1. C. Kittel. Kittel's Introduction to Solid State Physics. Wiley, 2018. ISBN: 9781119456186. URL: https://books.google.co.in/books?id=WHP2DwAAQBAJ.
2. A.J. Dekker. Solid State Physics. Prentice-Hall technical books. Prentice-Hall, 1965. URL: https://books.google.co.in/books?id=TkRRAAAAMAAJ.
3. S.O. Pillai. Modern Physics and Solid State Physics (Problems and Solutions). New Age International (P) Limited,2008. ISBN: 9788122422818. URL:https://books.google.co.in/books?id=Uq4HCuHpwkwC.
4. N.W. Ashcroft and N.D. Mermin. Solid State Physics. HRW international editions. Holt, Rinehart and Winston,1976. ISBN: 9780030839931. URL: https://books.google.co.in/books?id=1C9HAQAAIAAJ.

COURSE NAME: Atomic And Nuclear Physics

COURSE CODE: PY- CE - 6334

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to provide broad overview of atomic structure and its behaviour in electric and magnetic field. In this course, a broad overview of the constituents of nucleus, the basic force which binds these constituents together and its stability will be given. The phenomenon of radioactivity will also be covered.

Course Learning Outcome:

CLO – 01: *The learner will learn about the structure of atom and its behaviour in electric and magnetic field.*

CLO – 02: *The learner will learn the constituents of nucleus and the force which binds them together. They will learn about binding energy and understand the concept of stability of nucleus and the cause of radioactivity.*

CLO – 03: *This knowledge will help them in future study and doing R&D jobs. The knowledge of nuclear physics will make them competent to pursue a career in radiological physics, nuclear power plant, etc.*

Unit I - Discovery of Charged Particles (4 lectures)

Detection of Charged particles, *e/m* of the electron, Positive Ray Analysis: Thompson's Parabola method.

Unit II - X-Rays (4 lectures)

Ionizing power, X-ray Diffraction, Bragg's Law, Bohr's Atomic Model, Critical Potentials, X-Ray spectra - continuous and characteristic spectra, Mosley's Law.

Unit III - Atoms in Electric and Magnetic Fields (12 lectures)

Electron Angular Momentum, magnetic moment, Larmor's Theorem, Spin Magnetic Moment, Pauli's exclusion principle; Spin-orbit interaction - LS and JJ couplings; Spectroscopic notation; Normal and Anomalous Zeeman effect; Paschen Bach effect; Stark effect (qualitative study only); Stern-Gerlach experiment.

Unit IV - General properties of atomic nuclei and its stability (13 lectures)

Constituents of nucleus and their Intrinsic properties - quantitative facts about mass, radii, charge density, matter density, angular momentum, parity, magnetic moment, electric moments, nuclear excited states.

Binding energy, the variation of binding energy per nucleon against mass number, the main features of B.E/A vs. mass number curve, mass defect and packing fraction, Nuclear stability, Nuclear force and its

characteristics, Yukawa's mesonfield theory.

Liquid drop model and Shell model of nucleus (qualitative discussion only), Bethe-Weizsäckar's semi-empirical mass formula, applications - estimation of the mass number of the most stable nucleus in an isobaric family, estimation of fission energy.

Unit V - Radioactive Decay (12 lectures)

Radioactive decay - decay rate, secular and transient equilibrium.

Alpha decay - range, energy, straggling of alpha particles, Geiger-Nuttal law, alpha disintegration energy, Spectrumof alpha particles, Gamow's theory of alpha decay (qualitative idea only).

Beta decay - condition of spontaneous beta decay, beta particle spectrum, Pauli's neutrino hypothesis, Fermi theory of beta decay (qualitative idea only), K-electron capture. Gamma decay - origin and energy spectrum, interaction of gamma radiation with matter.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is five.

1. To determine the value of *e/m* by (a) Magnetic focusing or (b) Bar magnet.
2. To setup the Millikan oil drop apparatus and determine the charge of an electron.
3. To determine the value of Boltzmann Constant by studying Forward Characteristics of a Diode.
4. To determine the value of Planck's Constant by using a Photoelectric Cell.
5. To determine the value of Planck's Constant by using LEDs of at least 4 Different Wavelengths.
6. To measure Planck's constant using black body radiation and photo-detector.
7. To determine the wavelengths of Hydrogen spectrum and hence to determine the value of Rydberg's Constant.
8. To determine the ionization potential of mercury
9. To determine the Wavelength of H-alpha Emission Line of Hydrogen Atom.
10. To study of characteristics of GM tube and determination of operating voltage and plateau length using backgroundradiation as source (without commercial source).
11. To study of counting statistics using background radiation using GM counter

BOOKS RECOMMENDED:

1. A. Beiser. Concepts of Modern Physics. McGraw-Hill higher education. McGraw-Hill, 2003. ISBN: 9780072448481. URL: https://books.google.co.in/books?id=hjStQgAACAAJ.
2. J.B. Rajam. Atomic Physics. S. Chand & Company Pvt. Limited, 1974. URL: https://books.google.co.in/ books?id=1J9QtQEACAAJ.
3. SN Ghoshal. Atomic Physics. S. Chand Limited, 2007. ISBN: 9788121910958. URL: https://books.google.co.in/books?id=d85dWSbWpOkC.
4. S.B. Patel. Nuclear Physics: An Introduction. Wiley, 1991. ISBN: 9788122401257.

URL: https://books.google.co.in/books?id=aMzuEby4fX4C.

5. Krane.Kenneath. S. Introductory Nuclear Physics. Wiley India, 2008. ISBN: 9788126517855. URL: https://books.google.co.in/books?id=mkZjC1TLXh8C.
6. SN Ghoshal. Nuclear Physics. S. Chand Limited, 1997. ISBN: 9788121904131. URL: https://books.google.co.in/books?id=fkqHNMd_248C.
7. V.K. Mittal, R.C. Verma, and S.C. Gupta. Introduction To Nuclear And Particle Physics, Fourth Edition. PHI Learning Pvt. Ltd., 2018. ISBN: 9789387472624. URL: https://books.google.co.in/books?id=4JNuDwAAQBAJ.
8. A. B. Gupta. Modern Atomic and Nuclear Physics. New Age International, 2009. ISBN: 9788187134220.

COURSE NAME: Digital Electronics

COURSE CODE: PY- CE - 6344

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

This course aims at giving exposure to various types of digital circuits and applicationof Boolean algebra for simplification of the logic circuits.

Course Learning Outcome :

CLO – 01: *At the end of the course, a learner will have a broad exposure of different types of digital circuits and their applications.*

CLO – 02: A learner will know the basic knowledge of integrated circuit and its types and working process of computers

Unit - I Integrated Circuits (3 lectures)

Necessity of integrated circuits (ICs). Active and Passive Components. Concept of Wafer and Chip. Advantages and lim- itations of using ICs. Scale of integration: SSI, MSI, LSI, VLSI and ULSI (basic idea and definitions only). Classification of ICs: based on operating state, based on construction, based on use.

Unit - II Digital Circuits (8 lectures)

Difference between analog and digital circuits. Binary Numbers, Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. Basic logic gates using diodes and transistors: OR, AND and NOT Gates. Universal Gates: NAND and NOR Gates, XOR and XNOR Gates and application as Parity Checkers.

Unit - III Boolean Algebra (8 lectures)

De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Idea of Minterms and Maxterms, Conversion of Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Unit - IV Arithmetic Circuits (5 lectures)

Binary Addition. Binary Subtraction using 2's Complement, Half and Full Adders and Subtractors, 4-bit binary Adder/Subtractor.

Unit - V Sequential Circuits (5 lectures)

SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. Master Slave JK Flip-Flop.

Unit - VI Timer Circuits (4 lectures)

Block diagram and working of an IC-555 timer. Astable and monostable multivibrators.

Unit - VII Shift Registers (up to 4-bits only) (4 lectures)

Introduction to shift registers. Serial-in-Serial-out, Serial-in-Parallel-out. Parallel-in-Serial-out and Parallel-in Parallel- out Shift Registers.

Unit - VIII Counters (up to 4-bits only) (4 lectures)

Introduction to counters. Propagation delay and frequency division of a counter. Asynchronous counters. Ring counter. Basic ideas about synchronous counter and decade counter.

Unit - IX Computer Organization (4 lectures)

Block diagram of a computer and its units. Input and Output Devices. Data storage devices (idea of RAM and ROM). Computer memory. Memory and its types. Memory organization & addressing.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is eight.

1. To design a switch (NOT gate) using (i) a PNP transistor and (ii) an NPN transistor.
2. To verify and design AND, OR, NOT, and XOR gates using NAND gates.
3. To verify De Morgan's Theorems using ICs.
4. To design a combinational logic system for a specified Truth Table.
5. To convert a Boolean expression into a logic circuit and design it using logic gate ICs.
6. To design a Half Adder and Full Adder using ICs.
7. To design a 4-bit binary Adder using ICs.
8. To design Half Subtractor and Full Subtractor using ICs.
9. To design Adder-Subtractor using Full Adder IC.
10. To build a D flip-flop circuit using NAND gates.
11. To build a JK flip-flop circuit using NAND gates.
12. To build JK Master-slave flip-flop using flip-flop ICs.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To build SR flip-flop circuit using NAND gates.
15. To design an astable multivibrator of given specifications using 555 Timer.
16. To design a monostable multivibrator of given specifications using 555 Timer.

BOOKS RECOMMENDED

1. D.P. Leach Et Al. Digital Principles & Applications. Tata Mcgraw-Hill, 2010. ISBN: 9780071321402. URL: https://Books.Google.Co.In/Books?Id=Pbwktqeacaaj.
2. A.A. Kumar. Fundamentals Of Digital Circuits. Prentice Hall India Pvt., Limited, 2016. ISBN: 9788120352681. URL: https://books.google.co.in/books?id=CyavDAAAQBAJ.
3. G.K. Kharate. Digital Electronics. OUP India, 2012. ISBN: 9780198061830. URL: https://books.google.co.in/books?id=MwmscQAACAAJ.

4. Digital Circuits and Systems. McGraw-Hill Education (India) Pvt Limited, 2011. ISBN: 9780071072700. URL: https://books.google.co.in/books?id=zZpHzwEACAAJ.

5. R.J. Tocci, N.S. Widmer, and G.L. Moss. Digital Systems: Principles and Applications. Pearson Prentice Hall,2007. ISBN: 9780131725799. URL: https://books.google.co.in/books?id=4F_KPwAACAAJ.

6. S.P. Vingron. Logic Circuit Design: Selected Topics and Methods. Springer International Publishing, 2023. ISBN:9783031406737. URL: https://books.google.co.in/books?id=WADmEAAAQBAJ.

7. S. Ghoshal. Digital Electronics. Blue Kingfisher, 2012. ISBN: 9788131518076. URL: https://books.google.co.in/books?id=-zPpsgEACAAJ.

8. S.K. Mandal. Digital Electronics: Principles and Applications. Tata McGraw Hill, 2010. ISBN: 9780070153820. URL: https://books.google.co.in/books?id=TCRHzwEACAAJ.

9. Modern Digital Electronics 4E. McGraw-Hill core concepts in electrical engineering series. McGraw-Hill Edu- cation (India) Pvt Limited, 2010. ISBN: 9780070669116. URL: https://books.google.co.in/books?id= KD5HzwEACAAJ.

10. P.B. Zbar, A.P. Malvino, and M.A. Miller. Basic Electronics: A Text-lab Manual. Basic electricity-electronics series. McGraw-Hill Pub., 1990. ISBN: 9780071009867. URL: https://books.google.co.in/books?id= WsVIPgAACAAJ.

MINOR

Programme Specific Outcome of Bachelor of Science - Physics Minor

PSO No.	Name	Outcome
PSO - 1	Basic Knowledge	The learner will acquire knowledge regarding the fundamental princi- ples of Physics through the study of Mechanics, Optics, Waves, Heat and Thermodynamics, Electricity and Magnetism, Modern Physics, Electronics.
PSO - 2	Critical Thinking	The learner will be familiar with the state of the art of the appropriate level of technology for (a) experimental design and implementation, (b)analysis of experimental data.
PSO - 3	Communication Skill	The learner will learn effective communication skills to present their knowledge of physics from basic to advanced levels in the form of preparation of laboratory notebooks, project work, seminar presenta- tions, poster presentations, wall magazines, models, and other modes.
PSO - 4	Team Work	The learner will learn to work either independently or in a group during laboratory sessions, projects, and student seminar.
PSO - 5	Competency for Competitive Examinations	The learner will be competent to face competitive examinations con- ducted by UPSC, APSC.
PSO - 6	Ethical Thinking	The student will acquire a purposeful knowledge of scientific literatureand ethical issues related to physics.

Basic Syllabus Structure of Minor Course

Semester	Course Code & Name	Contents
1	MATHEMATICAL PHYSICS - I & MECHANICS - I PY-MN-1114	Vectors and scalars Vector differentiation Vector differential operatorVector Integration Work energy principleRigid body dynamics Gravitation Special theory of relativity
2	MATHEMATICAL PHYSICS - II & PROPERTIES OF MATTER PY-MN-2114	Ordinary Differential Equation Partial Differential EquationElasticity Surface Tension Viscosity
3	OPTICS PY-MN-3214	Geometrical Optics Wave Optics
4	WAVES & APPLIEDOPTICS PY-MN-4214	Harmonic Motion Wave MotionSound Wave Superposition of two harmonic waves Ultrasonic Wave
5	ELECTRICITY AND MAGNETISM PY-MN-5214	Electrostatics Current Electricity Magnetostatics Electromagnetic Wave
6	THERMAL PHYSICS PY-MN-6214	Heat Thermodynamics Thermal Radiation Kinetic Theory of gases

Course Learning Outcome (CLO)

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	MATHEMATICAL PHYSICS – I & MECHANICS - I PY-MN-1114	CLO - 01	After completing the course a student will be able to understand vector and their applications in various fields.
		CLO - 02	Further, a student will be able to understand and solve a real-life problem that needs an understanding of the laws of mechanics, gravitation, and relativity.
2	MATHEMATICAL PHYSICS - II & PROPERTIES OF MATTER PY-MN-2114	CLO - 01	After completing the course a student will be able to understand applications of differential equation in various fields. fields.
		CLO - 02	Further, a student will be able to understand and solve a real-life problem that needs an understanding of the elasticity, surface tension and viscosity.
		CLO - 01	After successful completion of the course, a learner will learn about formation of image due to a system of lenses, and defects of images of different types.

3	OPTICS PY-CE-3214	CLO - 02	Also, the learner will learn about detailed theory of wave like behaviour of light through the phenomena - interference, diffraction, and polarisation as well as associated phenomena - colourof thin film, Newton's ring etc.
		CLO - 03	The learner will also learn about Laser and the propagation of light through fibre along with their practical applications.
4	WAVES & APPLIED OPTICS PY-MN-4214	CLO - 01	This course will acquaint the learner with the oscillatory motion of simple harmonic type and its classification under different physical conditions; phenomenon like resonance. They will learn about wave motion in an elastic medium and its mathematical analysis, superposition of waves, stationary waves.
		CLO - 02	Also, they will learn about propagation of sound in an elastic medium, Newton's formula to determine the velocity of sound and Laplace correction. Fourier analysis of sound wave will also belearned in this course.
		CLO - 03	This course will help in understanding musical notes and working of the musical instruments; necessary criteria for constructing an auditorium etc.
		CLO - 04	After the course, the student will learn to handle practical instruments with laser, and fibre optics.
5	ELECTRICITY AND MAGNETISM PY-MN-5214	CLO - 01	One will learn the fundamental properties of charged particles and electric fields in this course.
		CLO - 02	This course will give learners an understanding of the phenomena of electricity, magnetism, electromagnetic induction, and electrical circuits which are essential for higher studies in physics and also important for various engineering applications.
		CLO - 03	This course builds the basis for studying more advanced topics in electromagnetic theory
6	THERMAL PHYSICS PY-MN-6214	CLO - 01	The basic laws of nature associated with heat and thermodynamics, the conversion of heat into work and vice-versa, principle of working of machine- carnot engine, concept of entropy, thermodynamic potentials, etc. Also, they will learnabout kinetic theory of gases.
		CLO - 02	They will learn to apply the concept of kinetic theory of gases to explain the real life physical phenomena like thermal conductivity, diffusion of gases in a medium, phenomenon like brownian motion, etc.

Mapping of Programe Outcome (PO) and Course Learning Outcome (CLO):

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Courses	CLO	Programme Outcome (SPO)										
		SPO - 1	SPO - 2	SPO - 3	SPO - 4	SPO - 5	SPO - 6	SPO - 7	SPO - 8	SPO - 9	SPO - 10	SPO -11
PY-MN-1114	CLO - 1	3	1	1	1	2	1	1	1	1	2	2
	CLO - 2	3	1	1	1	2	1	1	1	1	2	2
PY-MN-2114	CLO - 1	3	1	1	1	2	1	1	1	1	2	2
	CLO - 2	3	1	1	1	2	1	1	1	1	2	2
PY-MN-3214	CLO - 1	2	2	2	1	2	1	1	1	1	2	2
	CLO - 2	2	2	2	1	2	1	1	1	1	2	2
	CLO - 3	2	2	2	1	2	1	1	1	1	2	2
PY-MN-4214	CLO - 1	2	2	2	1	2	1	1	1	1	2	2
	CLO - 2	2	2	2	1	2	1	1	1	1	2	2
	CLO - 3	2	2	2	1	2	1	1	1	1	2	2
	CLO - 4	2	2	2	1	2	1	1	1	1	2	2
PY-MN-5214	CLO - 1	1	3	3	1	2	2	1	1	2	2	2
	CLO - 2	1	3	3	1	2	2	1	1	2	2	2
	CLO - 3	1	3	3	1	2	2	1	1	2	2	2
PY-MN-6214	CLO - 1	1	3	3	1	2	2	1	1	2	2	2
	CLO - 2	1	3	3	1	2	2	1	1	2	2	2

Mapping of Programe Specific Outcome (PSO) and Course Learning Outcome (CLO)

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Courses	CLO	PROGRAMME SPECIFIC OUTCOME					
		PSO - 1	PSO - 2	PSO - 3	PSO - 4	PSO - 5	PSO - 6
PY-MN-1114	CLO – 1	3	1	2	1	1	1
	CLO – 2	3	1	2	1	1	1
PY-MN-2114	CLO – 1	3	1	2	1	1	1
	CLO – 2	3	1	2	1	1	1
PY-MN-3214	CLO – 1	2	2	2	1	1	1
	CLO – 2	2	2	2	1	1	1
	CLO – 3	2	2	2	1	1	1
PY-MN-4214	CLO – 1	2	2	2	1	1	1
	CLO – 2	2	2	2	1	1	1
	CLO – 3	2	2	2	1	1	1
	CLO – 4	2	2	2	1	1	1
PY-MN-5214	CLO – 1	1	3	2	1	2	1
	CLO – 2	1	3	2	1	2	1
	CLO – 3	1	3		1	2	1
PY-MN-6214	CLO – 1	1	3	2	1	2	1
	CLO – 2	1	3	2	1	2	1

COURSE NAME: Mathematical Physics - I and Mechanics - I

COURSE CODE: PY- MN - 1114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

To impart advanced concepts and methods in Mathematics which include the Calculus of vector-valued functions.

To impart basic concepts of work-energy principle, rigid body dynamics, laws of gravitation, and a basic concept of relativity.

Course Learning Outcome:

CLO-01: *After completing the course a student will be able to understand vector and their applications in various fields.*

CLO-02: *Further, a student will be able to understand and solve a real-life problem that needs an understanding of the laws of mechanics, gravitation, and relativity.*

Mathematical Physics - I (Credit - 1; No. of lectures - 15)

Unit I: Vector and scalars(Lectures 2)

Introduction, dot and cross products including triple products, their physical significance

Unit II: Vector differentiation (Lectures 3)

Ordinary derivative of vectors, continuity, and differentiability, the partial derivative of vectors, applications to problems in Physics.

Unit III: Vector differential operator(Lectures 5)

Gradient, divergence, and curl - definitions and physical meaning, formulas involving del and invariance

Unit IV: Vector Integration (Lectures 5)

Ordinary integrals of vectors - line integral, surface integral and volume integral, Gauss's theorem, Stoke's theorem and Green's theorem (no rigorous proof is required)

Mechanics – I (Credit - 2; No. of lectures - 30)

Unit V: Work energy principle (Lectures 8)

Laws of motion - Concepts of work, energy, and power, Conservative forces - conservative force as a negative gradient of potential, Conservation of linear and angular momentum, motion of a rocket.
Centre of mass - motion of the centre of mass, collision problem in the centre of mass frame of reference and laboratory frame of reference

Unit VI: Rigid body dynamics (Lectures 9)

Rotational motion - translation and rotational motion, torque, angular momentum. Moment of inertia - general theorem of the moment of inertia, moment of inertia calculation in particular cases - disk, cylinder, and sphere; flywheel, the kinetic energy of rotational motion.

Unit VII: Gravitation (Lectures 7)

Newton's law of gravitation, Gravitational field - the intensity of the field, gravitational potential, and gravitational potential energy; gravitational field and potential due to a solid sphere and spherical shell. Motion under the central force field, two body problems, and reduced mass.

Unit VIII: Special theory of relativity (Lectures 6)

Reference frame - inertial and non-inertial, Galilean Transformation, Galilean Invariance, Postulates of special theory of relativity, Lorentz Transformation equations - length contraction, time dilation and mass variation.

PRACTICAL

Total Lectures: 30

A minimum of five experiments to be done.

1. To measure the thickness of a piece of glass using a vernier calliper, screw gauge, and spherometer and compare their results.
2. To measure the diameter of a capillary tube using a traveling microscope.
3. To determine the height using a sextant.
4. To determine the Moment of Inertia of a Symmetrical body about an axis by the torsional oscillation method.
5. To determine the moment of inertia of a flywheel.
6. To find the angular acceleration and torque of a flywheel.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum
9. To determine the value of g using the motion of an oscillating spring.

BOOKS RECOMMENDED:

1. Vector Analysis, Murray R. Spiegel (Schaum Series)
2. Mathematical Methods for Engineers and Scientists, K. T. Tang
3. Higher Engineering Mathematics, H. K. Das.
4. An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw Hill.
5. Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. Physics, Resnick, Halliday, and Walker 8/e. 2008, Wiley.
8. B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
9. A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

COURSE NAME: Mathematical Physics - II and Properties of Matter

COURSE CODE: PY- MN - 2114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

To impart advanced concepts and methods in Mathematics which include the Calculus of vector-valued functions.

To impart basic concepts of work-energy principle, rigid body dynamics, laws of gravitation, and a basic concept of relativity.

Course Learning Outcome:

CLO-01: *After completing the course a student will be able to understand application of differential equation in various fields.*

CLO-02: *Further, a student will be able to understand and solve a real-life problem that needs an understanding of elasticity, surface tension and viscosity.*

Mathematical Physics - II (Credit - 1, Lectures - 15)

Unit I: Ordinary Differential Equation (Lectures 8)

Order and degree of a differential equation, 1st order linear differential equation, 1st order and 2nd order homogenous differential equation. Radioactive decay, Newton's law of cooling, Free fall.

Unit II: Partial Differential Equation (Lectures 7)

Solution of Partial differential equation using separation of variables, exact and inexact differentials. Laplace's equation in the cartesian coordinate system, Wave equation.

Properties of Matter (Credit - 2, Lectures - 30)

Unit III: Elasticity (Lectures 10)

Hooke's law, Elastic behaviour of solids, Different types of elasticity, Elastic constants, Relation among different elastic constants, Poisson's ratio, determination of Poisson's ratio, Twisting couple of a cylinder. Bending moment, depression of a cantilever.

Unit IV: Surface Tension (Lectures 10)

Surface tension and surface energy, the Pressure difference across a liquid surface - drops and bubbles, Rise of liquid in a capillary tube - Jurin's law

Unit V: Viscosity (Lectures 10)

The flow of liquid, streamline flow, continuity equation - Bernoulli's theorem and its applications, Viscosity, coefficient of viscosity, Reynold's number, Poiseuille's equation, Effect of temperature and pressure on the viscosity of fluids.

PRACTICAL

Total Lectures: 30

A minimum of five experiments are to be done.

1. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
2. To determine the Modulus of Rigidity of a Wire Static method.
3. To determine the spring constant and rigidity modulus from the motion of a spring.
4. To determine the surface tension of water by Jaeger's method.
5. To determine the coefficient of viscosity of water by capillary flow method (Poiseuille's method).
6. To determine the surface tension of a liquid by the capillary rise method and verify Jurin's law
7. To determine the coefficient of viscosity of glycerine or mustard oil by Stoke's method.

BOOKS RECOMMENDED:

1. Mathematical Methods for Engineers and Scientists, K. T. Tang
2. Higher Engineering Mathematics, H. K. Das.
3. An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw Hill.
4. Properties of Matter by D. S. Mathur, S. Chand, and Company.
5. B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
6. A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

COURSE NAME: Optics

COURSE CODE: PY- MN - 3214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

To impart knowledge regarding image formation due to a system of lenses. To impart knowledge about wave like behaviour of light and related phenomena like interference, diffraction, and polarization. Principles of Laser, and principle of fibre optics will be discussed along with theirapplications.

Course Learning Outcome:

CLO – 01: *After successful completion of the course, a learner will learn about formation of image due to a system of lenses, and defects of images of different types.*

CLO – 02: *Also, the learner will learn about detailed theory of wave like behaviour of light through the phenomena - interference, diffraction, and polarisation as well as associated phenomena - colour of thin film, Newton's ring etc.*

CLO – 03: *The learner will also learn about Laser and the propagation of light through fibre along with their practical applications.*

Unit I - Geometrical Optics (20 lectures)

Fermat's principle - its application to laws of reflection and refraction, Refraction of paraxial rays at a single spherical surface, thick lens, magnification of image, interrelation among lateral, longitudinal, and angular magnification, Lagrange's law, and Helmholtz equation.

Defects of image

Spherical aberration and its minimization, Qualitative idea about coma, astigmatism and distortion, Chromatic aberration.

Unit II - Wave Optics (25 lectures)

Interference

Concept of light wave and its equation, Stokes' law, interference due to Fresnel's biprism, interference by a plane parallel film, colour of thin film, Newton's rings.

Diffraction

Difference between Fresnel and Fraunhofer classes, diffraction at a straight edge and a circular aperture, Fraunhofer diffraction due to a single slit, grating (its reduction to double slit), Resolving power and Dispersive power (derivation not required).

Polarisation

Plane polarised light, polarisation on reflection, Brewster's law, double refraction, Nicol prism, rotation of plane of polarization by optically active substances, specific rotation, polarimeter.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is six

1. To determine the refractive index of a liquid by using plane mirror and convex lens.
2. To dtermine the focal length of two lenses and their combination by displacement method.
3. Familiarization with Schuster's focusing, determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin sheet/paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.
11. To determine the specific rotation of sugar solution using a polarimeter.

BOOKS RECOMMENDED:

1. B Ghosh and KG Mazumdar. "A Text Book on Light". In: Sreedhar Pub., Calcutta, (2003).
2. B.K. Mathur. Principles of Optics. Gopala Printing, 1964. URL: https://books.google.co/.in/books?id=h85ttwAACAAJ.
3. P Chakrabarti. Geometrical & Physical Optics. New Central Book Agency, 2010.
4. A. Ghatak. Optics. McGraw-Hill Education, 2009. ISBN: 9780073380483. URL: https://books.google.co.in/books?id=KTMHOQAACAAJ.
5. Eugene Hecht. Optics. Pearson Education India, 2012.
6. CL Arora. B. Sc. Practical Physics. S. Chand Publishing, 2001.
7. S. Ghosh. A Textbook Of Advanced Practical Physics. New Central Book Agency (P) Limited, 2013. ISBN: 9788173812439.URL: https://books.google.co.in/books?id=HrWR0uAe_sMC.
8. D Chattopadhyay and PC Rakshit. An advanced course in practical physics. New Central Book Agency, 1990.

COURSE NAME: Waves & Applied Optics

COURSE CODE: PY- MN - 4214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

The objective of the course is to acquaint the learner with the concept of oscillatory motion of simple harmonic type and its different characteristics. Also, a broad overview will be given about propagation of wave in an elastic medium and different aspects of sound wave. Also, Fourier analysis of sound wave will be done. Principles of Laser, and Fibre Optics will be discussed along with their applications.

Course Learning Outcome:

CLO – 01: *This course will acquaint the learner with the oscillatory motion of simple harmonic type and its classification under different physical conditions; phenomenon like resonance. They will learn about wave motion in an elastic medium and its mathematicalanalysis, superposition of waves, stationary waves.*

CLO – 02: *Also, they will learn about propagation of sound in an elastic medium, Newton's formula to determine the velocity of sound and Laplace correction. Fourier analysis of sound wave will also be learned in this course.*

CLO – 03: *This course will help in understanding musical notes and working of the musical instruments; necessary criteria for constructing an auditorium etc.*

CLO – 04: *After the course, the student will learn to handle practical instruments with laser, and fibre optics.*

Unit I - Harmonic Motion (8 lectures)

Simple Harmonic motion, Composition of two simple harmonic oscillations at right angles, Lissajous figures. Free,damped, and forced oscillations, resonance, and sharpness of resonance.

Unit II - Wave Motion (6 lectures)

Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of Wave Equation. Pressure of a Longitudinal Wave, Energy Transport,

Intensity of Wave, Water Waves - Ripple and Gravity Waves.

Unit III - Sound Wave (8 lectures)

Velocity of Transverse Vibrations of Stretched Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction, effect of temperature and pressure on velocity of sound in air, intensity level of sound and its unit (bel and decibel), Acoustics of auditorium, reverberation, Sabine's law.

Unit IV - Superposition of Two Harmonic Waves (7 lectures)

Standing (Stationary) Waves in a String - Fixed and Free Ends, Phase and Group Velocities, Changes w.r.t Position and Time, Melde's Experiment, Longitudinal Standing Waves and Normal Modes, Open and Closed Pipes.

Unit V - Ultrasonic Wave (6 lectures)

Ultrasonic waves – production of ultrasonic waves, application of ultrasonic waves, principle of SONAR system.

Unit VI - Applied Optics (10 lectures)

Laser: Laser and its characteristics, stimulated absorption, spontaneous and stimulated emission, population inversion, basic elements of laser, Ruby laser, He-Ne laser (principle only).

Fibre Optics: Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is six

1. Study the motion of a spring in different medium (a) air and (b) water/kerosene oil. Calculate the value of g in bothcases and compare the result.
2. Determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law.
3. Study the Lissajous figure of two waves using a CRO and determine the value of unknown frequency of the wave.
4. Determine the velocity of sound wave in air at room temperature using a resonance tube at three different resonancepositions.
5. Study the relation between frequency and length/tension of a given wire under constant tension using a sonometerand also plot a graph between frequency and length/tension.
6. Study the diffraction of light due to the propagation of an ultrasonic wave in a given liquid and calculate the speedof sound in the given liquid.
7. Determine the grating radial spacing of the CD and DVD by using either reflection or refraction method with aHe-Ne or Solid State laser. Compare the experimental value with the theoretical one.
8. Find the width of the given wire using diffraction pattern obtained by a He-Ne or solid state laser and verify theresult using a screw gauge.
9. Study the V-I characteristics of a light dependent resistor (LDR). Show the relation between resistance and distanceof light source and calculate the dark resistance of the LDR.
10. Study the V-I characteristics of a photovoltaic cell and calculate the fill factor and efficiency of the cell.
11. Measure the numerical aperture and acceptance angle of an optical fibre.

BOOKS RECOMMENDED:

1. N.K. Bajaj. The Physics Of Waves And Oscillations. Tata Mcgraw-Hill, 1988. Isbn: 9780074516102. Url: https://Books.Google.Co.In/Books?Id=Lw1hzweacaaj.
2. M. Ghosh And D. Bhattacharya. A Textbook Of Oscillations, Waves And Acoustics. 5th. S. Chand Publications, 2007.Isbn: 9789385676154.
3. H.J. Pain. Physics Of Vibrations And Waves. John Wiley & Sons, Incorporated., 2005. Url: https://Books.Google.Co.In/Books?Id=2zbn0aeacaaj.
4. Anthony Philip French. Vibrations And Waves. Crc Press, 2017.
5. Francis A. Jenkins And Harvey E. White. Fundamentals Of Optics. Tata Mcgraw-Hill, 1981.
6. K.Thyagarajan And A.K.Ghatak. Lasers: Fundamentals & Applications. Tata Mcgraw Hill, 2010.
7. M.R. Shenoy Et Al. Fiber Optics Through Experiments. Mv Learning, 2015. Isbn: 9788130929835. Url: https://Books.Google.Co.In/Books?Id=Z_Vzjweacaaj.
8. S.C. Gupta. Optoelectronic Devices And Systems. Phi Learning, 2005. Isbn: 9788120326941. Url: Https://Books.Google.Co.In/Books?Id=A7j9w8xbs88c.
9. A. Lipson, S.G. Lipson, And H. Lipson. Optical Physics. Cambridge University Press, 2010. Isbn: 9781139492607. Url: https://Books.Google.Co.In/Books?Id=Aow3o0dhyjyc

COURSE NAME: Electricity and Magnetism

COURSE CODE: PY- MN - 5214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

The objective of the course is to give the learners a broad overview of Electrostatic, Current Electricity, and Magnetostatics which are essentially required for the pur- suance of Higher Studies or doing R & D job.

Course Learning Outcome:

CLO – 01: *One will learn the fundamental properties of charged particles and electric fields in this course.*

CLO – 02: *This course will give learners an understanding of the phenomena of electricity, magnetism, electromagnetic induction, and electrical circuits which are essential for higher studies in physics and also important for various engineering applications.*

CLO – 03: *This course builds the basis for studying more advanced topics in electromagnetic theory*

Unit I – Electrostatics (12 lectures)

Gauss's theorem and its applications to determine field due to linear, plane and spherical charge distribution, potential due to dipole, derivation of field due to a dipole, Mutual potential energy of two dipoles.

Capacity of parallel plate capacitor, spherical and cylindrical capacitor, effect of dielectric on capacity of capacitor, me-chanical force on charged conductor, energy stored in a charged capacitor.

Dielectrics, Electric polarisation of dielectrics, polarizability, Relation between D, E, & P, Gauss's law in dielectric. Elec-trostatic boundary conditions in dielectric medium.

Unit II - Current Electricity (12 lectures)

Electric current density, continuity equation, Ohm's law as $J = \sigma E$, Applications of Kirchoff's law to solve electrical network problem.

Moving coil ballistic galvanometer its sensitivity and uses.

Electromagnetic induction: Self and mutual induction, coefficient of coupling, reciprocity theorem, self induction of a long solenoid, mutual induction of two solenoids.

Transient growth and decay of current in LR, CR and LCR circuits.

Alternating current: Generation of alternating current, current and potential across resistive, inductive and capacitive elements and their phase relationships, power factor, concept of rotating magnetic field. a.c. motor, transformer, reflected impedance in transformer.

Unit III – Magnetostatics (15 lectures)

Electric current as source of magnetic field, Equivalent magnetic dipole produced by a current flowing though a circular conductor, magnetic dipole moment, force and couples on dipole placed in a uniform magnetic field, magnetic shell, potential due to magnetic shell, magnetic intensity, induction and intensity of magnetisation, magnetic susceptibility, permeability, hystersis and hystersis loss.

Dia, para and ferro magnetism, Atomic dipole moment, Langevin's Classical theory of para magnetism.

Unit IV - Electromagnetic wave (6 lectures)

Maxwell's equations, wave equation in free space from Maxwell's equations, velocity of electromagnetic waves in free space, Pointing vector.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is six

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking elec-trical fuses.
2. To study the characteristics of a series RC Circuit and calculate the time constant.
3. To determine the value of an unknown Low Resistance using Potentiometer.
4. To determine the value of an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength and its variation in a solenoid (determine $\frac{dB}{dx}$)
7. To determine self inductance of a coil by Anderson's bridge.
8. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.
10. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
11. Determine a high resistance by leakage method using Ballistic Galvanometer.
12. To determine self-inductance of a coil by Rayleigh's method.
13. To determine the mutual inductance of two coils by Absolute method.

BOOKS RECOMMENDED :

1. D.J. Griffiths. Introduction to Electrodynamics. Cambridge University Press, 2017. ISBN: 9781108357142. URL: https://books.google.co.in/books?id=Kh4xDwAAQBAJ.
2. Vasudeva.D. N. Fundamentals of Magnetism and Electricity. S. Chand Limited, 2007. ISBN: 9788121909556. URL:https://books.google.co.in/books?id=DbucEAAAQBAJ.
3. D. Chattopadhyay. Electricity And Magnetism. New Central Book Agency (P) Limited, 2013. ISBN: 9788173812514. URL: https://books.google.co.in/books?id=0WWmcgeF1XQC.

4. Laud.B. B. Electromagnetics. Wiley Eastern, 1987. ISBN: 9780852264997. URL: https://books.google.co.in/books?id=XtgFvbd9F2UC

COURSE NAME: Thermal Physics

COURSE CODE: PY- MN - 6214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The objective of the course is to provide a broad overview of thermodynamics covering the fundamental principles involved - First and Second law of thermodynamics, conversion of heat into work and vice-versa, Carnot engine, concept of entropy, importance of thermodynamic potentials etc.

Also, the kinetic theory of gases will be covered with an objective to learn the molecular motion of gaseous particles, phenomena like thermal conduction, diffusion, brownian motion, etc.

Course Learning Outcome :

CLO – 01: *The basic laws of nature associated with heat and thermodynamics, the conversion of heat into work and vice-versa, principle of working of machine - carnot engine, concept of entropy, thermodynamic potentials, etc. Also, they will learn about kinetic theory of gases.*

CLO – 02: *They will learn to apply the concept of kinetic theory of gases to explain the real life physical phenomena like thermal conductivity, diffusion of gases in a medium, phenomenon like brownian motion, etc.*

Unit I – Heat (15 lectures)

Platinum resistance thermometer and thermocouple thermometer.

The equation of state of real gases, Van-der-Waals' equation of state, reduced equation of state, critical constants. Zeroth law of themodynamics and concept of temperature.

Joule-Thomson effect, liquefaction of gases by Joule-Thomson effect.

Phase, first order phase transitions, Clausius–Clayperon equation, Gibbs' phase rule, triple point.

Unit II – Thermodynamics (10 lectures)

Heat and work and their equivalence, First law of thermodynamics and concept of internal energy, Applications of firstlaw of thermodynamics.

Inadequacy of first law of thermodynamics, Second law of thermodynamics, reversible and irreversible processes, isothermal and adiabatic processes, work done by perfect gas under isothermal and adiabatic expansion, Carnot engine and Carnot cycle, Thermodynamic scale of temperature.

Entropy, change of entropy in reversible and irreversible processes, Clausious inequality relation. Maxwell's thermodynamic relations and their applications.

Unit III - Thermal radiation (13 lectures)

Kirchhoff's law and its applications, relation between radiation pressure and energy density, Black body radiation, expres- sions of Stefan-Boltzmann law, Wien's displacement law, Rayleigh-Jean's law and Planck's law of black body radiation.

Unit IV - Kinetic theory of gases (7 lectures)

Kinetic theory of gases, expression of Maxwell's law of velocity distribution (deduction not necessary), degree of freedom,law of equipartition of energy, mean free path, Brownian motion.

PRACTICAL

Total Lectures: 30

List of Experiments

Minimum number of experiments to be performed is four

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer.
6. To determine the boiling point of a given liquid with the help of a Platinum Resistance thermometer.
7. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
8. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

BOOKS RECOMMENDED:

1. P.K. Chakrabarti. Theory and Experiments on Thermal Physics. New Central Book Agency (P) Limited, 2013. ISBN: 9788173815041.
   URL: https://books.google.co.in/books?id=JCNXhdvWCGkC.
2. J.P. Agarwal and S. Prakash. Thermodynamics and Statistical Physics. Pragati Prakashan, 1993.
   URL: https ://books.google.co.in/books?id=6UCcGwAACAAJ.
3. S.C. Garg, R.M. Bansal, and C.K. Ghosh. Thermal Physics: Kinetic Theory, Thermodynamics and Statistical Me- chanics. McGraw Hill Education (India) Private Limited, 2013. ISBN: 9781259097614. URL: https://books. google.co.in/books?id=VAbvjgEACAAJ.
4. F.W. Sears and G.L. Salinger. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics. Addison-Wesley principles of physics series. Addison-Wesley Publishing Company, 1975. ISBN: 978020106894
   URL: https ://books.google.co.in/books?id=3gRRAAAAMAAJ.

SKILL ENHANCEMENT COURSE (SEC)

Programme Specific Outcome of Bachelor of Science - Skill Enhancement Course

PSO No.	Name	Outcome
PSO - 1	Basic Knowledge	The learner will be familiar with computers and its associated softwares that are used in any digital environment. They will also learn the skill of computer coding with the help of Python Programming Language. Computer Algebra System (CAS) which is used in many scientific computation will be learned with the help Mathematica software. Further, they will learn about LaTeX, a scientific type setting system used for technical writing.
PSO - 2	Skill Enhancement through ICT and Employability	Familiarity with computer and knowledge of Python and Mathematica will help learners to become suitable for many diverse scientific jobs in the field of data science, deep learning, artificial intelligence as well as core fields of science disciplines and also, its allied fields.
PSO - 3	Communication Skill	The knowledge of LaTeX will make the learner competent for scientific communication. The learner will learn effective communication skills to present their knowledge through seminar, group discussion, etc.
PSO - 4	Team Work	The learner will learn to work either independently or in a group during laboratory sessions, projects, and student seminar.
PSO - 5	Ethical Thinking	The student will acquire a purposeful knowledge of scientific literature and ethical issues related to physics.

Basic Syllabus Structure of SEC

Semester	Course Name & Code	Contents
1	Basic Computer Knowledge PY-SE-1113	Knowing Computer
		Operating Computer using GUI-Based Operating System
		Understanding Word Processing
		Understanding Spreadsheet
		Understanding Presentation Software
		Introduction to Internet, WWW, and Web Browsers
		Communications and Collaboration Lectures
2	Programming Skill with Python PY-SE-2113	Introduction to Scientific Programming Algorithms and Flowcharts
		Basics of Scientific Programming
		NumPy Fundamentals
		Visualization with Matplotlib
3	Computer Algebra System and Scientific Word Processing PY-SE-3213	Introduction to CAS and Applications
		Getting started with LaTeX
		Mathematical Typesetting with LaTeX

Course Learning Outcome - Skill Enhancement Course (SEC)

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	Basic Computer Knowledge PY-SE-1113	CLO - 01	The learner will able to use the computer for basic purposes like preparing his letters, notes, presentation, etc., viewing information on the Internet (the web), and sending mail, etc.
		CLO - 02	This allows a student to be also part of a computer user list by making them digitally literate.
		CLO - 03	This would also aid the PC penetration program.
		CLO - 04	This helps them to maintain their small account using the computers and enjoy the world of Information Technology.
2	Programming Skills with Python PY-SE-2113	CLO - 01	After completing the course a student will be able to do coding.
		CLO - 02	It will help solving any real life problem.
		CLO - 03	Python is a powerful programming language that offers exciting career opportunity in a wide range of industry.
3	Computer Algebra System and Scientific Word Processing PY-SE-3213	CLO - 01	Use CAS as a calculator, for plotting functions and various applications.
		CLO - 02	The learner will be able to write a scientific report using LaTeX software and presenting their gwork with the help of LaTeX Beamer
		CLO - 03	This knowledge will help them a lot in their future endeavour.

Mapping of Course Learning Outcome and Programme Outcome

Courses	CLO	PROGRAMME OUTCOME										
		SPO-1	SPO-2	SPO-3	SPO-4	SPO-5	SPO-6	SPO-7	SPO-8	SPO-9	SPO-10	SPO-11
PY-SE-1113	CLO 1	3	1	2	3	2	2	1	1	3	2	2
	CLO 2	3	1	2	3	2	2	1	1	3	2	2
	CLO 3	3	1	2	3	2	2	1	1	3	2	2
	CLO 4	3	1	2	3	2	2	1	1	3	2	2
PY-SE-2113	CLO 1	2	2	2	3	2	3	1	1	3	2	2
	CLO 2	2	2	2	3	2	3	1	1	3	2	2
	CLO 3	2	2	2	3	2	3	1	1	3	2	2
PY-SE-3213	CLO 1	1	3	2	3	2	3	1	1	3	3	2
	CLO 2	1	3	2	3	2	3	1	1	3	3	2
	CLO 3	1	3	2	3	2	3	1	1	3	3	2

Mapping of Course Learning Outcome and Programme Specific Outcome

Courses	CLO	Programme Specific Outcome (PSO)				
		PSO - 1	PSO - 2	PSO - 3	PSO - 4	PSO - 5
PY-SE-1113	CLO 1	3	1	1	2	2
	CLO 2	3	1	1	2	2
	CLO 3	3	1	1	2	2
	CLO 4	3	1	1	2	2
PY-SE-2113	CLO 1	2	2	1	2	2
	CLO 2	2	2	1	2	2
	CLO 3	2	2	1	2	2
PY-SE-3213	CLO 1	1	3	1	2	2
	CLO 2	1	3	1	2	2
	CLO 3	1	3	1	2	2

COURSE NAME: Basic Computer Knowledge

COURSE CODE: PY- SE - 1113

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY

Total Lectures: 30

Course Objective:

The objective of the course is imparting a basic level of knowledge about computer and its related software in digital environment.

Course Learning Outcome:

CLO – 01 : *The learner will able to use the computer for basic purposes like preparing his letters, notes, presentation, etc., viewing information on the Internet (the web), and sending mail, etc.*

CLO – 02 : *This allows a student to be also part of a computer user list by making them digitally literate.*

CLO – 03 : *This would also aid the PC penetration program.*

CLO – 04 : *This helps them to maintain their small account using the computers and enjoy the world of Information Technology.*

Unit I: Knowing Computer (Lectures 2)

What is a Computer, Basic Applications of a Computer; Components of Computer System, Central Processing Unit (CPU), VDU, Keyboard and Mouse, Other input/output Devices, Computer Memory, Concepts of Hardware and Software; Concept of Computing, Data, and Information; Applications of IECT; Connecting keyboard, mouse, monitor and printer to CPU and checking power supply.

Unit II: Operating Computer using GUI-Based Operating System (Lecture 4)

What is an Operating System; Basics of Popular Operating Systems; The User Interface, Using Mouse; Using right Button of the Mouse and Moving Icons on the screen, Use of Common Icons, Status Bar, Using Menu and Menu-selection, Running an Application, Viewing of File, Folders, and Directories, Creating and Renaming of files and folders, Opening and closing of different Windows; Using help; Creating Short cuts, Basics of O.S Setup; Common utilities.

Unit III: Understanding Word Processing(Lectures 6)

Word Processing Basics; Opening and Closing of documents; Text creation and Manipulation; Formatting of text; Table handling; Spell check, language setting, and thesaurus; Printing of word document.

Unit IV: Understanding Spreadsheet (Lectures 6)

Basics of Spreadsheet; Manipulation of cells; Formulas and Functions; Editing of Spread Sheet, the printing of Spread Sheet.

Unit V: Understanding Presentation Software (Lectures 6)

Basics of presentation software; Creating Presentation; Preparation and Presentation of Slides; Slide Show; Taking printouts of presentation/handouts.

Unit VI: Introduction to Internet, WWW, and Web Browsers(Lectures 4)

Basic of Computer networks; LAN, WAN; Concept of the Internet; Applications of the Internet; connecting to the Internet; What is ISP; Knowing the Internet; Basics of internet connectivity related troubleshooting, World Wide Web; Web Browsing software, Search Engines; Understanding URL; Domain name; IP Address; Using e-governance website.

Unit VII: Communications and Collaboration Lectures (Lecture 2)

Basics of electronic mail; Getting an email account; Sending and receiving emails; Accessing sent emails; Using Emails; Document collaboration; Instant Messaging.

PRACTICAL

Total Lectures: 30

1. Do the following tasks specific to Windows Operating System
    a. Creating a new folder, copying/pasting files.
    b. Creating a new file.
    c. Deleting a folder/file.
2. To check the hardware present in the computer, note down the specifications of the PC.
    a. What is the operating system being used?
    b. What service pack is installed?
    c. What is the CPU name?
    d. What is the clock speed of the computer's CPU?
3. Take an unformatted document and do all the formatting exercises as discussed in the theory class.
4. Create a spreadsheet and explore all the aspects discussed in the theory class.
5. Create a PowerPoint presentation on any topic and explore all the aspects as discussed in the theory class.
6. Choose an unknown topic and collect as much information as possible with the help of a search engine and record them appropriately.
7. Create a mail account and share documents as attached files.

BOOKS RECOMMENDED

1. Operating System Principle by Galvin.
2. Data Communication Networks by Udit Agarwal.
3. A-Z MS/Excel by Ms. Rinkoo Jain.
4. Exploring ms/Office by Kevin Wilson.

COURSE NAME: Programming Skills with Python

COURSE CODE: PY-SE-2113

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY

Total Lectures: 30

Course Objectives:

The course is designed to provide Basic knowledge of Python. It will help one to learn how to design and program Python applications.

Course Learning Outcome:

CLO – 1: *After completing the course a student will acquire programming capability and will be able to solve a real-life problem.*

CLO – 02 : *It will help solving any real life problem.*

CLO – 03 : *Python is a powerful programming language that offers exciting career opportunity in a wide range of industry.*

Unit I: Introduction to Scientific Programming (Lectures 6)

Algorithm: Definition, properties, and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit II: Basics of Scientific Programming (Lectures 16)

Variables and Formatting: Introduction to HLL, Concepts of a Compiler. Character Set, Constants and their types, Variables and their types.

Operators: Arithmetic, Relational, Logical, and Assignment Operators.

Expressions: Arithmetic, Relational, Logical, Character, and Assignment Expressions. I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of a Program, Format of writing Program and concept of coding, Initialization, and Replacement Logic. Examples from physics problems.

Control Statements and Functions: Logical statements - IF, IF-ELSE block, Looping Statements - WHILE, FOR loop, Functions, open a file, writing in a file, reading from a file.

Unit III: Visualization (Lectures 8)

Introduction to graphical analysis, the importance of visualization of computational data, simple plots, plotting data from a file, saving and exporting, multiple data sets per file, curve fitting – straight line, polynomials, user-defined function.

PRACTICAL

Total Lectures: 30

1. The height of a satellite above the earth should be

$$h = \left(\frac{GM_E T^2}{4\pi^2}\right)^{1/3} - R_E$$

where, G = 6.673 x 10^{-11} Nm^2/kg^2 is the universal gravitational constant. M_E = 5.98 x 10^{24} kg, mass of the earth, R_E = 6.37 x 10^6 m, radius of the earth

A geosynchronous orbit (GEO) is a prograde, low inclination orbit about Earth having a period of 23 hours 56 minutes 4 seconds. A spacecraft in geosynchronous orbit appears to remain above Earth at a constant longitude, although it may seem to wander north and south. Estimate the height of a Geosynchronous satellite.

2. To find a set of prime numbers between two given numbers.
3. Sum the series

$$\sum_{k=1}^{100} \frac{1}{k}$$

4. The Fibonacci numbers are the sequence of integers in which each is the sum of the previous two, with the first two numbers being 1, 1. Thus the first few members of the sequence are 1, 1, 2, 3, 5, 8, 13, 21.
   Calculate Fibonacci numbers up to 100.
5. Write a program for calculating the wavelengths of emission lines in the spectrum of the hydrogen atom, based on the Rydberg formula

$$\frac{1}{\lambda} = R\left(\frac{1}{m^2} - \frac{1}{n^2}\right)$$

The value of R = 1.097 x 10^{-2} m^{-1}

6. The coordinate of a point in the cartesian coordinate system is given by (x, y) and that in the polar coordinate system is given by (r, θ). Write a user-defined function to transform coordinates from one system to another.
7. Make a plot of the curve which is defined by

$$x = 2\cos\theta + \cos 2\theta; \quad y = 2\sin\theta - \sin 2\theta$$

where $0 \leq \theta \leq 2\pi$. Take a set of values of θ between 0and 2π, calculate x and y for each from the equations above, and then, plot y as a function x.

BOOKS RECOMMENDED

1. Computational Physics, by Mark Newman.
2. Computational Physics: Problem Solving with Python, by Manuel J. Páez , Rubin H. Landau , Cristian C. Bordeianu.
3. Python Programming: An Introduction to Computer Science by John Zelle, Franklin, Beedle& Associates INC.

COURSE NAME: Computer Algebra System and Scientific Word Processing

COURSE CODE: PY-SE-3213

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY

Total Lectures: 30

Course Objectives:

This course aims at familiarizing students with the usage of computer algebra systems using Mathematica. The basic emphasis is on plotting using CAS.

Course Learning Outcome:

CLO – 01: *Use CAS as a calculator, for plotting functions and various applications.*

CLO – 02: *The learner will be able to write a scientific report using $LaTeX$ software and presenting their work with the help of $LaTeX$ Beamer.*

CLO – 03: *This knowledge will help them a lot in their future endeavour.*

Unit - I Introduction to CAS and Applications (15 lectures)

Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.

Factoring and expanding polynomials, Finding roots of a polynomial with Solve and NSolve, Solving system of equations.

Computing limits, Derivative and its visualization, Differential equations, Integral - definite and improper integrals, Numerical Integration.

Matrices - eigenvalues and eigenvectors.

Unit - II Getting started with LATEX (15 lectures)

Document Classes - article, report, book and beamer.

Page Layout - Titles, Abstract, Chapters, Sections, subsections, paragraph, verbatim, equation/Figure References, Generating table of contents, bibliography and citation, Making an index and glossary.

List structures - Itemize, enumerate, description etc.

Representation of mathematical equations - Inline math, Equations, Fractions, Matrices, trigonometric, logarithmic, exponential functions, line-surface-volume integrals with and without limits, closed line integral, surface integrals etc.

Customization of fonts - Bold fonts, emphasize, Changing sizes - Large, larger, Huge, tiny, etc. Writing tables - Creating tables with different alignments, placement of horizontal, vertical lines. Figures - Changing and placing the figures, alignments.

Packages - amsmath, amssymb, graphics, graphicx, Geometry, algorithms, color, Hyperref etc. (simple ideas about their relevance in the context of a document).

PRACTICAL

Total Lectures: 30

Suitable Examples may be drawn to exemplify the content in theory section.

BOOKS RECOMMENDED

1. B.F. Torrence and E.A. Torrence. The Student's Introduction to MATHEMATICA ®: A Handbook for Precalculus, Calculus, and Linear Algebra. Cambridge University Press, 2009. ISBN: 9781139473736. URL: https://books.google.co.in/books?id=F8VhFRhZw-MC.
2. L. Lamport. LATEX: A Document Preparation System : User's Guide and Reference Manual. Addison-Wesley series on Tools and Techniques for Computer Typesetting p. 2. Addison-Wesley, 1994. ISBN: 9780201529838.
   URL: https://books.google.co.in/books?id=khVUAAAAMAAJ

INTER-DISCIPLINARY COURSE (IDC)

Programme Specific Outcome of Bachelor of Science - IDC (Physics forAll)

PSO No.	Name	Outcome
PSO - 1	Basic Knowledge	The learner will acquire knowledge about the contribution of great scientists who has enriched our knowledge about science particularly Physics. They will learn about nature and their surroundings.
PSO - 2	Critical Thinking	The learner will be familiar with the logical thinking and explanations of various mysteries in nature. They will be familiar with the working principles of different mechanical activities. Overall, it will inculcate a scientific bent of mind.
PSO - 3	Competency for Competitive Examinations	The learner will be competent to face national/international level examinations like UGC-CSIR NET, GATE, JAM, JEST, GRE, TOEFL andUPSC Civil Service Examinations.
PSO - 4	Ethical Thinking	The student will acquire a purposeful knowledge of scientific literatureand ethical issues related to physics.

Basic Syllabus Structure of IDC

Semester	Course Name & Code	Contents
1	Physics for All - Part 1 PY-ID-1113	Great Indian Scientists and their Contributions
		Underlying Science of Indian Monuments
		Indian Space Programme and its Impact
		Beyond Sky
		Introduction to measurement units
2	Physics for All - Part 2 PY-ID-2113	Know your planet - Earth
		World through a Physicist Eye
		Beyond our Sky
		Light and its related phenomena
3	Physics for All - Part 3 PY-ID-3213	Renewable Energy and Resources
		Wonderful World of Sound and Waves
		Physics in Everyday Life
		From Classical to Quantum World

Course Learning Outcome (CLO)

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	Physics for All- Part 1 PY-ID-1113	CLO - 01	A student will know about the contribution of Indian Scientists in different fields from ancient days to modern days.
		CLO - 02	A learner can now enjoy the famous Indian architecture and monuments by thinking about the underlying physics during their visit in that particular spot.
		CLO - 03	Students can feel proud and gather knowledge by knowing the achievements of our own space agency ISRO.
		CLO - 04	A student will be able to understand the basic concepts of different appliances in everyday life.
2	Physics for All- Part 2 PY-ID-2113	CLO - 01	A student will know about the construction of earth's body and its atmosphere, their significance and importance.
		CLO - 02	A learner will get a general idea of the working of various tools and appliances used in our day-to day lifestyle.
		CLO - 03	A student can explain the possible states of matter and their phase changing processes, their impact in various phases of weather conditions, various classes and applications of materials.
		CLO - 04	A student will familiar with the world beyond our earth and the history and development of human civilization in case of units and measurements.
3	Physics for All- Part 3 PY-ID-3213	CLO - 01	A student will aware the uses of renewable energy sources and learn about the impact of them in real world.
		CLO - 02	A learner will familiar with the concepts of sound and waves and their practical importance in various instruments and technology.
		CLO - 03	A student acquires knowledge of working principle of various instruments, tools and appliances used in our day to day life.
		CLO - 04	A learner will go through the journey of different major events and the names of important persons behind the event in the history of civil human society.

Mapping of Course Learning Outcome (CLO) and Programme Outcome (PO)

Courses	CLO	Programme Outcome (PO)										
		SPO - 1	SPO - 2	SPO - 3	SPO - 4	SPO - 5	SPO - 6	SPO - 7	SPO - 8	SPO - 9	SPO - 10	SPO - 11
PY-ID-1113	CLO - 1	3	1	1	1	2	2	1	1	1	1	2
	CLO - 2	3	1	1	1	2	2	1	1	1	1	2
	CLO - 3	3	1	1	1	2	2	1	1	1	1	2
	CLO - 4	3	1	1	1	2	2	1	1	1	1	2
PY-ID-2113	CLO - 1	3	1	1	1	2	2	1	1	1	1	2
	CLO - 2	3	1	1	1	2	2	1	1	1	1	2
	CLO - 3	3	1	1	1	2	2	1	1	1	1	2
	CLO - 4	3	1	1	1	2	2	1	1	1	1	2
PY-ID-3213	CLO - 1	3	1	1	1	2	2	1	1	1	1	2
	CLO - 2	3	1	1	1	2	2	1	1	1	1	2
	CLO - 3	3	1	1	1	2	2	1	1	1	1	2
	CLO - 4	3	1	1	1	2	2	1	1	1	1	2

Mapping of Course Learning Outcome (CLO) and Programme Specific Outcome (PSO)

Courses	CLO	Programme Specific Outcome (PSO)			
		PSO - 1	PSO - 2	PSO - 3	PSO - 4
PY-ID-1113	CLO - 1	3	2	2	1
	CLO - 2	3	2	2	1
	CLO - 3	3	2	2	1
	CLO - 4	3	2	2	1
PY-ID-2113	CLO - 1	3	2	2	1
	CLO - 2	3	2	2	1
	CLO - 3	3	2	2	1
	CLO - 4	3	2	2	1
PY-ID-3213	CLO - 1	3	2	2	1
	CLO - 2	3	2	2	1
	CLO - 3	3	2	2	1
	CLO - 4	3	2	2	1

COURSE NAME : Physics for All - Part: 1

COURSE CODE : PY – ID – 1113

TOTAL CREDITS : 3 (Theory: 3)

THEORY

Total Lectures - 45

Course Objective:

This course provides students to know about the great Indian scientists and their contributions in the various fields of science, History and science behind the well-popular Indian architecture and monuments, get a chance to proud on our achievements of our own space agency ISRO, know about the solar system and its related terminology, development of units and measurements.

Course Learning Outcome:

CLO – 01: *A student will know about the contribution of Indian Scientists in different fields from ancient days to modern days.*

CLO – 02: *A learner can now enjoy the famous Indian architecture and monuments by thinking about the underlying physics during their visit in that particular spot.*

CLO – 03: *Students can feel proud and gather knowledge by knowing the achievements of our own space agency ISRO.*

CLO – 04: *A student will be familiar with the world beyond our earth and the history and development of human civilization in case of units and measurements.*

Unit – I: Great Indian Scientists and their contributions (10 lectures)

- Ancient Era: Aryabhatta, Bhaskaracharya, Budhayana, Nagarjuna, Susruta, Kanada, Varahamihira.
- Medieval Era: Gangadhara, Mughal philosophers, Nilakantha Somasutvan, Sukraniti.
- Modern Era: Srinivasa A. Ramanujan, Jagdish Chandra Bose, Satyendra Nath Bose, Meghnad Saha, Homi Jahangir Bhabha, Vikram A. Sarabhai, A. P. J. Abdul Kalam, Deepak Dhar, Ashok Sen.
- Nobel Laureates of Indian Origin: Sir Chandrasekhara Venkata Raman, Har Gobind Khorana, Subrahmanyan Chan-drasekhar, Venkatraman Ramakrishnan.
- Notable Assamese Scientists: Guruprasad Das, Jitendra Nath Goswami.

Unit – II: Underlying Science of Indian monuments (5 lectures)

Konark Sun temple, Shree Jagannatha Temple Puri, Vitthala temple and its musical pillars, Somnath temple and its link to Antarctica, Qutab Minar, Jantar Mantar, Hawa Mahal, Taj Mahal, Ajanta and Ellora Caves, Shiva temples on the same longitude.

Unit – III: Indian Space Program and its impact (13 lectures)

- Birth of Indian space research program, Indian Space Research Organization (ISRO) and its allied institutions, Launching story of first Indian Satellite: Aryabhatta.

- Geostationary and polar satellites.
- Launch vehicles: PSLV and GSLV.
- Major Missions of ISRO: Chandrayan-I, Mangalyan, Chandrayan-II, Launching of 104 satellites, Chandrayan-III,Aditya L1, Gaganyaan (Crew Escape Module), NAVIC.
- INSAT and IRS satellites for telecommunication and disaster management support.
- Artificial satellite and its importance: Weather forecasting, Disaster management, Flood relief and monitoring, Draught Control, Cyclones prediction, Telecommunications, mobile communications, Agriculture sector, Motion of outer earth's objects.

Unit – IV: Beyond Our Sky (10 lectures)

- Solar System: Formation story of our own solar system, Sun and its basic properties, Solar atmosphere, Corona, Planets and their satellites, Basic Properties of each planet, Pluto is no longer considered as a planet.
- Our own satellite Moon and its properties, Solar Eclipse and Lunar Eclipse, Tide.
- Our own galaxy Milky way.
- Astronomical Telescopes: Hubble Space Telescope, James Web Telescope, Indian Astronomical Observatory, Hanle (Basic Ideas Only).

Unit – V : Introduction to measurement units (7 lectures)

- Evolution of Units, History of measurements.
- Standardization of measurements of length, mass and time.
- Instruments used in measurements: meter scale, Vernier scale, clocks, balance box.
- Astronomical Units: Light Years, Parsec, Stellar and Solar Masses.

COURSE NAME : Physics for All - Part: 2

COURSE CODE : PY – ID – 2113

TOTAL CREDITS : 3 (Theory: 3)

THEORY

Total Lectures - 45

Course Objective:

This course is intended to provide the students about the knowledge of our planet earth's structure and atmosphere, physics of our day to day instruments and appliances, mater and its various forms, different types of materials, light and its applications in our everyday life.

Course Learning Outcome :

CLO – 01: *A student will know about the construction of earth's body and its atmosphere, their significance and importance.*

CLO – 02: *A learner will get a general idea of the working of various tools and appliances used in our day-to day lifestyle.*

CLO – 03: *A student can explain the possible states of matter and their phase changing processes, their impact in various phases of weather conditions, various classes and applications of materials.*

CLO – 04: *A student will be able to understand the basic concepts of different appliances in everyday life.*

Unit - I : Know your planet – Earth (10 lectures)

Part A: Structure of the Earth

- Basic properties of the earth, Water and land percentage, Continents and Oceans.
- Compositional layers: Crest, Mantle, Core.
- Mechanical layers: Lithosphere, Asthenosphere, Mesosphere, Outer Core.
- Tectonic plate, Volcano Eruptions, Earthquake, Richter scale, Seismometer, Tsunami.

  The 1950's Earthquake of Assam and its impact.

Part B: Atmosphere of the Earth

- Earth's atmosphere and its composition, layers of the atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere and Ionosphere.
- Necessity, Importance and significance of each layer from various practical aspects.
- Greenhouse gases, Greenhouse effect and its consequences: Ozone hole, Global warming, Climate change.

Unit – II: World through a Physicist Eye (15 lectures)

- Sir Isaac Newton and his contribution to the development of mechanics and discovery of gravity and gravitation force,
- Application of gravity in various aspects of human civilizations.
- Motion in everyday life: translational and rotational.
- Concept of Work and Energy with practical examples, different forms of energy.
- Discovery of wheels.
- Practical examples of Mechanical tools: lever, pulley, and chains.
- Concept of pressure and its impact in our day to day life, Ideas of hydraulic lift and hydraulic brake, Pressure Cooker.
- Archimedes principle and the legend associated with it, Ideas of floating of ships and sinking of submarines.
- Application of fluid mechanics in everyday life - jet spray, capillarity.

Unit – III: Know your surroundings (12 lectures)

Part A: Concept of Matter

- Different states of matter (solid, liquid and gas) and their basic properties.
- Change of state (Melting, boiling, vaporisation).
- Concept of evaporation, sublimation, and condensation.
- Dew, fog, and occurrence of rain, Formation of cloud.

Part B: History and Evolution of materials

- Starting of human civilization.
- Era of materials: Stone Age, Copper Age, Iron Age.
- Development of materials: Metals and non-metals, Metalloids, Alloys (Basic ideas and examples of each class only).
- Basic Ideas about Advanced Materials: Polymers, Ceramics, Synthetic fibres, Smart materials, Biomaterials, Nanomaterial, Quantum dots.

Unit - IV Light and its related phenomena (8 lectures)

- Concepts of reflection and refraction.
- Concept of image (real and virtual).
- Ideas of mirrors and lenses, Types of mirrors and Lenses, Uses of mirrors and lenses.
- Working of a camera, human eye, power of a lens.
- Historical background of the development of telescope and microscope (stories of Galileo and Leeuwenhoek).
- Basics of dispersion, dispersion in a prism, VIBGYOR and rainbow.
- Scattering of light, Red sky of the sunset, Blue sky at day time, Blue colour of the ocean.

COURSE NAME : Physics for All - Part: 3

COURSE CODE : PY – ID – 3213

TOTAL CREDITS : 3 (Theory: 3)

THEORY

Total Lectures - 45

Course Objective :

A student will aware the uses of renewable energy sources and learn about the impactof them in real world.

Course Learning Outcome:

CLO – 01: *A student will aware the uses of renewable energy sources and learn about the impactof them in real world.*

CLO – 02: *A learner will familiar with the concepts of sound and waves and their practical importance in various instruments and technology.*

CLO – 03: *A student acquires knowledge of working principle of various instruments, tools and appliances used in our day to day life.*

CLO – 04: *A learner will go through the journey of different major events and the names of important persons behind the event in the history of civil human society.*

Unit – I: Renewable Energy and Resources (12 lectures)

- Renewable and non-renewable energy and there natural sources, Need for renewable energy sources and present day status.
- Brief description of renewable energy sources (Solar energy, Wind energy, Hydro energy, Tidal energy, Geothermal energy, and Biomass energy).
- Advantages and disadvantages of renewable energy sources. History and evolution of the concept of sustainable development.
- Consequences of fossil fuel burning - ozone layer depletion, greenhouse effects, global warming.
- Ideas about solar cells and their uses in household and industrial applications, solar heater/cooker (qualitative discussions only).
- Future of renewable energy sources, social issues related to hydropower generation

Unit – II: Wonderful World of Sound and Wave (8 lectures)

- Concept of oscillatory motion, Pendulum of Wall Clocks. Wave, Nature of Wave, Different types of waves.
- Application in different musical instruments: flute, guitar, drum (qualitative). Qualitative definition of frequency, time period, wavelength, velocity of wave.
- Echo in a Hall, Audible range of sound, Concept of ultrasonic waves and its practical applications (bat hunting, SONAR), Supersonic jets.

Unit – III: Physics in every day life (13 lectures)

- Household circuit, usage of fuse and MCB, and importance of earthing. Heating effect of current: Heater and Iron.
- Concept of direct and alternating current.
- Magnet, earth's magnetism, Electric current can act as a magnet; Magnet can also induce current, Concept of electro- magnetic induction. Primary and secondary cells (qualitative).
- Qualitative explanation of generator, motor, and transformer.
- Application in everyday life: Washing machine, Mixer Grinder, Drilling, and Cutting machines. Concepts on conductors, insulators and semiconductors.
- Discovery of X-rays and its applications.
- Superconductor and its applications - Bullet train, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) machines (basic ideas only).
- Basics of communication systems: History and development, Different modes of communications: Satellite communication, Mobile communications, GPS (qualitative discussion only).

Unit – IV: From Classical to Quantum World (12 lectures)

- Theoretical progress and consequent experimental evidence.
- Newton's Era and the contribution of Newton to the major fields of Physics.
- Development of modern physics, about the father of modern physics, discovery of proton, electron, and neutron (qualitative).
- Birth of Quantum Physics and its impact.
- Albert Einstein and Discovery of Relativity. The impact of relativity in modern physics and technology. Marie Curie, discovery of radioactivity and its applications.
- Nuclear energy (qualitative idea only), nuclear holocaust with special reference to Hiroshima and Nagasaki, Chernobyl Disaster.
- Nuclear isotopes and its applications.