S.Y.B.Sc. (Physics)
Semester-III
&
Semester-IV
Syllabus

2019 Pattern

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Course Structure for S.Y.B.Sc. Physics 2019 pattern

Semester	Paper Code	Title of Paper	No. of Credits
I	PHY 2301	A] Electronics-I / B] Instrumentation	3
	PHY 2302	Thermal Physics	3
	PHY 2303	Practical-I	2
II	PHY 2401	Mathematical Methods of Physics-I	3
	PHY 2402	Elements of Modern Physics	3
	PHY 2403	Practical-II	2

Program Outcomes

PO1: Disciplinary Knowledge

PO2: Critical Thinking and Problem solving

PO3: Social competence

PO4: Research-related skills and Scientific temper

PO5: Trans-disciplinary knowledge

PO6: Personal and professional competence

PO7: Effective Citizenship and Ethics

PO8: Environment and Sustainability

PO9: Self-directed and Life-long learning

Class : S.Y.B.Sc. (Semester- IV)
Paper code : PHY 2401
Paper : I Title of Paper: Mathematical Methods in Physics -I
Credit : 3 No. of Lectures: 48

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

CO1: Understand the complex algebra useful in physics courses
CO2: Understand the concept of partial differentiation.
CO3: Understand the role of partial differential equations in physics
CO4: Understand vector algebra useful in mathematics and physics
CO5: Understand the singular points of differential equation
CO6: Understand the Functions Fourier series and analysis
CO7: Significance of mathematics formulations for understanding of physics principles

UNIT 1: Complex Numbers (12)

1.1 Introduction to complex numbers.
1.2 Rectangular, polar and exponential forms of complex numbers.
1.3 Argand diagram.
1.4 Algebra of complex numbers using mathematical and Argand diagram
1.5 De-Moivre's Theorem.
1.6 Powers, roots and log of complex numbers.
1.7 Trigonometric, hyperbolic and exponential functions.
1.8 Applications of complex numbers to determine velocity and acceleration in curved motion.
1.9 Problems.

UNIT 2: Vector Algebra and Vector Analysis (16)

2.1 Introduction to scalars and vectors.
2.2 Dot product and cross product of two vectors and its physical significance
2.3 Scalar triple product and its geometrical interpretation.
2.4 Vector triple product and its proof.
2.5 Scalar and vector fields.
2.6 Differentiation of vectors with respect to scalar.
2.7 Vector differential operator and Laplacian operator.
2.8 Gradient of scalar field and its physical significance.
2.9 Divergence of scalar field and its physical significance.
2.10 Curl of vector field.
2.11 Different vector identities.
2.12 Problems.

UNIT 3: Partial Differentiation and Differential Equation (12)

3.1 Definition of partial differentiation.
3.2 Successive differentiation.
3.3 Total differentiation.
3.4 Exact differential.
3.5 Chain rule.
3.6 Theorems of differentiation.
3.7 Change of variables from Cartesian to polar co-ordinates.

3.8 Implicit and explicit functions.
3.9 Conditions for maxima and minima (without proof).
3.10 Degree, order, linearity and homogeneity of differential equation.
3.11 Concept of Singular points. Example of singular points ($x = 0$, $x = x_0$ and $x = \infty$) of differential equation.
3.12 Problems.

UNIT4: Fourier series (08)

4.1 Definition
4.2 Evaluation of coefficient of Fourier series
4.3 Dirichlet's condition
4.4 Sine and cosine series
4.5 Graphical representation of even and odd function
4.6 Physical application of Fourier series analysis, square wave, half wave rectifier

Reference Books:

1. Methods of Mathematical Physics by Laud, Takwale and Gambhir
2. Mathematical Physics by B. D. Gupta
3. Mathematical Physics by Rajput and Gupta
4. Mathematical Methods in Physical Science by Mary and Boas
5. Vector analysis by Spiegel and Murrey
6. Mathematical Methods for Physicists by Arfken and Weber, 5th Edition, Academic Press.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3								2
CO 2	3								
CO 3		3		2					
CO 4	3								
CO 5		3							
CO 6	3								
CO7	3								

Justification

PO1: Disciplinary Knowledge

CO1: Understand the complex algebra useful in physics courses.Weightage: 3

Understanding complex algebra directly contributes to building disciplinary knowledge in physics.

CO2: Understand the concept of partial differentiation.Weightage: 3

Understanding partial differentiation is fundamental to building disciplinary knowledge in physics.

CO4: Understand vector algebra useful in mathematics and physics.Weightage: 3

Understanding vector algebra directly contributes to building disciplinary knowledge in physics.

CO6: Understand the Functions Fourier series and analysis.Weightage: 3

Understanding Fourier series and analysis directly contributes to building disciplinary knowledge in physics.

CO7: Significance of mathematics formulations for understanding of physics principles.Weightage: 3

Recognizing the significance of mathematical formulations directly contributes to building disciplinary knowledge in physics.

PO2: Critical Thinking and Problem Solving

CO3: Understand the role of partial differential equations in physics.Weightage: 3

Understanding the role of partial differential equations involves critical thinking and problem-solving skills in the context of physics.

CO5: Understand the singular points of differential equation.Weightage: 3

Understanding singular points in differential equations requires critical thinking and problem-solving skills.

PO4: Research-related Skills and Scientific Temper

CO3: Understand the role of partial differential equations in physics.Weightage: 2

Understanding the role of partial differential equations can be part of research-related skills, but the link may not be as direct.

PO9: Self-directed and Life-long Learning

CO1: Understand the complex algebra useful in physics courses.Weightage: 2

Understanding complex algebra is relevant to self-directed and life-long learning, though the link may not be as direct.

Class : S.Y.B.Sc. (Semester- IV)
Paper code : PHY 2402
Paper : II Title of Paper: Elements of Modern Physics
Credit : 3 No. of Lectures: 48

Learning Outcomes:
After the completion of this course students will be able to
CO1: Significance of element for understanding of physics principles
CO2: Demonstrate understanding of the scientific method of work and the evolution of physics from the classical to its modern era.
CO3: Demonstrate knowledge and understanding of electric and magnetic phenomena in everyday life.
CO4: Discuss the nature of light and the electromagnetic spectrum and outline practical applications.
CO5: Demonstrate knowledge of the fundamentals of important physics theories (e.g. relativity, quantum) and discuss the way they challenge our preconceptions.
CO6: Explain radioactivity and discuss different aspects of nuclear energy in nuclear reactors and in the universe.
CO7: Applications of knowledge for making various models for easy understanding and explanation

UNIT 1: Structure of Atom (16)

1.1 Introduction
1.2 Thomson Model
1.3 Rutherford Atom Model
1. Theory of alpha particle scattering
2. Rutherford scattering formula
3. Experimental verification of Rutherford's scattering theory

1.4 Bohr Atom Model
1. Basic postulates
2. The Bohr Radius formula
3. Hydrogen spectrum
4. Effect of Nuclear motion on Atomic spectra
5. Equation for the wave number of spectral lines of the atom
6. Evidence in favor of Bohrs theory

1.5 Sommerfield Relativistic Atom Model
1. Elliptical orbit for hydrogen and total energy
2. Sommerfield relativistic theory
3. Fine structure of the H line

1.6 The Vector Atom Model
1. Introduction
2. Spatial quantization
3. Spinning electron

4. Quantum numbers associated with vector atom model

UNIT 2: Nuclear Physics **(08)**

2.1 Introduction
2.2 Classification of nucleus
2.3 General properties of nucleus
2.4 Binding energy and nuclear stability
2.5 Theories of nuclear composition
2.6 Nuclear forces
2.7 Introduction to Semi-empirical mass formula

UNIT 3: Radioactivity **(12)**

3.1 Introduction
3.2 Fundamental laws of radioactivity
3.3 Half life and mean life
3.4 Radioactive dating : the age of the earth
3.5 Biological effects of nuclear radiation
3.6 Alfa, beta, and gamma decay and their properties
3.7 Concept of Fission and fusion

UNIT 4: Molecular spectra and lasers **(12)**

4.1 Introduction
4.2 Theory of origin of pure rotational spectrum of a molecule
4.3 Theory of origin of vibrational –rotational spectrum of molecule
4.4 Electronic spectra of molecule
4.5 Fluorescence and phosphorescence
4.6 Lasers
4.6.1. Introduction
4.6.2 Induced, Absorption, Spontaneous emission and stimulated emission
4.6.3 Principle of lasers
4.6.4 Types of lasers: Ruby laser, He-Ne Laser, semiconductor laser
4.6.5 Properties of laser beam

Reference Books:

1. Elements of Modern Physics- Arther Baiser
2. Nuclear Physics- D. C. Tayal
3. Fundamentals of atomic structure and atomic model- Gerhard Hertzberg
4. Atomic Structure and Atomic Spectra- White
5. Atomic and Nuclear Physics- Subramanyam
6. Nuclear Physics- S. N. Ghoshal

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3								
CO 2	3	3							
CO 3	3		2						
CO 4	3				2				
CO 5	3	3							2
CO 6	3			2					
CO7						2			

Justification

PO1: Disciplinary Knowledge

CO1: Significance of element for understanding of physics principles.Weightage: 3

Understanding the significance of elements directly contributes to building disciplinary knowledge in physics.

CO2: Demonstrate understanding of the scientific method of work and the evolution of physics from the classical to its modern era.Weightage: 3

Understanding the scientific method and the evolution of physics is fundamental to building disciplinary knowledge.

CO3: Demonstrate knowledge and understanding of electric and magnetic phenomena in everyday life.Weightage: 3

Demonstrating knowledge of electric and magnetic phenomena contributes directly to building disciplinary knowledge in physics.

CO4: Discuss the nature of light and the electromagnetic spectrum and outline practical applications.Weightage: 3

Discussing the nature of light and the electromagnetic spectrum directly contributes to building disciplinary knowledge in physics.

CO5: Demonstrate knowledge of the fundamentals of important physics theories (e.g. relativity, quantum) and discuss the way they challenge our preconceptions.Weightage: 3

Demonstrating knowledge of fundamental physics theories contributes directly to building disciplinary knowledge in physics.

CO6: Explain radioactivity and discuss different aspects of nuclear energy in nuclear reactors and in the universe.Weightage: 3

Explaining radioactivity and discussing nuclear energy directly contributes to building disciplinary knowledge in physics.

PO2: Critical Thinking and Problem Solving

CO2: Demonstrate understanding of the scientific method of work and the evolution of physics from the classical to its modern era.Weightage: 3

Understanding the scientific method and the evolution of physics requires critical thinking and problem-solving skills.

CO5: Demonstrate knowledge of the fundamentals of important physics theories (e.g. relativity, quantum) and discuss the way they challenge our preconceptions.Weightage: 3

Discussing the challenging aspects of physics theories requires critical thinking skills.

PO3: Social Competence

CO3: Demonstrate knowledge and understanding of electric and magnetic phenomena in everyday life.Weightage: 2

Demonstrating knowledge of electric and magnetic phenomena can contribute to social competence, but the link may not be as direct.

PO4: Research-related Skills and Scientific Temper

CO6: Explain radioactivity and discuss different aspects of nuclear energy in nuclear reactors and in the universe.Weightage: 2

Explaining radioactivity and discussing nuclear energy can be part of research-related skills, but the link may not be as direct.

PO5: Trans-disciplinary Knowledge

CO4: Discuss the nature of light and the electromagnetic spectrum and outline practical applications.Weightage: 2

Discussing the nature of light and its practical applications can contribute to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

CO7: Applications of knowledge for making various models for easy understanding and explanation.Weightage: 2

Applying knowledge for making models contributes to personal and professional competence, but the link may not be as direct.

PO9: Self-directed and Life-long Learning

CO5: Demonstrate knowledge of the fundamentals of important physics theories (e.g. relativity, quantum) and discuss the way they challenge our preconceptions.Weightage: 2

Demonstrating knowledge of challenging physics theories is relevant to self-directed and life-long learning, though the link may not be as direct.

Class : S.Y.B.Sc. (Semester- IV)
Paper code : PHY 2403
Paper : III Title of Paper: Practical-II
Credit : 2 No. of Practical: 10

Learning Outcome:
After successfully completing this laboratory course, the students will be able to do the following:
CO1: Use various instruments and equipment.
CO2: Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
CO3: Investigate the theoretical background to an experiment.
CO4: Set up experimental equipment to implement an experimental approach.
CO5: Analyze data, plot appropriate graphs and reach conclusions from your data analysis.
CO6: Work in a group to plan, implement and report on a project/experiment.
CO7: Experimental Models for easy understanding and explanation Physics concepts.

List of Experiments: (Students have to perform Any 10 Experiments)

1. Determination of Plank's constant
2. e/m by magnetic focusing
3. Millikan oil drop method to determine the charge on electron.
4. Work function of filament of directly heated vacuum diode.
5. Stefan's constant
6. Study of laser beam diversity
7. Determine the wavelength of Laser
8. Measurement of value of Boltzmann constant using I-V characteristic of PN diode
9. Thickness of sharp blade by laser diffraction
10. Wavelength of H-alpha emission line of Hydrogen atom
11. Determination of beta particle range
12. Verification of inverse square law
13. Plotting various trigonometric functions using MS-excel software: sin x, cos x, tan x, e^{x} , e^{-x} , log x, ln x, x^{n}
14. Equations and Graphs using MS-excel for the following figures: circle, ellipse, parabola, hyperbola.

3. Additional Activities

1. Student Involvement (Any one equivalent to two experiments)

A. Mini Projects

Group of 4 students should carry out mini project with the report.

Students have to perform at least two additional activities out of three activities in addition to sixteen experiments mentioned above. Total Laboratory work with additional activities should be equivalent to twenty experiments.

B. Study tour /visit

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2								
CO 2	3	3		2					2
CO 3	2			2					
CO 4	2								
CO 5	3	3							
CO 6		3	3						
CO7					2				

Justification

PO1: Disciplinary Knowledge

CO1: Use various instruments and equipment. Weightage: 2

Using various instruments is a practical application that contributes to disciplinary knowledge.

CO2: Design experiments to test a hypothesis and/or determine the value of an unknown quantity.

Weightage: 3

Designing experiments involves critical thinking and problem-solving skills, contributing directly to disciplinary knowledge.

CO3: Investigate the theoretical background to an experiment. Weightage: 2

Investigating theoretical backgrounds enhances understanding, contributing to disciplinary knowledge.

CO4: Set up experimental equipment to implement an experimental approach. Weightage: 2

Setting up experimental equipment is a practical application that contributes to disciplinary knowledge.

CO5: Analyze data, plot appropriate graphs and reach conclusions from your data analysis. Weightage: 3

Analyzing data and drawing conclusions involve critical thinking and problem-solving skills, contributing directly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Design experiments to test a hypothesis and/or determine the value of an unknown quantity.Weightage: 3

Designing experiments requires critical thinking and problem-solving skills.

CO5: Analyze data, plot appropriate graphs and reach conclusions from your data analysis.Weightage: 3

Analyzing data and drawing conclusions involve critical thinking and problem-solving skills.

CO6: Work in a group to plan, implement and report on a project/experiment.Weightage: 3

Collaborative work in a group requires critical thinking and problem-solving skills.

PO3: Social Competence

CO6: Work in a group to plan, implement and report on a project/experiment.Weightage: 3

Working in a group enhances social competence.

PO4: Research-related Skills and Scientific Temper

CO2: Design experiments to test a hypothesis and/or determine the value of an unknown quantity.Weightage: 2

Designing experiments is a part of research-related skills.

CO3: Investigate the theoretical background to an experiment.Weightage: 2

Investigating theoretical backgrounds is a part of research-related skills.

PO5: Trans-disciplinary Knowledge

CO7: Experimental Models for easy understanding and explanation Physics concepts.Weightage: 2

Creating experimental models contributes to trans-disciplinary knowledge.

PO9: Self-directed and Life-long Learning

CO2: Design experiments to test a hypothesis and/or determine the value of an unknown quantity.Weightage: 2

Designing experiments is relevant to self-directed and life-long learning.