# T.Y.B.Sc. (Physics)

# Semester-V

# &

# Semester-VI

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)

## T.Y.B. Sc. Sem-V [Physics] 2019 pattern

| Semester | Paper Code | Title of Paper | No of Credits |
|---|---|---|---|
| V | PHY 3501 | Mathematical Methods of Physics-II | 3 |
| | PHY 3502 | Classical Mechanics | 3 |
| | PHY 3503 | Advanced Optics | 3 |
| | PHY 3504 | Solid State Physics | 3 |
| | PHY 3505 | Atomic and Molecular Physics | 3 |
| | PHY 3506 | Elective-I (Select anyone) | 3 |
| | | A] Elements of Material Science | |
| | | B] Renewable Energy Sources | |
| | | C] Physics and Technology of sensors | |
| | PHY 3507 | Practical I | 2 |
| | PHY 3508 | Practical II | 2 |
| | PHY 3509 | Project I | 2 |
| Total | | | 24 |
| VI | PHY 3601 | Classical Electrodynamics | 3 |
| | PHY 3602 | Quantum Mechanics | 3 |
| | PHY 3603 | Statistical Physics | 3 |
| | PHY 3604 | Nuclear Physics | 3 |
| | PHY 3605 | Electronics II/ Advanced Electronics | 3 |
| | PHY 3606 | Elective-II (Select anyone) | 3 |
| | | A] Physics of Nanomaterials | |
| | | B] Solar Energy Conversion Devices | |
| | | C] Sensors and its Applications | |
| | PHY 3607 | Practical III | 2 |
| | PHY 3608 | Practical IV | 2 |
| | PHY 3609 | Project II | 2 |
| Total | | | 24 |

**T. Y. B. Sc. Physics**

**PHY 3501:** Mathematical Methods in Physics-II

Class: **T.Y. B. Sc. (Semester-V)** Paper: **I**

Credit: **3** No. of lectures: **48**

**Learning Objectives:**

CO1: Recall the knowledge of calculus, vectors, vector calculus.

CO2: Learn some mathematical techniques required to understand the physical phenomena at the undergraduate level.

CO3: The students will solve nonhomogeneous differential equations and partial differential equations using simple methods.

CO4: The students are expected to be able to solve simple problems on Matrix.

CO5: Understand the generalized coordinate system and transformation equation between cartesian coordinate and generalized coordinates.

CO6: Explain the Fourier analysis of periodic functions and reconstruct physical problems.

CO7: Apply the various methods for solving differential equations in various physical problems such as in quantum mechanics, which they will learn in future courses in detail.

**Learning Outcomes:**

After successful completion of the course student will be able to

1. Learn some mathematical techniques required to understand the physical phenomena at the undergraduate level.
2. The students will solve nonhomogeneous differential equations and partial differential equations using simple methods.
3. The students are expected to be able to solve simple problems on Matrix.
4. Understand the generalized coordinate system and transformation equation between cartesian coordinate and generalized coordinates.

**1. Curvilinear Co-ordinates (12 L)**

1.1 Introduction to Cartesian

1.2 Spherical polar and Cylindrical co-ordinate systems

1.3 Transformation equations, General Curvilinear co-ordinate system

1.4 Co-ordinate surface, lines, length, and volume elements in curvilinear system

1.5 Orthogonal Curvilinear co-ordinate system,

1.6 Expressions for: a) gradient b) divergence c) Laplacian d) Curl in Cartesian system

**2. Special Theory of Relativity (12 L)**

2.1 Introduction of Special Theory of Relativity and its limitations.

2.2 Newtonian relativity Galilean transformation equation

2.3 Lorentz transformations

2.4 Length contraction, Transformation of velocities

2.5 Variation of mass with velocity, Mass-energy relation

2.6 Problems

**3. Differential Equations (12 L)**

3.1 Partial differential equations

3.2 Degree, order, linearity, and homogeneity (Revision)

3.3 Method of separation of variables, Singular points

3.4 Frobenius method for power series

3.5 Solution of Legendre, Hermite and Bessel differential equation

3.6 Problems

**4. Special Functions (8 L)**

4.1 Generating function for Legendre, Hermite Polynomials

4.2 Recurrence relations, differential equations, and properties of special functions

4.3 Bessel function of first kind and their properties

4.4 Problems

**5. Matrix (4 L)**

5.1 Definition and Types of Matrix

5.2 Matrix representation

5.3 Caley -Hamilton theorem of matrix

5.4 Problems

**References Books:**


1. Mathematical method for Physicists, Arfken and Weber, Academic press New York.
2. Mathematical Physics, Rajput, Pragati Prakashan
3. Mathematical methods in the Physical sciences – Marry L. Boas, John Willy and Sons Publication.
4. Introduction to special relativity, Robert Resnick, Willyeastrn Ltd.
5. Mathematical Physics, B. D. Gupta
6. Mathematical Physics, H. K. Dass

| | 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 | 3 | | | | | | | |
| CO 4 | 2 | | | | | | | | |
| CO 5 | 3 | | | | | | | | |
| CO 6 | 3 | | | | | | | | |
| CO7 | 3 | 3 | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: Recall the knowledge of calculus, vectors, vector calculus.Weightage: 3

Recalling the knowledge of calculus and vectors is crucial for building disciplinary knowledge in physics.

CO2: Learn some mathematical techniques required to understand the physical phenomena at the undergraduate level.Weightage: 3

Learning mathematical techniques directly contributes to building disciplinary knowledge in physics.

CO3: The students will solve nonhomogeneous differential equations and partial differential equations using simple methods.Weightage: 3

Solving differential equations is a fundamental skill for applying mathematical methods in physics.

CO4: The students are expected to be able to solve simple problems on Matrix.Weightage: 2

Solving problems on matrices is relevant to disciplinary knowledge but may not be as direct as other outcomes.

CO5: Understand the generalized coordinate system and transformation equation between cartesian coordinate and generalized coordinates.Weightage: 3

Understanding generalized coordinate systems contributes directly to building disciplinary knowledge in physics.

CO6: Explain the Fourier analysis of periodic functions and reconstruct physical problems.Weightage: 3

Explaining Fourier analysis is essential for understanding mathematical tools used in physics.

CO7: Apply the various methods for solving differential equations in various physical problems such as in quantum mechanics, which they will learn in future courses in detail.Weightage: 3

Applying methods for solving differential equations is crucial for further studies in physics.

**PO2: Critical Thinking and Problem Solving**

CO3: The students will solve nonhomogeneous differential equations and partial differential equations using simple methods.Weightage: 3

Solving differential equations involves critical thinking and problem-solving skills.

CO7: Apply the various methods for solving differential equations in various physical problems such as in quantum mechanics, which they will learn in future courses in detail.Weightage: 3

Applying methods for solving differential equations requires critical thinking skills.

**PO9: Self-directed and Life-long Learning**

CO1: Recall the knowledge of calculus, vectors, vector calculus.Weightage: 2

Recalling knowledge is relevant to self-directed and life-long learning.

**T.Y.B.Sc. Physics**

**PHY 3502: Classical Mechanics**

**Class: T.Y. B. Sc. Sem: V** **Paper II**

**Credit: 3** **No of lectures: 48**

**Learning Objectives:**

1. To understand the newtons laws and applications of newtons laws of motion
2. To understand the central forces, types of central forces and Kepler's laws of planetary Motion.
3. To know the Langrangian approach in classical mechanics.
4. To understand theory of scattering in detail

**Learning Outcomes:**

After completion of the course, the student should be able to:

CO1: The students will introduce about methods of solving equations of motions i.e. the newton's laws of motion, linear momentum, angular momentum, and knowledge about the applications of newton's laws of motion.

CO2: The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.

CO3: This paper enables the students to understand the Langrangian approach in classical mechanics.

CO4: The students should be able to understand theory of scattering, types of scattering and differential cross section.

CO5: Explain necessity of considering constraints.

CO6: Apply different techniques to find solutions of problems in Mechanics.

1. CO7: Determine the constraint equations and decide the generalized co-ordinates to be used.

Syllabus/Topic

**1. Mechanics of System of Particles (12 L)**

1.1 Introduction –newton's laws, Limitations of Newton's Laws

1.2 Applications of Newton's laws of motion: Projectile motion in various medium, Rocket motion, Motion of a charged particle in constant electric, magnetic and electromagnetic field.

1.3 System of particles, Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles (statements only)

1.4 Problems

**2. Motion in Central Force Field (12 L)**

2.1 Types of forces: Forces of Gravitation, Lorentz force, Hooks Force, Frictional Force, Fundamental Forces of Nature Central force, equivalent one body problem

2.2 Motion in central force field

2.3 General features of motion, equation of orbit

2.4 Deduction of Kepler's laws of planetary motion

2.5 Orbits of artificial satellite

2.6 Problems

**3. Scattering Theory of Particles (12 L)**

3.1 Introduction, Elastic, and Inelastic Scattering

3.2 Laboratory and Centre of mass system

3.3 Relation between scattering angles in Lab and CM system

3.4 Inelastic scattering

3.5 Differential cross section, impact parameter and total cross section

3.6 Problems

**4. Langrangian Formulation (12 L)**

1.1 Limitations of Newtonian mechanics

1.2 Types of constraints, degrees of freedom, generalized coordinates, configuration space.

1.3 D'Alemberts principle, Virtual displacement, Principal of virtual work

1.4 Langrage's equation of motion from D'Alemberts principle

1.5 Equation of motion of Simple pendulum, spring mass arrangement, Attwood's machine, particle under gravity by using Langrangian formulation.

1.6 Problems.

**Reference Books:**


1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.
2. Classical mechanics by N.C. Rana and P.S. Joag, Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.
4. Classical Mechanics by Kumar, Gupta, Sharma.
5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.
6. Classical Mechanics by D. S. Mathur.
7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

| | 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 | | | | | | | | |
| CO 4 | 2 | | | | | | | | |
| CO 5 | | | | | | | | | |
| CO 6 | | 3 | | | | | | | |
| CO7 | | 3 | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: The students will introduce methods of solving equations of motions i.e. Newton's laws of motion, linear momentum, angular momentum, and knowledge about the applications of Newton's laws of motion.

Weightage: 3

Introducing methods of solving equations of motion is directly aligned with building disciplinary knowledge in classical mechanics.

CO2: The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.Weightage: 3

Understanding central forces and the deductions of Kepler's laws contribute directly to building disciplinary knowledge in classical mechanics.

CO3: This paper enables the students to understand the Lagrangian approach in classical mechanics.Weightage: 3

Understanding the Lagrangian approach is a fundamental aspect of classical mechanics, contributing directly to disciplinary knowledge.

CO4: The students should be able to understand the theory of scattering, types of scattering, and differential cross-section.Weightage: 2

Understanding the theory of scattering contributes to disciplinary knowledge but may not be as direct as other outcomes.

**PO2: Critical Thinking and Problem Solving**

CO6: Apply different techniques to find solutions to problems in Mechanics.Weightage: 3

Applying different techniques to solve problems requires critical thinking and problem-solving skills.

CO7: Determine the constraint equations and decide the generalized coordinates to be used.Weightage: 3

Determining constraint equations and deciding generalized coordinates involve critical thinking and problem-solving skills.

**PO9: Self-directed and Life-long Learning**

CO1: The students will introduce methods of solving equations of motions i.e. Newton's laws of motion, linear momentum, angular momentum, and knowledge about the applications of Newton's laws of motion.

Weightage: 2

Introducing methods of solving equations of motion is relevant to self-directed and life-long learning.

**T.Y.B.Sc. Physics**

**PHY 3503: Advanced Optics**

**Class: T.Y. B. Sc. Sem: V** **Paper III**

**Credit: 3** No. of lectures: **48**

**Learning Objectives:**

1. Understand the diffraction and polarization processes and applications of them in physical situations.
2. Understand the applications of interference in design and working of interferometers.
3. Understand the resolving power of different optical instruments.

**Learning Outcomes:**

CO1: Acquire the basic concept of wave optics.

CO2: Describe how light can constructively and destructively interfere.

CO3: Explain why a light beam spread out after passing through an aperture

CO4: Summarize the polarization characteristics of electromagnetic wave

CO5: Understand the operation of many modern optical devices that utilize wave optics

CO6: Understand optical phenomenon such polarization, diffraction and interference in terms of the wave model

CO7: Analyze simple example of interference and diffraction.

**1. Interference** **(13 Lecture)**

1.1 Revision to Interference

1.2 Phase change on reflection (Stokes Treatment)

1.3 Interference by parallel sided thin films

1.4 Interference due to reflected light

1.5 Interference due to refracted light

1.6 Interference due to Wedge Shaped thin film

1.7 Principle construction and working of Michelson Interferometer & its applications.

1.8 Problems.

**2. Diffraction** **(13 Lecture)**

2.1 Types of Diffraction: Fresnel's diffraction and Fraunhoffer's diffraction

2.2 Fraunhoffer's diffractions at a double slit

2.3 Plane diffraction grating

2.4 Newton's Rings

2.5 Rayleigh's criterion for resolution

2.6 Resolving power of telescopes and microscopes.

2.7 Dispersive and resolving power of grating.

2.8 Problems.

**3. Polarization (13 Lecture)**

3.1 Introduction

3.2 Brewster's law

3.3 Law of Malus

3.4 Polarization by double refraction.

3.5 Nicol prism.

3.6 Elliptically and circularly polarized light

3.7 Quarter wave plate

3.8 Polarimeter

3.9 Problems

**4. Optical Fibber (09 Lecture)**

1.1 Introduction

1.2 Structure and types of fibres

1.3 Numerical Aperture (Definition only)

1.4 Pulse dispersion in step index fiber

1.5 Optical communication system (Qualitative treatment only)

1.6 Advantages and disadvantages of optical fiber

1.7 Fiber materials, photonic crystal, fiber optic cables

1.8 Problems

**References Books:**


1. Textbook of Optics: N. Subrahmanyam and Brij Lal: S. Chand Publication.
2. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
3. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
4. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, S. Chand publication
5. University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986.Addison-Wesley
6. Fiber optic communication-Joseph C. Palais 4 $^{th}$ edition, Pearson Education

| | 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 | | | | | | | | |
| CO 3 | 3 | | | | | | | | |
| CO 4 | 3 | | | | | | | | |
| CO 5 | 3 | | | | | | | | |
| CO 6 | 3 | | | | | | | | |
| CO7 | 3 | 3 | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: Acquire the basic concept of wave optics. Weightage: 3

Acquiring the basic concept of wave optics directly contributes to building disciplinary knowledge in optics.

CO2: Describe how light can constructively and destructively interfere.Weightage: 3

Describing interference phenomena is a fundamental aspect of wave optics, contributing directly to disciplinary knowledge.

CO3: Explain why a light beam spread out after passing through an aperture.Weightage: 3

Explaining the spreading of light after passing through an aperture is a key concept in wave optics, contributing directly to disciplinary knowledge.

CO4: Summarize the polarization characteristics of electromagnetic waves.Weightage: 3

Summarizing polarization characteristics is directly related to the wave nature of light and contributes to disciplinary knowledge.

CO5: Understand the operation of many modern optical devices that utilize wave optics.Weightage: 3

Understanding the operation of optical devices using wave optics is essential for building disciplinary knowledge.

CO6: Understand optical phenomena such as polarization, diffraction, and interference in terms of the wave model.Weightage: 3

Understanding optical phenomena in terms of the wave model is a fundamental aspect of wave optics, contributing directly to disciplinary knowledge.

CO7: Analyze simple examples of interference and diffraction.Weightage: 3

Analyzing interference and diffraction examples involves applying wave optics concepts, contributing directly to disciplinary knowledge.

**PO2: Critical Thinking and Problem Solving**

CO7: Analyze simple examples of interference and diffraction. Weightage: 3

Analyzing examples of interference and diffraction requires critical thinking and problem-solving skills.

**T. Y. B. Sc. Physics**

**PHY3504: Solid State Physics**

**Class: T.Y. B. Sc. Sem V** **Paper IV**

**Credit: 3** **No of lectures: 48**

**Learning objectives:**

1. Understand the basics of crystallography.
2. Understand electrical properties of metals and Band theory of solids.
3. Understand the basics of magnetism.
4. To study the basics of Solid-State Physics and Semiconductor Physics

**Learning Outcomes:**

**CO1: List seven crystal systems.**
**CO2: Explain free electron theory and band theory.**
**CO3: Calculate lattice parameter from given XRD pattern.**
**CO4: Identify the structure of materials.**
**CO5: Evaluate the density of state equation in 3D.**
**CO6: Specify the importance of magnetic materials and classification based on susceptibility value.**
**CO7: classification of hard and soft magnet based on Hysteresis curve of magnetic sample.**

**1. Free Electron Theory of Solids (15 L)**

1.1 Classical free electron theory of metals
1.2 Drawbacks of classical theory
1.3 Energy levels and Density of orbital in 1D and 3D
1.4 Bloch theorem (only statement and properties)
1.5 Nearly free electron model, Fermi energy, Fermi level
1.6 Hall Effect, Origin of energy gap
1.7 Energy bands in Solids,
1.8 Effective mass of electron (with derivation),
1.9 Distinction between metal,
1.10 Semiconductor and insulator
1.11 Problems

**2. Crystalline Solids (16 L)**

2.1 Introduction: Classification of solids (crystalline, amorphous & polycrystalline),
2.2 Lattice, Basis, Translational vectors
2.3 Primitive unit cell, Symmetry operations
2.4 Different types of lattices 2D and 3D (Bravais lattices)
2.5 Miller indices inter planer distances.
2.6 Number of atoms per unit cell,
2.7 Co-ordination number,
2.8 Atomic radius and packing fraction for SC, BCC and FCC structures
2.9 Study of NaCl, diamond, CsCl, ZnS and HCP crystals,
2.10 Concept of reciprocal lattice and its properties with proof.

2.11 X-ray diffraction: Crystal as a grating,
2.12 Bragg's law and Bragg's Diffraction condition in direct and reciprocal lattice
2.13 Ewald's construction,
2.14 Experimental methods of X-ray diffraction: Laue method, Rotating Crystal method, Powder (Debye Scherer) method
2.15 Problems

**3. Semiconductor (6 L)**

3.1 Intrinsic semiconductor
3.2 Conductivity
3.3 Carrier concentrations
3.4 Donor and Acceptor impurities
3.5 Extrinsic Semiconductor
3.6 Charge densities in a Semiconductor
3.7 Diffusion,
3.8 Carrier lifetime, the p-n junction as a diode
3.9 Volt-Ampere characteristics
3.10 Problems

**4. Magnetism (11 L)**

4.1 Diamagnetism,
4.2 Langevin theory of Diamagnetism
4.3 Application of diamagnetic material
4.4 Superconductor, Occurrence of Superconductivity,
4.5 Critical magnetic field and Meissner effect
4.6 Paramagnetism, Langevin theory of Para magnetism
4.7 ferromagnetism, ferromagnetic domains
4.8 Hysteresis, Curie temperature
4.9 Anti-ferromagnetism, Neel temperature,
4.10 Problems

**Reference Books:**


1. Solid State Physics-S.O.Pillai, 3rd Edition, New Age International (P) Ltd, Publisher, (1999).
2. Solid State Physics – Kakani and Hemrajani, S. Chand Publication.
3. Solid State Physics BySaxena, Gupta and Saxena, PragatiPrakation.
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics-A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Problems in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
8. Solid State Physics-Palanyswamy.
9. Solid State Physics- David, Snoke, Pearson Publication.
10. Semiconductor Physics and Devices: Donald Neamen (3rd Ed.) TMH.
11. S. M. Sze, 2nd ed, Semiconductor Devices: Physics and Technology. John Wiley & Sons.

| | 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 | | | | | | | | |
| CO 3 | | 3 | | | | | | | |
| CO 4 | 3 | | | | | | | | |
| CO 5 | 3 | 3 | | | | | | | |
| CO 6 | | | | | | | | | |
| CO7 | | 3 | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: List seven crystal systems.Weightage: 3

Listing the crystal systems directly contributes to building disciplinary knowledge in material science.

CO2: Explain free electron theory and band theory.Weightage: 3

Explaining the electron and band theories is essential for building a strong foundation in material science.

CO4: Identify the structure of materials.Weightage: 3

Identifying the structure of materials is a crucial aspect of disciplinary knowledge in material science.

CO5: Evaluate the density of state equation in 3D.Weightage: 3

Evaluating the density of state equation contributes directly to disciplinary knowledge in material science.

**PO2: Critical Thinking and Problem Solving**

CO3: Calculate lattice parameter from a given XRD pattern.Weightage: 3

Calculating lattice parameters involves critical thinking and problem-solving skills in the context of material science.

CO5: Evaluate the density of state equation in 3D. Weightage: 3

Evaluating the density of state equation requires critical thinking skills and problem-solving abilities.

CO7: Classify hard and soft magnets based on the Hysteresis curve of a magnetic sample. Weightage: 3

Classifying magnets based on hysteresis curves involves critical thinking and problem-solving skills.

**T. Y. B. Sc. Physics**

**PHY 3505: Atomic and Molecular Physics**

Class: **T.Y. B. Sc. (Semester- V)** Paper**: V**

Credit: **3** No. of lectures: **48**

**Learning Objective:**

After successful completion of the course students will be able to

1 The subject of Atomic and Molecular Physics has reached a significant advancement in high–precision experimental measurement techniques.

2 This area covers a wide spectrum ranging from conventional to new emerging multidisciplinary areas like molecular physics, optical science, especially spectroscopy.

3 In the present syllabus sequence of articles in each chapter enables the student to understand the gradual development of the subject.

**Learning Outcomes:**

Upon successful completion of this course, the student will understand.

CO1: The application of quantum mechanics in atomic physics

CO2: The importance of electron spin, symmetric and antisymmetric wave functions, and vector atom model

CO3: Effect of magnetic field on atoms and its application

CO4: Learn Molecular physics and its applications.

CO5: This course will be useful to get an insight into spectroscopy.

**CO6: Relate atomic theory to analyse spectra.**

**CO7: Evaluate spectroscopic data to identify elements using atomic spectra.**

**1. Atomic structure (8 L)**

1.1 Rutherford model of atom

1.2 Electron orbits

1.3 Bohr atom and Sommer field atomic Model

1.4 Energy levels and spectra (1 to 4 Revision)

1.5 Vector atom model (Concepts of space and quantization and electron spin)

1.6 Atomic excitation and atomic spectra,

1.7 Problems Ref 1 ch4

**2. One Valence Electron System (8 L)**

2.1 Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states.

2.2 Energy levels of Na atom, selection rules, spectra of sodium atom.

**3. Two valence electron systems (8 L)**

3.1 Spectral terms of two electron atoms, LS and JJ coupling schemes.

3.2 Lande's Interval rule, spectra of Helium atom

3.3 Problems, Ref 1: ch7, Ref. 2: ch8 and ch12

**4. Zeeman Effect (8 L)**

4.1 Early discoveries and developments

4.2 Experimental arrangement

4.3 Normal and anomalous Zeeman Effect

4.4 Stark effect (Qualitative discussion)

4.5 Problems Ref 2 ch10

**5. X ray spectroscopy (8 L)**

5.1 Nature of X rays

5.2 Discrete and continuous Xray spectra, Daune and Hunt's Rule

5.3 Xray emission spectra

5.4 Mosley's law and its applications

5.5 Auger effect

5.6 Problems Ref 2 ch16

6. **Raman spectroscopy (8 L)**

6.1 Classical theory of Raman Effect. Molecular polarizability

6.2 Quantum theory of Raman Effect

6.3 Experimental set up for Raman Effect

6.4 Applications of Raman spectroscopy Ref 3 ch4

**Reference Books:**


1. Concepts of Modern Physics 4 $^{th}$ edition Arthur Baiser (McGraw Hill International ed)
2. Introduction to Atomic spectra White. H. E (McGraw Hill International edition)
3. Fundamentals of Molecular spectroscopy, C.N. Banwell and E.M Mc Cash (McGraw Hill International edition)
4. Modern Physics, J.B. Rajam

| | 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 | | | | | | | | |
| CO 3 | | 3 | | | | | | | |
| CO 4 | 3 | | | | | | | | |
| CO 5 | | 3 | | | | | | | |
| CO 6 | 2 | | | | | | | | |
| CO7 | 2 | | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: The application of quantum mechanics in atomic physics.Weightage: 3

Understanding the application of quantum mechanics in atomic physics is a direct contribution to disciplinary knowledge in physics.

CO2: The importance of electron spin, symmetric and antisymmetric wave functions, and vector atom model.Weightage: 3

Grasping the importance of electron spin and wave functions directly contributes to disciplinary knowledge in atomic physics.

CO4: Learn Molecular physics and its applications.Weightage: 3

Learning molecular physics and its applications expands disciplinary knowledge in physics to include molecular aspects.

CO6: Relate atomic theory to analyze spectra.Weightage: 2

Relating atomic theory to analyze spectra contributes to disciplinary knowledge but may not be as direct as other outcomes.

CO7: Evaluate spectroscopic data to identify elements using atomic spectra.Weightage: 2

Evaluating spectroscopic data contributes to disciplinary knowledge but may not be as direct as other outcomes.

**PO2: Critical Thinking and Problem Solving**

CO3: Effect of magnetic field on atoms and its application.Weightage: 3

Understanding the effect of a magnetic field on atoms and its application involves critical thinking and problem-solving skills.

CO5: This course will be useful to get insight into spectroscopy.Weightage: 3

Gaining insight into spectroscopy requires critical thinking skills and problem-solving abilities.

**T. Y. B. Sc. Physics**

**PHY 3506: A] Elements of Material Science**

**Class: T.Y. B. Sc. Sem V (Elective)** **Paper VI**

**Credit: 3** **No of lectures: 48**

**Learning objectives:**

1. Students will demonstrate an understanding of core graduate-level theoretical knowledge in materials science.
2. An ability to use modern techniques, skills, and engineering tools appropriate to materials science.
3. An integrated understanding of structure, properties, processing, and performance of materials systems.

**Learning Outcomes:**

CO1: Describe types of materials, their properties and identify types of defects.
CO2: Explain functional properties of ceramic bulk materials and different nanomaterials.
CO3: Select materials for design and construction. Test materials using different characterization methods with the fundamental principles underlying and connecting the structure and properties
CO4: Students are able to apply knowledge of advanced science and engineering principles to materials systems.
CO5: Students will demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.
CO6: An ability to apply knowledge of mathematics, science, and engineering to materials issues.
CO7: An ability to design and conduct experiments and critically analyse and interpret data.

**1. Introduction to Materials Science (12 L)**

1.1 Historical perspectives of materials science

1.2 Classification of materials

1.3 Smart materials

1.4 Nano structured Materials

1.5 Organic Materials: Chemistry of polymer molecule, Molecular weight, Molecular structure

1.6 Material Properties: Mechanical, Electrical, Thermal and Magnetic

**2. Defects in Solids (12L)**

2.1 Types of materials: Conductors, Semiconductors, and Insulators

2.2 Defects in solids: Point, Line, Surface, and Volume

2.3 Solid solutions and their applications, Rules of solid solubility

2.4 Hume-Rothery's Rules of formation of solid solution

2.5 Diffusion in Solids: Introduction, Mechanisms of diffusion, Fick's laws of diffusion, Solution to Fick's second law, Few applications of diffusion process,

2.6 Kirkendall effect with example

**3. Phase Diagram (12L)**

3.1 Basic terms: System, Surrounding, Component, Coordinates, Phase, Equilibrium.

3.2 Phase Diagram: definition, importance, and objective

3.3 Lever rule, Gibb's phase rule

3.4 Phase diagram of a) Sugar water b) NaCl water

3.5 Types of phase diagrams with construction

3.6 Type-I: Lens type CuNi phase diagram

3.7 Type-II: Only introduction

3.8 Type-III: Eutectic type Pb-Sn phase diagram

3.9 Some applications of phase diagrams

**4. Ceramic and Ferrite Materials (12L)**

4.1 Ceramic Phases, Classification of ceramic materials, Ceramic crystals (AX)

4.2 Mechanical behavior of ceramics

4.3 Electric properties of ceramics: dielectrics, semiconductors, piezoelectric

4.4 Magnetic Properties of ceramics: Magnetic Ceramics, hard and soft ferrites.

**Reference books:**


1. Elements of materials science and Engineering: H. Van Vlach
2. Materials Science and Engineering: V. Raghavan
3. Material Science: S. L. Kakani and Amit Kakani
4. Solid State Physics: A. J. Dekker
5. Materials Science & Engineering: An Introduction (6th Edition): William D. Callister


**List of experiments:**

1. Determination of the yield point and the breaking point of an elastic material
2. To determine magnetic susceptibility of $FeCl_3$
3. To determine the dipole moment of a given liquid
4. To determine the specific heat of graphite
5. Ionic conductivity of NaCl
6. Synthesis of metal oxide ceramic powder by solid state route
7. Plotting Pb-Sn phase diagram

| | 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 | | | | | | | | |
| CO 3 | | 3 | | | | | | | |
| CO 4 | 3 | | | | | | | | |
| CO 5 | | | | 2 | | | | | |
| CO 6 | | 2 | | | | | | | |
| CO7 | | 3 | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: Describe types of materials, their properties and identify types of defects.Weightage: 3

Describing types of materials, their properties, and identifying defects directly contributes to building disciplinary knowledge in materials science.

CO2: Explain functional properties of ceramic bulk materials and different nanomaterials.Weightage: 3

Explaining functional properties of materials, especially ceramics and nanomaterials, is essential for disciplinary knowledge in materials science.

CO4: Students are able to apply knowledge of advanced science and engineering principles to materials systems.Weightage: 3

Applying knowledge of advanced science and engineering principles to materials systems is a direct application of disciplinary knowledge.

**PO2: Critical Thinking and Problem Solving**

CO3: Select materials for design and construction. Test materials using different characterization methods with the fundamental principles underlying and connecting the structure and properties.Weightage: 3

Selecting materials for design and construction and testing them using different characterization methods requires critical thinking and problem-solving skills.

CO6: An ability to apply knowledge of mathematics, science, and engineering to materials issues.Weightage: 2

Applying knowledge to materials issues contributes to critical thinking but may not be as direct as other outcomes.

CO7: An ability to design and conduct experiments and critically analyse and interpret data.Weightage: 3

Designing and conducting experiments and critically analyzing data require critical thinking skills and problem-solving abilities.

**PO4: Research-related Skills and Scientific Temper**

CO5: Students will demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.Weightage: 2

Demonstrating proficiency in data acquisition and analysis in a laboratory setting reflects research-related skills and scientific temper, but the relationship is not as strong as some other outcomes.

**T. Y. B. Sc. Physics**

**PHY 3506: B]** Renewable Energy Sources

Class: **T.Y. B. Sc. Semester-V** (Elective) **Paper: VI**

Credit: **3** No. of lectures: **48**

**Learning Objectives:**

1. To create awareness of environment quality
2. To develop skills in handling equipment's related to solar energy, biogas etc
3. To create manpower in renewable energy
4. Understand the various forms of conventional energy resources.
5. Learn the present energy scenario and the need for energy conservation.
6. Explain the concept of various forms of renewable energy.

**Learning Outcomes:**

CO1: Understand the need of renewable energy resources and latest developments for environmental balance.

CO2: Use of solar energy in the energy production with different applications like - heating, cooling, desalination, power generation, drying, cooking etc for pollution free energy consumption

CO3: Understand concept and use of Wind Energy and the various components used in energy generation.

CO4: Understand the concept of Biomass energy resources and their classification along with marketing of waste for agriculture

CO5: Address various issues of environmental imbalance using promotion of Renewable energy sources than conventional energy resources.

CO6: Illustrate the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc for domestic and rural regions.

CO7: Awareness campaign for the promotion of Solar Energy, Wind energy, Biomass energy resources and biogas Plants- applications for environment sustenance.

1. **Solar Energy** **(12 L)**

1.1 Energy resources and forms of energy, Energy from sun

1.2 Solar constant, solar thermal collectors, solar pond, Solar boiler

1.3 Principle of Photovoltaic cell

1.4 IV characteristics of solar cell

1.5 Large solar PV system,

1.6 Solar PV power system for space station

1.7 Assembly and maintenance

1.8 Solar charging, solar air heating and cooling system, Thermal pad

1.9 Solar water heaters, solar cookers, solar drying

1.10 Solar photovoltaic system

1.11 Solar energy pumps.

**2. Energy Storage System (10 L)**

2.1 **Battery:** Introduction

2.2 Battery Energy Storage Systems

2.3 Lead Acid Battery Cells,

2.4 Nickel-Cadmium Battery

2.5 Li-ion Battery,

2.6 Advanced Batteries.

2.7 **Fuel Cell:** Introduction,

2.8 Advantages of Fuel cell power sources,

2.9 Principle and operation of Fuel Cell

2.10 Classification and Types of Fuel Cells

**3. Biomass energy (10 L)**

3.1 Introduction

3.2 Biomass for urban waste and rural waste to biogas energy

3.3 Agricultural waste and agricultural energy crops, fruit farms

3.4 Anaerobic fermentation process in biogas plants

3.5 Principal of marine bioenergy resources

3.6 Bio-hydrogen production

3.7 Isolation of methane from Biogas & packing and its utilization.

3.8 Introduction to gasifiers.

**4. Wind Energy (10 L)**

4.1 Introduction, Basic concept, and component of wind energy conversion

4.2 Types of wind machines

4.3 Application of wind machine

4.4 Hybrid wind energy systems wind + diesel power

4.5 Wind + conventional grid

4.6 Wind + Photovoltaic system etc.

4.7 Wind to electrical energy conversion alternatives

4.8 Wind map of India,

4.9 Wind electrical energy stations in India.

**5. Energy Audit (06 L)**

5.1 Introduction

5.2 Types of energy audits

5.3 Walk through energy audit

5.4 Case Study, Audit report

5.5 Intermediate & Compressive Energy audit

5.6 Procedure of energy auditing.

**Case Study**: 1. Solar PV Panel

2. Biogas production from kitchen waste

**References:**


1 Biomass Renegerable Energy – D.O.hall and R.P. Overeed ( John Wiley and Sons, New york, 1987)

2 Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss (Pergamon Press Ltd. 1982)

3 Thermo chemical processing of Biomass, Bridgurater A V.

4 Biomass as Fuel – L.P.White (Academic press1981)

5 Biomass Gasification Principles and Technology, Energy technology review No. 67, T.B. Read (Noyes Data Corp., 1981)


**List of experiments:**

1. Study of solar cell characteristics
2. PV- IV characteristics of solar cell
3. Performance evaluation of box type Solar Cooker
4. Recording the amount of sunlight receives throughout a day using Sunshine recorder.
5. Utilizing the latent heat absorbed by the condensing water steam using Solar Still.
6. Measure the solar radiation flux density using Pyrometer.

| | 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 | | | | | | | | |
| CO 3 | 3 | | | | | | | | |
| CO 4 | 3 | | | | | | | | |
| CO 5 | 3 | | | | | | | | |
| CO 6 | 3 | | | | | | | | |
| CO7 | 3 | | | | | | | | |

Justification

PO1: Disciplinary Knowledge

CO1: Understand the need for renewable energy resources and the latest developments for environmental balance.Weightage: 3

Understanding the need for renewable energy resources and staying updated on the latest developments directly contributes to building disciplinary knowledge in renewable energy for maintaining environmental balance.

CO2: Use of solar energy in the energy production with different applications like - heating, cooling, desalination, power generation, drying, cooking, etc., for pollution-free energy consumption.Weightage: 3

Applying the knowledge of using solar energy in various applications for pollution-free energy consumption aligns directly with disciplinary knowledge in renewable energy.

CO3: Understand the concept and use of Wind Energy and the various components used in energy generation.Weightage: 3

Understanding the concept and components of wind energy contributes directly to building disciplinary knowledge in renewable energy.

CO4: Understand the concept of Biomass energy resources and their classification along with marketing of waste for agriculture.Weightage: 3

Understanding the concept and classification of biomass energy resources, including waste marketing for agriculture, aligns directly with disciplinary knowledge in renewable energy.

CO5: Address various issues of environmental imbalance using promotion of Renewable energy sources than conventional energy resources.Weightage: 3

Addressing environmental imbalances through the promotion of renewable energy sources reflects an application of disciplinary knowledge to solve real-world issues.

CO6: Illustrate the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking, etc., for domestic and rural regions.Weightage: 3

Illustrating the use of solar energy in various applications for domestic and rural regions directly contributes to disciplinary knowledge in renewable energy.

CO7: Awareness campaign for the promotion of Solar Energy, Wind energy, Biomass energy resources and biogas Plants- applications for environment sustenance.Weightage: 3

Conducting an awareness campaign for the promotion of renewable energy resources aligns directly with disciplinary knowledge and promotes the understanding of their applications for environmental sustenance.

**T.Y.B.Sc. Physics**

**PHY 3506: C] Physics and Technology of Sensor**

**Class: T.Y. B. Sc. Sem: V (Elective) Paper VI**

**Credit: 3 No of lectures: 48**

**Learning objectives:**

1. Select the right sensor for a given application.
2. Understand physics behind sensor fabrication.
3. Simulate, synthesize, and layout a complete sensor or sensor system, a device or microsystem.

**Learning Outcome:**

At the end of this course, students will be able to:

CO1: Understand the concept of sensors and its characteristics.
CO2: Understand the practical approach in design of technology based on different sensors.
CO3: Learn various sensor materials and technology used in designing sensors.
CO4: Getting information about various sensing parameter conditions for instrumentation.
CO5: Design experiments or demo using sensors for application.
CO6: Use of knowledge in electronics based project work for demonstration.
CO7: Application of logic and electronics for new ideas and societal demands.

**Topics**

**1. Sensors Classification and Characteristics (8 L)**

- 1.1 Fundamentals and Characteristics Sensors
- 1.2 Signals and Systems
- 1.3 Sensor Classification
- 1.4 General specifications of sensors and transducers
- 1.5 Sensor Characteristics
- 1.6 Selection Criteria for sensors and transducers
- 1.7 Problems

**2. Physical Principles of Sensing (12 L)**

- 2.1 Resistive Sensors
- 2.2 Pressure Inductive sensor
- 2.3 Magnetic flow meter
- 2.4 Piezo electric sensors
- 2.5 Photo electric and Photo voltaic
- 2.6 Temperature and Thermal Properties of Material
- 2.7 Heat Transfer
- 2.8 Problems

**3. Acceleration and Pressure Sensors (12 L)**

- 3.1 Accelerometer characteristics
- 3.2 Capacitive accelerometers
- 3.3 Piezo-resistive accelerometers

3.4 Piezoelectric accelerometers
3.5 Thermal accelerometers heated plate accelerometer, heated gas accelerometer.
3.6 Gyroscopes, rotor gyroscope, optical gyroscopes, piezoelectric cables.
3.7 Strain Gauges, piezoelectric force sensors
3.8 Pressure gauges: mercury pressure sensor, bellows, membranes and thin plates, optoelectronic sensors.

**4. Flow, Acoustic and Humidity Sensors (12 L)**

4.1 Basics of flow dynamics
4.2 Pressure gradient technique
4.3 Thermal transport sensors
4.4 Ultrasonic sensors
4.5 Electromagnetic Sensors
4.6 Acoustic sensors: resistive microphones, condenser microphones
4.7 Fiber optic microphone Piezoelectric microphones, electric microphones
4.8 Solid state acoustic detectors
4.9 Humidity and moisture sensors, concept of humidity
4.10 Capacitive sensors,
4.11 Electrical conductivity sensors – thermal conductivity sensor.

**5. Sensor Materials and Technologies (4 L)**

1.1 Sensor Materials
1.2 Surface Processing
1.3 Technology of Sensors

**Reference Books:**


1. D. Patranabis, Sensors and Transducers, 2nd ed., Prentice-Hall of India (2005).
2. Jacob Fraden, Handbook of Modern Sensors: Physics, Design, and Application, 3rd edition, Springer (2004).
3. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer
4. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).
5. Sensors and Transducers- Dr. A. D. Shaligram


**List of Experiments:**

1. Characteristics of Piezo-electric Transducer
2. Characteristics of Thermocouple
3. Operation of digital humidity sensor
4. Study of resistive soil moisture sensor
5. Study of digital response an IR motion sensor

| | 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 | | | | | | | | |
| CO 3 | 3 | | | | | | | | |
| CO 4 | | 3 | | | | | | | |
| CO 5 | | | | 3 | | | | | |
| CO 6 | | | | | | 3 | | | |
| CO7 | | | | | | | 3 | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: Understand the concept of sensors and its characteristics.Weightage: 3

Understanding the concept and characteristics of sensors directly contributes to disciplinary knowledge in sensor technology, a key aspect of the program.

CO2: Understand the practical approach in the design of technology based on different sensors.Weightage: 3

Grasping the practical approach in designing technology based on sensors aligns directly with disciplinary knowledge and application of sensor technology.

CO3: Learn various sensor materials and technology used in designing sensors.Weightage: 3

Learning about various sensor materials and technologies used in designing sensors contributes significantly to disciplinary knowledge in the field of sensors.

**PO2: Critical Thinking and Problem Solving**

CO4: Getting information about various sensing parameter conditions for instrumentation.Weightage: 3

Justification: Gathering information about sensing parameter conditions requires critical thinking and problem-solving skills, directly addressing PO2.

**PO4: Research-related Skills and Scientific Temper**

CO5: Design experiments or demo using sensors for application.Weightage: 3

Designing experiments or demonstrations using sensors involves research-related skills and fosters a scientific temper, aligning with PO4.

**PO6: Personal and Professional Competence**

CO6: Use of knowledge in electronics-based project work for demonstration.Weightage: 3

Utilizing knowledge in electronics-based project work enhances personal and professional competence, connecting with PO6.

**PO7: Effective Citizenship and Ethics**

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 3

Applying logic and electronics for new ideas and societal demands demonstrates effective citizenship and ethical considerations, aligning with PO7

**T.Y.B.Sc. Physics**

**PHY 3507: Practical -I**

**Class: T.Y. B. Sc. Sem: V** **Paper VII**

**Credit: 2** **No of Practical: 10**

**Learning Outcome:**

At the end of this course, students will be able to:

CO1: Acquire technical and manipulative skills in using laboratory equipment, tools, and materials.
CO2: Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.
CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.
CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.
CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.
CO6: Use of experiment to analyse various experimental parameters concerning their application .
CO7: Experimental Models for easy understanding and explanation Physics concepts.

Student has to perform any EIGHT experiments from the list given below plus any TWO experiments from the optional subject. (TOTAL 10 experiments)

1. Moment of Inertia by Bifilar suspension
2. Young's modulus by Koeing method
3. Katter's pendulum
4. Y by vibration of wooden scale
5. Determination of Resolving Power of grating
6. Determination of wavelength of light by Michelson's interferometer
7. Young's modulus by Newton's rings
8. Determination of wavelength by Constant deviation spectrometer
9. Determination of refractive index of liquid using hollow prism.
10. Llyod's mirror
11. Study of diffraction using a reflection grating (metal ruler)
12. Determination of wavelength of given source by Newton's rings.

| | 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 | | | | | | | |
| CO 3 | | | | 2 | | | 3 | 2 | |
| CO 4 | 3 | 3 | | 2 | | | | | |
| CO 5 | | | 3 | | 2 | | | | |
| CO 6 | | | | | | 2 | | | 2 |
| CO7 | | | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: Acquire technical and manipulative skills in using laboratory equipment, tools, and materials.Weightage: 3

Acquiring technical skills in a laboratory setting is fundamental to building disciplinary knowledge.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.Weightage: 3

Visualizing and experiencing abstract concepts directly contribute to disciplinary knowledge.

**PO2: Critical Thinking and Problem Solving**

CO2: Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.Weightage: 3

Critical thinking is essential in collecting and interpreting data in a laboratory setting.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.Weightage: 3

Visualizing abstract concepts contributes to critical thinking skills.

**PO3: Social Competence**

CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.Weightage: 3

Collaborative learning and teamwork in a laboratory setting directly contribute to social competence.

**PO4: Research-related Skills and Scientific Temper**

CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.

Weightage: 2

Understanding laboratory procedures is part of research-related skills, but the link may not be as direct.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.Weightage: 2

Visualizing abstract concepts can be part of developing a scientific temper, but the link may not be as strong.

**PO5: Trans-disciplinary Knowledge**

CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

Weightage: 2

Collaborative learning and teamwork contribute to trans-disciplinary knowledge, but the link may not be as strong.

**PO6: Personal and Professional Competence**

CO6: Use of experiment to analyze various experimental parameters concerning their application.Weightage: 2

Analyzing experimental parameters can contribute to personal and professional competence, but the link may not be as direct.

**PO7: Effective Citizenship and Ethics**

CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.Weightage: 3

Understanding laboratory procedures, especially safety and scientific methods, directly contributes to effective citizenship.

**PO8: Environment and Sustainability**

CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.

Weightage: 2

Adhering to laboratory safety procedures can indirectly contribute to considerations of environment and sustainability.

**PO9: Self-directed and Life-long Learning**

CO6: Use of experiment to analyze various experimental parameters concerning their application.Weightage: 2

Analyzing experimental parameters is relevant to self-directed and life-long learning, though the link may not be as direct.

**T.Y.B.Sc. Physics**

**PHY 3508: Practical -II**

**Class: T.Y. B. Sc. Sem: V** **Paper VIII**

**Credit: 2** **No of Practical: 10**

**Learning Outcome:**

At the end of this course, students will be able to:

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.

Student has to perform any EIGHT experiments from the list given below plus any TWO experiments from the optional subject. (TOTAL 10 experiments)

1. Energy gap of a semiconductor
2. Resistivity by Four probe method
3. Platinum resistance thermometer
4. Core losses in transformers
5. Hall Effect
6. Electromagnetic pendulum
7. Study of damped oscillations of physical pendulum and finding log decrement.
8. Verification of Stefan's law by torch bulb filament
9. Thermal conductivity by Forbes Method.
10. Thermal conductivity of rubber tubing
11. Determination of Rydberg's constant
12. Dielectric constant of a non-polar liquid

| | 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.

**T.Y.B.Sc. Physics**

**PHY 3509: Project -I**

**Class: T.Y. B. Sc.  Sem: V  Paper IX**

**Credit: 2**

**Learning Outcome:**

At the end of this course, students will be able to:

CO1: Understanding of concept research in various field applications.
CO2: Perform various experimentations through suitable method for research
CO3: Able to characterize and analyse prepared samples as per applications point of view.
CO4: This will initiate innovations and thinking ability of students towards solution of societal problems.
CO5: Analyze data, plot appropriate graphs and reach conclusions from your data analysis.
CO6: Work individual or in a group to plan, implement and report on a project.
CO7: Experimental prototype models for easy understanding and explanation project purpose.

The student will have to perform the project course for both semesters V and VI. The continuous evaluation of the project will be done during each semester. Student must complete 50% project work in semester V and evaluation will be done at the end of semester and credit will be assigned to the students according to their performance.

| | 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 | | | | | | | |
| CO 3 | | | | 3 | | | | | |
| CO 4 | | | | | | | | | |
| CO 5 | | | | | | | | | |
| CO 6 | | | | | | 3 | | | |
| CO7 | | | | | | | | | |

Justification

**PO1: Disciplinary Knowledge**

CO1: Understanding of concept research in various field applications.Weightage: 3

Understanding the concept of research in various field applications directly contributes to disciplinary knowledge, aligning with PO1.

**PO2: Critical Thinking and Problem Solving**

CO2: Perform various experimentations through a suitable method for research.

Weightage: 3

Performing various experimentations with suitable methods for research requires critical thinking and problem-solving skills, addressing PO2.

**PO4: Research-related Skills and Scientific Temper**

CO3: Able to characterize and analyze prepared samples as per applications point of view.Weightage: 3

The ability to characterize and analyze prepared samples enhances research-related skills and scientific temper, aligning with PO4.

**PO6: Personal and Professional Competence**

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

Working individually or in a group to plan, implement, and report on a project enhances personal and professional competence, connecting with PO6.