Faculty of Science

Department of Physics

2022 Pattern

Syllabus

For

T.Y.B.Sc.(Sem-VI)

in Physics

For Academic Year 2024-2025

Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS,
SCIENCE AND COMMERCE, BARAMATI

(Empowered Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

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-VI (2022 Pattern) [Physics]

For academic Year 2024-2025

Semester	Paper Code	Title of Paper	No of Credits
VI	USPH 361	Classical Electrodynamics	3
	USPH 362	Quantum Mechanics	3
	USPH 363	Thermodynamics and Statistical Physics	3
	USPH 364	Nuclear Physics	3
	USPH 365 (A)	Electronics II	3
	USPH 365 (B)	Advanced Electronics	
	USPH 366 (A)	Solar Energy Conversion Devices	3
	USPH 366 (B)	Sensors and its Applications	
	USPH 366 (C)	Physics of Nanomaterials	
	USPH 367	Practical IV	2
	USPH 368	Practical V	2
	USPH 369	Project	2
	Total		**24**

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Theory
Course Code	: USPH 361
Course Title	: Classical Electrodynamics
No. of Credits	: 03
No. of Teaching Hours	: 45

Course Objectives:

1. To apprise the students regarding the concepts of electrodynamics and Maxwell equations and use them various situations earn
2. Derive mathematical equations to expalin some of the electromagnetic phenomena

Course Outcomes

Learning Outcomes: On successful completion of this course the students will be able to do the following:

CO1: Understanding of electric fields and potentials: Students will be able to explain electric fields, electric potentials, and the behaviour of charges in electrostatic equilibrium using concepts like Coulomb's law and Gauss's law etc

CO2: Able to solve electrostatic problems: Students will develop the ability to solve complex electrostatic problems involving conductors, insulators, and dielectrics, including the use of boundary conditions.

CO3: Application of magnetostatics: Students will understand and apply the principles of magnetostatics, including Ampère's law and the Biot-Savart law, to analyze magnetic fields produced by steady currents.

CO4: Understanding wave propagation: Students will be able to derive the wave equation from Maxwell's equations and understand the propagation of electromagnetic waves in free space and in various media.

CO5: Reflection, Refraction, and Dispersion: Students will understand and mathematically describe the phenomena of reflection, refraction, and dispersion of electromagnetic waves at interfaces between different media.

CO6: Understanding Maxwell's Equations: Students will learn to derive and interpret Maxwell's equations in both integral and differential forms, and understand their significance in unifying electric and magnetic fields.

CO7: Application of Maxwell's Equations to Physical Problems: Students will apply Maxwell's equations to solve problems in electromagnetism, including the propagation of electromagnetic waves, and the analysis of time-varying electric and magnetic fields.

Topics and Learning Points

Unit 1. Electrostatics **(16 L)**

1.1. Coulomb's law, Gauss law, Electric field, Electrostatic Potential

1.2. Potential energy of system of charges.

1.3. Statement of Poisson's equation, Boundary Value problems in electrostatics- Solution of Laplace equation in Cartesian system,

1.4. Method of image charges: Point charge near an infinite grounded conducting Plane, Point charge near grounded conducting sphere.

1.5. Polarization **P**, Electric displacement **D**, Electric susceptibility, and dielectric Constant, bound volume and surface charge densities.

1.6. Electric field at an exterior and interior point of dielectric.

1.7 Problems.

Unit 2.Magnetostatics **(14 L)**

2.1. Magnetic induction, magnetic flux, magnetic field and static magnetic fields

2.2. Magnetic induction due to straight current carrying conductor, Energy density in magnetic field, magnetization of matter. Relationship between **B, H** and **M.**

2.3 Biot-Savart's law, Ampere's law for force between two current carrying loops, Ampere's circuital law,

2.4 Equation of continuity, Magnetic vector potential **A**.

2.5. Magnetic susceptibility and permeability, Hysteresis loss, B-H curve.

2.6 Problems.

Unit 3. Electrodynamics **(15 L)**

3.1. Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law

3.2. Maxwell's equations (Differential and Integral form) and their physical Significance

3.3 Maxwell's equations in terms of scalar and vector potentials.

3.4. Polarization, reflection & refraction of electromagnetic waves through media

3.5. Wave equation and plane waves in free space.

3.6. Poynting theorem & Poynting vector, Polarizations of plane wave.

3.7. Microscopic form of ohm's law ($\mathbf{J}=\sigma\mathbf{E}$)

3.8 Problems.

References:

1) Introduction to Electrodynamics - By D. J. Griffith

2) Classical Electrodynamics – By J. D. Jackson.

3) Introduction to Electrodynamics - By A. Z. Capri, Panat P. V.

4) Electricity and magnetism – By Reitz and Milford

5) Electrodynamics - By Gupta, Kumar, Singh (Pragati Prakashan)

6) Electromagnetic field and waves - By Paul-Lorrain and Dale R Corson

7) Electricity and magnetism – By Murugeshan (S. Chand)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Classical Electrodynamics **Course Code**: USPH 361

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	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	1	2	2	2	1	1	2
CO 2	3	3	1	3	2	2	1	1	3
CO 3	3	3	1	3	2	2	1	1	2
CO 4	3	3	1	3	3	2	1	2	2
CO 5	3	3	1	3	3	2	1	2	2
CO 6	3	3	1	3	3	3	1	2	3
CO7	3	3	1	3	3	3	1	2	

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) because they provide a deep understanding of electrostatics, magnetostatics, electromagnetic wave propagation, and Maxwell's equations, all fundamental to electromagnetism.

PO2: Critical Thinking and Problem Solving

- CO2 to CO7 have a strong relation (3) as they involve solving complex problems related to electromagnetism, boundary conditions, wave propagation, and field interactions.
- CO1 has a moderate relation (2) because it focuses more on conceptual understanding rather than problem-solving.

PO3: Social Competence

- All COs have a weak relation (1) as electromagnetism is mostly theoretical and mathematical, with little direct emphasis on social interaction or teamwork.

PO4: Research-related Skills and Scientific Temper

- CO2 to CO7 have a strong relation (3) since they involve mathematical derivations, problem-solving, and applications of Maxwell's equations, which align with research-oriented thinking.
- CO1 has a moderate relation (2) as it provides foundational knowledge but is not heavily research-focused.

PO5: Trans-disciplinary Knowledge

- CO4 to CO7 have a strong relation (3) because electromagnetism is crucial in various fields such as optics, communication, and quantum mechanics.
- CO1 to CO3 have a moderate relation (2) since they contribute to interdisciplinary learning but are more fundamental.

PO6: Personal and Professional Competence

- CO6 and CO7 have a strong relation (3) as Maxwell's equations and electromagnetic wave propagation are widely used in practical applications such as wireless communication and antenna design.
- Other COs have a moderate relation (2) because they contribute to technical competence but are less application-driven.

PO7: Effective Citizenship and Ethics

- All COs have a weak relation (1) because the course focuses on physics concepts rather than ethical or societal issues.

PO8: Environment and Sustainability

- CO4 to CO7 have a moderate relation (2) since understanding electromagnetic waves helps in designing energy-efficient wireless systems, solar energy applications, and sustainable electrical networks.
- CO1 to CO3 have a weak relation (1) as they focus more on theoretical aspects rather than sustainability.

PO9: Self-directed and Life-long Learning

- CO2 to CO7 have a strong relation (3) as electromagnetism is a foundational subject for advanced studies in physics, electrical engineering, and applied sciences.
- CO1 has a moderate relation (2) as it introduces key concepts but does not deeply encourage independent learning.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 362
Course Title	**:** Quantum Mechanics
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. To understand and learn Theoretical aspects at Quantum Level
2. To know more about the insight of the microscopic world

Course Outcomes:

Here's a brief overview of typical outcomes or goals you might expect from a course in quantum mechanics:

CO1. Understanding Fundamental Principles: Gain a solid grasp of key quantum mechanics concepts such as wave-particle duality, the Schrödinger equation, quantization, and the Heisenberg uncertainty principle.

CO2. Mathematical Proficiency: Develop the ability to solve quantum mechanical problems using mathematical tools like linear algebra (including Hilbert spaces and operators), differential equations, and complex numbers.

CO3. Application of Quantum Theory: Learn to apply quantum mechanics to various systems, including simple models (like the particle in a box, harmonic oscillator, and hydrogen atom) and more complex systems.

CO4. Interpretation of Quantum Mechanics: Explore different interpretations of quantum mechanics, such as the Copenhagen interpretation, many-worlds, and pilot-wave theory, and understand their philosophical implications.

CO5. Quantum Mechanics in Practice: Gain familiarity with experimental techniques and technologies that rely on quantum mechanics, such as quantum computing, quantum cryptography, and spectroscopy.

CO6. Problem-Solving Skills: Develop critical problem-solving skills by working through a variety of quantum mechanics problems and exercises, enhancing your ability to analyse and interpret results.

CO7. Scientific Communication: Improve your ability to communicate complex quantum mechanics concepts and results clearly and effectively, both in written and oral formats.

Topics and Learning Points

Unit 1. Origin of Quantum Mechanics **(10 L)**

1.1 Historical Background a) Review of Black body radiation.

1.2 Matter waves - De Broglie hypothesis. Davisson and Germer experiment.

1.3 Wave particle duality

1.4 Wave function of a particle having definite momentum

1.5 Concept of wave packet, phase velocity, group velocity and their relations

1.6 Heisenberg's uncertainty principle and different forms of uncertainty.

1.7 Problems

Unit 2. The Schrodinger Equation **(12 L)**

2.1 Introduction

2.2 Physical interpretation of wave function

2.3 Schrodinger time dependent equation.

2.4 Schrodinger time independent equation. (Steady state equation).

2.5 Probability current density, equation of continuity

2.6 Eigen function and Eigen values, Expectation value – Ehrenfest's theorem

2.7 Problems

Unit 3. Applications of Schrodinger Steady state equation **(12 L)**

3.1 Free particle.

3.2 Particle in infinitely deep potential well (one - dimension).

3.3 Particle in three-dimension rigid box.

3.4 Step potential

3.5 Potential barrier penetration and tunnelling effect.

3.6 Harmonic oscillator (one-dimension), 3.7 Problems

Unit 4. Spherically symmetric potentials **(6L)**

4.1 Schrodinger’s equation in spherical polar co-ordinate system.

4.2 Rigid rotator (free axis).

4.3 Hydrogen atom: radial and angular parts of the bound state energy, energy state functions, Quantum numbers n, l, m_l, m_s.

4.4 Problems

Unit 5. Operators in Quantum Mechanics **(8L)**

5.1. Definition of an operator in Quantum mechanics.

5.2 Position, Momentum operator, energy operator, angular momentum operator, and total energy operator (Hamiltonian).

5.3 Commutator algebra.

5.4 Commutator brackets using position, momentum and angular momentum operator.

5.5 Problems

References:

1. Quantum Mechanics by Noureddine Zettili, A John Wiley and Sons, Ltd.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan.
4. Quantum mechanics by A. Ghatak and S. Lokanathan.
5. Quantum Mechanics by L. I. Schiff.
6. Quantum Physics by R. Eisberg and R. Resnick.
7. Introduction to Quantum Mechanics by David J. Griffiths.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Quantum Mechanics **Course Code**: USPH 362

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	2	1	2	2	2	1	1	2
CO 2	3	3	1	3	2	2	1	1	3
CO 3	3	3	1	3	3	2	1	1	2
CO 4	3	3	2	3	3	2	2	1	2
CO 5	3	3	1	3	3	3	2	2	3
CO 6	3	3	1	3	3	3	1	2	3
CO7	3	2	2	3	2	3	2	1	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as quantum mechanics is a core subject in physics, requiring deep disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

- CO2, CO3, CO4, CO5, and CO6 have a strong relation (3) as they involve solving mathematical problems, analyzing quantum phenomena, and applying theoretical concepts to real-world applications.
- CO1 and CO7 have a moderate relation (2) as they provide foundational understanding but are not directly focused on problem-solving.

PO3: Social Competence

- CO4 and CO7 have a moderate relation (2) since understanding different interpretations of quantum mechanics and scientific communication can foster discussions in academic and professional settings.

- Other COs have a weak relation (1) as quantum mechanics is mostly an individual theoretical discipline rather than a social or collaborative subject.

PO4: Research-related Skills and Scientific Temper

- CO2 to CO7 have a strong relation (3) since they involve mathematical derivations, problem-solving, experimental techniques, and interpretations, all of which are essential for research in quantum mechanics.
- CO1 has a moderate relation (2) as it provides the foundation but is not directly research-oriented.

PO5: Trans-disciplinary Knowledge

- CO3 to CO6 have a strong relation (3) because quantum mechanics is widely applied in fields like chemistry, computer science (quantum computing), and engineering (semiconductor physics).
- CO1, CO2, and CO7 have a moderate relation (2) as they contribute to interdisciplinary learning but focus more on foundational concepts.

PO6: Personal and Professional Competence

- CO5 to CO7 have a strong relation (3) as they focus on the practical applications of quantum mechanics, problem-solving, and communication skills that are valuable in professional settings.
- Other COs have a moderate relation (2) as they contribute to technical competence but are more theoretical.

PO7: Effective Citizenship and Ethics

- CO4, CO5, and CO7 have a moderate relation (2) as the ethical implications of quantum technologies (such as quantum cryptography) and philosophical debates on quantum interpretations can be relevant to citizenship and ethics.
- Other COs have a weak relation (1) since quantum mechanics is primarily a scientific discipline without direct ethical considerations.

PO8: Environment and Sustainability

- CO5 and CO6 have a moderate relation (2) as quantum mechanics contributes to sustainable technologies, such as energy-efficient quantum computing and new materials with advanced properties.
- Other COs have a weak relation (1) since they focus more on theoretical aspects rather than environmental applications.

PO9: Self-directed and Life-long Learning

- CO2 to CO7 have a strong relation (3) as quantum mechanics is an evolving field that requires continuous learning and adaptation to new research and technological advancements.
- CO1 has a moderate relation (2) as it introduces key concepts but does not deeply encourage independent learning.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 363
Course Title	**:** Thermodynamics and Statistical Physics
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. To understand the various concepts of thermodynamics and statistics.
2. To understand the necessity of studying Statistical Mechanics in light of knowledge of classical and quantum mechanics.
3. To understand the behaviour of particle under classical and quantum condition.
4. To understand the partition function so that one can easily determine the mean value of internal energy, magnetization etc.

Course Outcomes

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

CO1: Understand the relevant quantities used to describe macroscopic systems, thermodynamic potentials and ensembles.

CO2: Understand the concepts of partition functions by taking into account the different types of ensemble.

CO3: Describe the consequences in classical and quantum statistics.

CO4: Design statistical tools to study thermodynamical interactions in ensembles.

CO5: To Compare the MB, BE and FD statistics and classify particles according to them.

CO6: Explain the quantum statistics and differentiate between classical and quantum statistics.

CO7: Study and apply Bose Einstein Statistics, Fermi Dirac Statistics in problem solving.

Topics and Learning Points

Unit 1. Maxwell's relations and Application **[12 L]**

1.1. Revision of concepts and laws of thermodynamics

1.2. Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function

1.3. Derivation of Maxwell Relations, Specific heat and latent heat equations

1.4. Joule Thomson effect (Throttling Process), Problems.

Unit 2. Elementary Concepts of Statistics [8L]

2.1 Probability, distribution functions

2.2 Random Walk and Binomial distribution

2.3 Calculation of mean values

2.4 Probability distribution for large-scale N, Problems.

Unit 3. Statistical Distribution of System of Particles and Ensembles **[20 L]**

3.1 Specification of state of system, Microstate and Macrostates Statistical ensembles

3.2 Basic Postulates, Probability calculations, Behaviors of density of states

3.3 Thermal, Mechanical and general interactions

3.4 Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble

3.5 Molecules in Ideal gas, Calculation of mean values in canonical ensemble

3.6 Problems.

Unit4: Introduction to Quantum Statistics **[5L]**

4.1 Quantum distribution function

4.2 Maxwell-Boltzmann's statistics, Bose-Einstein Statistics

4.3 Fermi-Dirac Statistics, Comparison of the distributions

4.4 Problems.

References:

1 Statistical and Thermal physics - Lokanathan, R.S. Gambhir,

2. Fundamentals of Statistics and Thermal Physics - F. Reif

3. Perspectives of Modern Physics - A. Beiser

4. Fundamental of Statistical Mechanics - B.B. Laud

5. Statistical Mechanics - Gupta

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Thermodynamics and Statistical Physics **Course Code**: USPH 363

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	2	1	2	2	2	1	1	2
CO 2	3	3	1	3	2	2	1	1	3
CO 3	3	3	1	3	3	2	1	1	2
CO 4	3	3	2	3	3	2	2	1	2
CO 5	3	3	1	3	3	3	2	2	3
CO 6	3	3	1	3	3	3	1	2	3
CO7	3	2	2	3	2	3	2	1	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as statistical mechanics is a fundamental subject in physics, requiring deep theoretical understanding and application of disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

- CO2 to CO6 have a strong relation (3) as they involve analyzing partition functions, classical and quantum statistics, and thermodynamic interactions.
- CO1 and CO7 have a moderate relation (2) as they introduce foundational concepts but do not emphasize problem-solving directly.

PO3: Social Competence

- CO4 and CO7 have a moderate relation (2) since statistical tools and problem-solving techniques require discussions and collaboration in academic and research settings.

- Other COs have a weak relation (1) as statistical mechanics is mainly a theoretical and mathematical subject rather than a socially collaborative field.

PO4: Research-related Skills and Scientific Temper

- CO2 to CO7 have a strong relation (3) since they involve mathematical modeling, research-based statistical tools, and quantum statistical mechanics, all essential for academic and applied research.
- CO1 has a moderate relation (2) as it provides fundamental knowledge but does not directly involve research.

PO5: Trans-disciplinary Knowledge

- CO3 to CO6 have a strong relation (3) because statistical mechanics is widely used in physics, chemistry, material science, and even data science.
- CO1, CO2, and CO7 have a moderate relation (2) as they contribute to interdisciplinary understanding but focus more on core principles.

PO6: Personal and Professional Competence

- CO5 to CO7 have a strong relation (3) as they focus on applying statistical mechanics concepts in various fields, enhancing analytical and professional skills.
- Other COs have a moderate relation (2) as they contribute to professional competence but are more theoretical.

PO7: Effective Citizenship and Ethics

- CO4, CO5, and CO7 have a moderate relation (2) as the ethical implications of scientific research and knowledge-sharing are relevant to responsible scientific conduct.
- Other COs have a weak relation (1) since statistical mechanics is primarily a theoretical subject with limited direct ethical considerations.

PO8: Environment and Sustainability

- CO5 and CO6 have a moderate relation (2) as statistical mechanics is used in understanding thermodynamics, climate models, and energy efficiency.
- Other COs have a weak relation (1) since they focus more on theoretical aspects rather than environmental applications.

PO9: Self-directed and Life-long Learning

- CO2 to CO7 have a strong relation (3) as statistical mechanics is a continuously evolving field that requires independent learning and adaptation to new research.
- CO1 has a moderate relation (2) as it introduces key concepts but does not deeply encourage independent learning.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 364
Course Title	**:** Nuclear Physics
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. To know the composition of the nucleus in detail and the terms related to the nuclei.
2. The present course is designed to cover all areas of the subject with research and application of nuclear energy.
3. To understand the physics behind nuclear power generation and nuclear weapons.
4. To know the applications of nuclear physics like in medicine, magnetic resonance imaging and radiocarbon dating in geology and archaeology.

Course Outcomes:

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

CO1: The students will understand the fundamental principles and concepts governing classical nuclear and particle physics.

CO2: The students should be able to understand the fundamental constituents of matter and set foundation for the understanding of unsolved questions about dark matter, antimatter, and other research-oriented topics.

CO3: Knowledge of their applications interactions of ionizing radiation with matter the key techniques for particle accelerators the physical processes involved in nuclear power generation.

CO4: The students should be able to understand the interactions of radiations with matter which is the key technique for particle accelerators and nuclear power generators.

CO5: To understand the principle, construction and working of various particle accelerators like Cyclotron and Betatron and their use in new experimentations.

CO6: The students should be able to classify and explain the principle, construction and working of Geiger-Muller counter, Cloud Chamber and the Scintillation counter.

CO7: To classify and categorize the different properties of elementary particles: leptons, hadrons (baryons and mesons), quarks

Topics and Learning Points

Unit 1. Basic Properties of Nucleus **[10 L]**

1.1 Composition of nucleus - Charge, Size, Density of nucleus

1.2 Nuclear Angular Momentum

1.3 Nuclear Magnetic Dipole Moment,

1.4 Mass defect and Binding energy,

1.5 Packing fraction

1.6 Classification of nuclei,

1.7 Problems.

Unit 2. Radioactivity **[10 L]**

2.1 Radioactivity disintegration (concept of natural and artificial radioactivity)

2.2 Properties of α, β, γ rays

2.3 Laws of radioactive decay

2.4 Half-life, mean life, Specific activity and its units

2.5 Application of radioactivity (Agricultural, Medical, Industrial, Archaeological),

2.6 Problems

Unit 3. Nuclear forces **[08 L]**

3.1 Meson theory of nuclear forces

3.2 Properties of nuclear force

3.3 Elementary particles

3.4 Quark model for elementary particles

3.5 Problems

Unit 4. Particle Accelerator and Detectors **[08 L]**

4.1 Introduction to particle Accelerators

4.2 Linear Accelerator (Linac)

4.3 Cyclic (Cyclotron)

4.4 Classification of Nuclear Detector

4.5 Gas filled Detectors (G. M. counter)

4.6 Problems

Unit 5. Nuclear Reactions and Nuclear Energy **[09 L]**

5.1 Introduction to nuclear reactions

5.2 Q value equation

5.3 Exothermic and Endothermic reaction

5.4 Conservation laws

5.5 Nuclear fission and nuclear fusion,

5.6 Nuclear reactor and its basic components,

5.7 Power reactor

5.8 Problems

References:

1. Introduction to Nuclear Physics - H.A. Enge (Addition Wesley co.)
2. The Atomic Nucleus - R.D. Evans (Tata McGraw Hill co.)
3. Concepts of Nuclear Physics – B.L. Cohen (Tata McGraw Hill co.)
4. Schum's Outline Series Modern Physics R. Gautrearu (McGraw Hill co.)
5. Introduction to Nuclear Physics - S. B. Patel
6. Atomic and Nuclear Physics - Shatendra Sharma (Pearson Education,1 st Edition)
7. Nuclear Physics - Kaplan (Narosa Publishing House)
8. Introduction to Nuclear Physics - Y.R. Waghmare (Oxford IBH.)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Nuclear Physics **Course Code**: USPH 364

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	2	1	2	2	1	1	1	2
CO 2	3	3	1	3	3	2	1	1	3
CO 3	3	3	2	3	2	2	2	3	3
CO 4	3	3	2	3	2	2	2	3	3
CO 5	3	2	1	2	2	3	1	2	2
CO 6	3	2	1	2	2	3	1	2	2
CO7	3	3	1	3	3	2	1	1	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 are strongly related (weightage: 3) since all these outcomes develop a deep understanding of nuclear and particle physics, radiation interactions, accelerators, detectors, and particle classification.

PO2: Critical Thinking and Problem Solving

- CO2, CO3, CO4, and CO7 have a strong relation (weightage: 3) as they involve problem-solving skills related to understanding the fundamental nature of matter and radiation interactions.
- CO1, CO5, and CO6 have a moderate relation (weightage: 2) as they require analytical thinking for understanding concepts and their applications.

PO3: Social Competence

- CO3 and CO4 have a moderate relation (weightage: 2) since nuclear physics has applications in health, industry, and defense, requiring awareness of social impact.

- Other COs have a weak relation (weightage: 1) as they focus more on theoretical and experimental knowledge rather than social aspects.

PO4: Research-related Skills and Scientific Temper

- CO2, CO3, CO4, and CO7 have a strong relation (weightage: 3) as they deal with scientific explorations, experimental techniques, and unsolved problems in particle physics.
- CO1, CO5, and CO6 have a moderate relation (weightage: 2) as they provide foundational knowledge required for research.

PO5: Trans-disciplinary Knowledge

- CO2 and CO7 have a strong relation (weightage: 3) as particle physics connects with cosmology, astrophysics, and quantum mechanics.
- CO1, CO3, CO4, CO5, and CO6 have a moderate relation (weightage: 2) since they include interdisciplinary aspects such as engineering applications in accelerators and detectors.

PO6: Personal and Professional Competence

- CO5 and CO6 have a strong relation (weightage: 3) as understanding the working of accelerators and detectors is essential for careers in research and applied physics.
- CO2, CO3, CO4, and CO7 have a moderate relation (weightage: 2) due to their relevance to professional scientific inquiry.

PO7: Effective Citizenship and Ethics

- CO3 and CO4 have a moderate relation (weightage: 2) as nuclear power and radiation applications have ethical implications.
- Other COs have a weak relation (weightage: 1) as they focus more on fundamental physics than on ethical considerations**.**

PO8: Environment and Sustainability

- CO3 and CO4 have a strong relation (weightage: 3) since nuclear energy plays a crucial role in sustainable power generation.
- CO5 and CO6 have a moderate relation (weightage: 2) as accelerators and detectors have environmental applications, such as medical imaging and pollution monitoring.

PO9: Self-directed and Life-long Learning

- CO2, CO3, CO4, and CO7 have a strong relation (weightage: 3) as they encourage ongoing exploration of fundamental and emerging physics concepts.
- CO1, CO5, and CO6 have a moderate relation (weightage: 2) as they provide foundational knowledge for further learning.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 365 (A)
Course Title	**:** Electronics-II
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. To understand the operation of UJT, JFET and their applications.
2. To understand basic application circuits of op-amp.
3. To understand combinational logical circuits
4. To understand active filters using op-amp.
5. To understand basics of timer IC 555 and its applications
6. To understand different types of flip-flops and their operation.
7. To understand sequential logical circuits

Course Outcomes:

After successful completion of the course student will be able to -

CO1. To analyze performance parameters based on study of characteristics of electronic devices like UJT, JFET and their applications.

CO2. To understand op-amp circuits and its usefulness in different applications

CO3. To know operating principle of IC 555 in different configurations

CO4. Evaluate frequency response to filter circuits.

CO5. Build and test digital circuits using universal/basic logic gates and flip flops.

CO6. .Analyze, design and implement sequential logic circuits.

CO7. Understanding electronic components, designing circuits, analyzing signals and using test equipment.

Topics and Learning Points

UNIT 1: UNI- JUNCTION TRANSISTOR **[4L]**

1.1: Symbol, types

1.2: Construction and working

1.3: I-V characteristics

1.4: UJT as a relaxation oscillator

1.5: Problems

UNIT 2: FIELD EFFECT TRANSISTOR **[6L]**

2.1: Introduction,

2.2: Classification, principle,

2.3: Working and IV characteristics of JFET

2.4: Application of JFET: -as Variable resistor, electronic switch and analog multiplexer.

2.5: Problems

UNIT 3: APPLICATIONS OF OPERATIONAL AMPLIFIER **[8L]**

3.1: Comparator, Schmitt Trigger

3.2: Instrumentation Amplifier

3.3: Current to voltage Converter

3.4: Voltage to current convertors

3.6: Problems

UNIT 4: TIMER (IC555) **[06L]**

4.1: Block diagram of IC 555 Timer

4.2: Astable Multivibrator

4.3: Monostable Multivibrator

4.4: Bistable Multivibrator

4.5: Problems

UNIT 5: FLIPFLOPS **[10L]**

5.1: RS flip flop using NAND/NOR Gate

5.2: Clocked R-S flip-flop

5.3: preset and clear inputs

5.4: J-K /M-S J-K flip-flop

5.5: D and T flip flops

5.6: Problems

UNIT 6: COUNTERS **[11L]**

6.1: Asynchronous counter

6.2: Synchronous counter

6.3: A Mod-5 Counter

6.4: Decade counter

6.5: IC7490 TTL Decade Counter

References:

1. Electronic Principles (8 th edition), Malvino (Tata McGraw Hill, New Delhi)2.
2. Digital Principles and Applications, 8 th edition Donald P leach, Albert Paul Malvino, Goutam Saha McGraw-Hill Education,
3. Modern Digital Electronics (3 rd Edition), R. P. Jain, (Tata McGraw Hill, New Delhi)
4. OP-Amps and Linear Integrated circuits, Ramakant A. Gayakwad Prentice-
5. Hall of India, New Delhi 4th Edition

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Electronics-II **Course Code**: USPH 365 (A)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	1	2	2	3	1	1	2
CO 2	3	3	1	2	2	3	1	1	2
CO 3	3	2	1	2	2	3	1	1	2
CO 4	3	3	1	2	2	3	1	1	2
CO 5	3	3	2	3	3	3	1	2	3
CO 6	3	3	2	3	3	3	1	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) since they cover fundamental and applied knowledge of electronic devices, circuit analysis, filters, logic circuits, and instrumentation.

PO2: Critical Thinking and Problem Solving

- CO1, CO2, CO4, CO5, CO6, and CO7 have a strong relation (3) as they involve analytical thinking, circuit design, and troubleshooting skills.
- CO3 has a moderate relation (2) since understanding the IC 555 configurations requires analytical skills but is more focused on applications.

PO3: Social Competence

- CO5, CO6, and CO7 have a moderate relation (2) as they involve teamwork, collaboration, and an understanding of real-world applications of digital electronics.

- Other COs have a weak relation (1) as they focus more on theoretical and practical knowledge rather than social aspects.

PO4: Research-related Skills and Scientific Temper

- CO5, CO6, and CO7 have a strong relation (3) as they involve experimentation, circuit analysis, and problem-solving in digital and analog electronics.
- CO1, CO2, CO3, and CO4 have a moderate relation (2) as they provide fundamental knowledge required for research-oriented applications.

PO5: Trans-disciplinary Knowledge

- CO5, CO6, and CO7 have a strong relation (3) as they connect with computer science (logic circuits), instrumentation (signal processing), and communication systems.
- CO1 to CO4 have a moderate relation (2) as they contribute to interdisciplinary applications in automation, biomedical electronics, and embedded systems.

PO6: Personal and Professional Competence

- CO1 to CO7 have a strong relation (3) since understanding electronic circuits, designing systems, and using test equipment are essential skills for a career in electronics and embedded systems.

PO7: Effective Citizenship and Ethics

- CO7 has a moderate relation (2) as understanding circuits and electronic systems is essential in ethical considerations related to safety, technology policies, and responsible design.
- Other COs has a weak relation (1) as they are more focused on technical knowledge than ethical implications.

PO8: Environment and Sustainability

- CO5, CO6, and CO7 have a moderate relation (2) as efficient circuit design impacts power consumption, electronic waste, and sustainability in electronics.
- Other COs has a weak relation (1) as they focus primarily on circuit analysis rather than environmental concerns.

PO9: Self-directed and Life-long Learning

- CO5, CO6, and CO7 have a strong relation (3) as digital and analog electronics evolve continuously, requiring professionals to keep learning about new technologies.
- CO1 to CO4 have a moderate relation (2) as they provide a foundation for further advancements in electronics.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme : B.Sc. Physics

Programme Code : USPH

Class : T.Y.B.Sc.

Semester : VI

Course Type : Theory

Course Code : USPH 365 (B)

Course Title : Advanced Electronics

No. of Credits : 03

No. of Teaching Hours : 45

(**Important Note:** This course is designed for the student who has offered Electronics as one of the subjects at S.Y.B.Sc. level)

Course Objectives:

CO1. To familiarize with different sensors

CO2. To elucidate sensors and signal conditioning circuits

CO3. To explain signal conditioning circuits

CO4. To familiarize with process control system and its objectives

Course Outcomes:

After successful completion of the course student will be able to -

CO1: Apply different methods for the measurement of various physical quantities.

CO2: Describe signal conditioning circuits.

CO3: Differentiate between signal conditioning processes.

CO4: Identify various process control systems

CO5. It aims to equip students with the ability to analyze, design, and implement complex electronic circuits using advanced components and techniques

CO6. Analyze performance of spread spectrum communication system.

CO7. Apply the knowledge of digital electronics to the real world problems.

Topics and Learning Points

UNIT 1: SENSORS **[12L]**

1.1 Metal resistance versus Temperature devices: Metal resistance versus Temperature devices, resistance versus temperature approximation, resistance temperature detectors.

1.2 Semiconductor resistance versus Temperature, Thermistor characteristics.

1.3 Thermocouples: Thermoelectric effects, Thermocouple characteristics, Thermocouple sensors.

1.4 Other Thermal Sensors: Gas thermometers, Vapour pressure thermometers, Liquid expansion thermometers, solid state temperature sensors.

1.5 Optical sensors: Photo detectors: Photo detector characteristics, photoconductive detectors, photo voltaic detectors, photo diode detectors, photo emissive detectors.

1.6 Optical sources: Conventional light sources, Laser principles

1.7 Problems

UNIT 2: ANALOG SIGNAL CONDITIONING USING OP-AMP **[12 L]**

2.1 Principles of Analog Signal Conditioning: Signal level and bias changes, linearization, conversions, filtering and impedance matching, concept of loading.

2.2 Passive circuits: Divider circuits, bridge circuits, RC filters,

2.3 Operational Amplifier, characteristics

2.4 Specification of OP-AMP Circuits in Instrumentation, Voltage Follower, Inverting and Non-Inverting Amplifier, Instrumentation Amplifier, I to V Converter and V to I converter, Integrator, Differentiator.

UNIT 3: DIGITAL SIGNAL CONDITIONING **[12L]**

3.1 Review of digital fundamentals, digital information,

3.2 Fractional Binary System, Boolean algebra, and expressions

3.3 Combinational Circuits, Multiplexer, De- Multiplexer, Encoder, Decoder

3.4 Converters: DAC, ADC,

3.5 Data Acquisition System, characteristics of digital data, sampled data systems, linearization.

UNIT 4: INTRODUCTION TO PROCESS CONTROL **[09]**

1.1 Control systems: Process control principles,

1.2 servo mechanism,

1.3 Discrete state Control of systems

1.4 Process control block diagram Identification of elements, block diagram

1.5 Control system evaluation: Stability, steady state regulation, Transient regulation,

1.6 Evaluation criteria

References:

1. Electronic Principles (8th edition), Malvino (Tata McGraw Hill, New Delhi)2.
2. Digital Principles and Applications, 8th edition Donald P leach, Albert Paul Malvino, Goutam Saha McGraw-Hill Education,
3. Modern Digital Electronics (0033Wrd Edition), R. P. Jain, (Tata McGraw Hill, New Delhi)
4. OP-Amps and Linear Integrated circuits, Ramakant A. Gayakwad Prentice-
5. Hall of India, New Delhi 4th Edition
6. Process Control Instrumentation Technology by C.D. Johnson Pearson Education 8th edition (Economic Edition).
7. Computer Based Industrial Control by Krishna Kant (Eastern Economic Edition)
8. Instrument of Device System by Rangan, Mani, Sharma 4. Instrument measurement and analysis by B. C. Nakra, K. K. Chaudhari

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Advanced Electronics **Course Code**: USPH 365 (B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	1	2	2	3	1	2	2
CO 2	3	3	1	2	2	3	1	1	2
CO 3	3	3	1	2	2	3	1	1	2
CO 4	3	3	2	3	3	3	2	2	3
CO 5	3	3	2	3	3	3	1	2	3
CO 6	3	3	2	3	3	3	1	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as they focus on fundamental and advanced knowledge of measurement, signal processing, control systems, circuit design, communication systems, and digital electronics**.**

PO2: Critical Thinking and Problem Solving

- CO1 to CO7 have a strong relation (3) as they involve analyzing different techniques, designing and implementing circuits, differentiating processes, and applying digital electronics to real-world problems.

PO3: Social Competence

- CO4, CO5, CO6, and CO7 have a moderate relation (2) as they involve teamwork, collaboration, and practical applications in industrial and societal contexts.
- CO1, CO2, and CO3 have a weak relation (1) as they focus more on technical knowledge rather than social skills.

PO4: Research-related Skills and Scientific Temper

- CO4, CO5, CO6, and CO7 have a strong relation (3) as they require research-based learning, scientific temper, and an analytical approach to solving complex engineering problems.
- CO1, CO2, and CO3 have a moderate relation (2) since they provide foundational knowledge necessary for research and development.

PO5: Trans-disciplinary Knowledge

- CO4, CO5, CO6, and CO7 have a strong relation (3) as they integrate concepts from multiple domains like signal processing, control systems, communication, and digital electronics.
- CO1, CO2, and CO3 have a moderate relation (2) since they are essential for interdisciplinary applications but are more focused on a specific domain.

PO6: Personal and Professional Competence

- CO1 to CO7 have a strong relation (3) since they equip students with technical expertise in electronics, signal processing, communication, and circuit design, preparing them for professional careers.

PO7: Effective Citizenship and Ethics

- CO4 and CO7 have a moderate relation (2) as process control systems and digital electronics impact industries, ethical practices, and automation, influencing society.
- Other COs have a weak relation (1) since they primarily focus on technical and engineering skills rather than ethical considerations.

PO8: Environment and Sustainability

- CO1, CO4, CO5, CO6, and CO7 have a moderate relation (2) since efficient measurement techniques, control systems, and electronic circuit design can contribute to sustainable practices, energy-efficient systems, and eco-friendly solutions.
- CO2 and CO3 have a weak relation (1) as they focus more on circuit design than sustainability aspects.

PO9: Self-directed and Life-long Learning

- CO4, CO5, CO6, and CO7 have a strong relation (3) as advancements in electronics, communication, and control systems require continuous learning and adaptation.
- CO1, CO2, and CO3 have a moderate relation (2) since they provide foundational knowledge for further specialization and research.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 366 **(**A**)**
Course Title	**:** Solar Energy Conversion Devices
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. Define sustainable development including its three pillars.
2. Referring to the energy conversion matrix, identify the conversion steps taken by various renewable energy technologies

Course Outcomes:

On successful completion of this course students will be able to do the following:

CO1: The course providing a basic understanding of theory and practice of various photovoltaic technologies and design concepts.

CO2: To understand the physical principles of the photovoltaic (PV) solar cell

CO3: Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.

CO4: Use solar energy for domestic purpose and reduce conventional electricity consumption.

CO5: Take initiation in awareness program for promotion and more use of solar energy for society.

CO6: Can implement ideas and knowledge to replace unnecessary high wattage Electricity source in domestics appliances

CO7: Knowledge should be transferred to society through demonstrations of Solar equipment.

Topics and Learning Points

Unit 1: Photovoltaic converters **(10L)**

1.1 Photovoltaic effect, types of solar cell

1.2 Equivalent circuit diagram of a solar cell, determination of series resistance (Rs) and shunt resistance (Rsh), solar cell output parameters: RL, Voc, Isc, Pm, FF, efficiency

1.3 Performance dependence of a solar cell on band gap energy

1.4 Types of heterojunction, construction of energy band diagram of heterojunction

1.5 problems.

Unit 2: Materials and Solar cell Technology **(12L)**

2.1 Fabrication technology of Silicon solar cell

2.2 Single, poly – and amorphous silicon, GaAs, CdS, Cu_2S, $CuInSe_2$, CdTe etc. technologies for fabrication of single and polycrystalline silicon solar cells

2.3 Solar cell modules, photovoltaic systems

2.4 Dye-sensitized solar cell, perovskite solar cell

2.5 Problems

Unit 3: Photochemical Converters **(12L)**

3.1 Semiconductor–electrolyte interface, Helmholtz double layer, Gouy-Chapman model, Stern model

3.2 Principle of photoelectrochemical solar cells, photoelectrolysis cell, driving force of photoelectrolysis

3.3 Alkaline fuel cell, semiconductor- septum storage cell

3.3 Concept of photocatalysis and photoelectrocatalysis process

3.4 Problems.

Unit4: Thermoelectric Converters **(11L)**

4.1. Thermoelectric effects, solid state description of thermoelectric effect

4.2 Kelvin's thermodynamic relations, analysis of thermoelectric generators

4.3 Basic assumptions, temperature distribution and thermal energy transfer for generator, co-efficient of performance for thermoelectric cooling

4.4 Problems.

References:

1. Solar energy conversion: The solar cell, by Richard C. Neville.
2. Photoelectrochemical solar cells –Suresh Chandra
3. Solar energy conversion – A. E. Dixon and J. D. Leslie.
4. Solar cells– Martin A. Green
5. Heterojunction and metal–semiconductor junctions –A. G. Milnes and D. L. Feucht.
6. Solid state electronic devices- B. G. Streetman.
7. Principles of solar engineering–Frank Kreith and Janf Kreider.
8. Direct energy conversion (4th edition)– Stanley WAngrist

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Solar Energy Conversion Devices **Course Code**: USPH 366 **(**A**)**

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	1	2	2	3	1	3	2
CO 2	3	3	1	2	2	3	1	3	2
CO 3	2	2	3	2	3	2	3	3	2
CO 4	2	3	2	2	3	3	2	3	3
CO 5	2	3	3	2	3	3	3	3	3
CO 6	3	3	2	3	3	3	2	3	3
CO7	2	2	3	2	3	2	3	3	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as they provide fundamental knowledge of photovoltaic (PV) technology, solar energy applications, and energy efficiency.

PO2: Critical Thinking and Problem Solving

- CO1, CO2, CO4, CO5, and CO6 have a strong relation (3) since they require the application of analytical skills to evaluate PV technologies, reduce electricity consumption, and optimize solar energy use.
- CO3 and CO7 have a moderate relation (2) as they involve awareness and societal aspects but not deep problem-solving.

PO3: Social Competence

- CO3, CO5, and CO7 have a strong relation (3) since they focus on promoting solar energy awareness, educating society, and discussing its environmental impacts.

- CO4 and CO6 have a moderate relation (2) as they involve practical implementations affecting society.
- CO1 and CO2 have a weak relation (1) since they are more technical.

PO4: Research-related Skills and Scientific Temper

- CO6 has a strong relation (3) since it involves innovative ideas for replacing high-wattage electricity sources.
- CO1 to CO5 and CO7 have a moderate relation (2) as they encourage scientific discussions but do not involve in-depth research.

PO5: Trans-disciplinary Knowledge

- CO3 to CO7 have a strong relation (3) as they integrate engineering, environmental science, and societal aspects.
- CO1 and CO2 have a moderate relation (2) since they focus on PV technology itself.

PO6: Personal and Professional Competence

- CO1, CO2, CO4, CO5, and CO6 have a strong relation (3) as they develop professional expertise in solar energy applications.
- CO3 and CO7 have a moderate relation (2) as they focus more on advocacy and awareness than direct professional skills.

PO7: Effective Citizenship and Ethics

- CO3, CO5, and CO7 have a strong relation (3) as they promote responsible energy consumption, social awareness, and sustainable development.
- CO4 and CO6 have a moderate relation (2) as they contribute to energy efficiency at an individual level.
- CO1 and CO2 have a weak relation (1) since they are more technical.

PO8: Environment and Sustainability

- CO1 to CO7 have a strong relation (3) as solar energy is directly linked to sustainability, reducing carbon footprints, and promoting green technology.

PO9: Self-directed and Life-long Learning

- CO4 to CO7 have a strong relation (3) as they encourage continuous learning about solar technologies, implementation strategies, and public awareness.
- CO1 to CO3 have a moderate relation (2) since they provide foundational knowledge but require further exploration for real-world applications.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 366 **(**B**)**
Course Title	**:** Sensors and its Applications
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. To elucidate sensors and signal conditioning circuits.
2. To introduce different error analysis methods.
3. To familiarize with different sensors and transducers.
4. To explain signal conditioning circuits.

Course Outcomes:

After successful completion of the course student will be able to -

CO1: Apply different methods for the measurement of various physical quantities.

CO2: Ability to Analyse, formulate and select suitable sensor for the given industrial applications.

CO3: Describe signal conditioning circuits.

CO4: Differentiate between different types of smart sensors.

CO5: Identify various optical transducer.

CO6: Design application based instrumentation for demonstration using sensors.

CO7: Use of knowledge in electronics based project work for demonstration.

Topics and Learning Points

UNIT 1: SENSORS **[12L]**

1.1 Definition, Types, Basic principle and applications of Resistive, Inductive, Capacitive, Piezoelectric and their Dynamic performance.

1.2 Fiber optic sensors, Bio-chemical sensors, Hall-Effect, Photo emissive, Photo Diode/ Photo Transistor, Photovoltaic, LVDT, Strain Gauge

1.3 Digital transducers: Principle, Construction, Encoders, Absolute and incremental encoders, Silicon micro transducers.

UNIT 2: SIGNAL CONDITIONING **[12 L]**

2.1 Operational Amplifiers: application in instrumentation, Charge amplifier, Carrier amplifier

2.2 Introduction to active filters, Classification, Butterworth, Chebyshev, First order, Second order and higher order filters

2.3 Voltage to frequency and frequency to voltage converters.

UNIT 3: OPTICAL TRANSDUCERS **[12L]**

3.1 Theory of photo emission

3.2 classification of photo electric devices

3.3 vacuum photo tube, Gas photo tube, Photo multiplier tube, photo conductive cell, photo diode, photo transistor

3.4 Opto-coupler and their applications,

3.5 Optical Fibre sensors.4

UNIT 4: SMART SENSORS & ITS APPLICATIONS **[09]**

4.1 Introduction, Definition,

4.2 Block Diagram of Smart Sensors,

4.3 Difference between non smart Sensors & Smart Sensors,

4.4 Smart Transducers,

4.5 Introduction to Internet of Things (IoT) Sensors and actuators

References:

1. Doebelin, E.O. and Manic, D.N., Measurement Systems: Applications and Design, McGraw Hill (2004).
2. Sawhney, A.K. and Sawhney, P., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai (2008).
3. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India (2003).
4. Nakra, B.C. and Chaudhry, K.K., Instrumentation, Measurement and Analysis, TMH (2003)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Sensors and its Applications **Course Code**: USPH 366 (B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	1	2	2	3	1	2	2
CO 2	3	3	1	2	3	3	1	2	2
CO 3	3	3	1	2	2	3	1	2	2
CO 4	3	3	2	3	3	3	2	2	3
CO 5	3	3	2	3	3	3	1	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as they focus on fundamental and applied knowledge of sensors, transducers, signal conditioning, and instrumentation.

PO2: Critical Thinking and Problem Solving

- CO1 to CO7 have a strong relation (3) as they involve analysis, formulation, selection of sensors, differentiation between sensor types, and designing applications for industrial and research purposes.

PO3: Social Competence

- CO4, CO5, CO6, and CO7 have a moderate relation (2) as they involve teamwork, collaboration, and practical demonstrations that can benefit industries and society.
- CO1, CO2, and CO3 have a weak relation (1) since they focus more on technical aspects rather than social interaction.

PO4: Research-related Skills and Scientific Temper

- CO4, CO5, CO6, and CO7 have a strong relation (3) as they require innovation, application of scientific principles, and research-based learning in sensor technologies and instrumentation.
- CO1, CO2, and CO3 have a moderate relation (2) since they provide foundational knowledge necessary for research.

PO5: Trans-disciplinary Knowledge

- CO2, CO4, CO5, CO6, and CO7 have a strong relation (3) as they integrate knowledge from electronics, physics, and industrial applications.
- CO1 and CO3 have a moderate relation (2) since they focus more on measurement and signal conditioning but still contribute to interdisciplinary learning.

PO6: Personal and Professional Competence

- CO1 to CO7 have a strong relation (3) since they develop technical expertise in sensor technology, signal processing, and application-based instrumentation, preparing students for professional careers.

PO7: Effective Citizenship and Ethics

- CO4, CO6, and CO7 have a moderate relation (2) as sensor-based applications can contribute to industrial safety, healthcare, and automation, which impacts society positively.
- Other COs have a weak relation (1) since they are primarily technical.

PO8: Environment and Sustainability

- CO1, CO4, CO5, CO6, and CO7 have a moderate relation (2) as efficient sensor technology and instrumentation can contribute to sustainable industrial practices, energy efficiency, and environmental monitoring.
- CO2 and CO3 have a weak relation (1) as they focus more on technical aspects than sustainability.

PO9: Self-directed and Life-long Learning

- CO4 to CO7 have a strong relation (3) as advancements in sensor technology and instrumentation require continuous learning, adaptation, and innovation.
- CO1, CO2, and CO3 have a moderate relation (2) as they provide foundational knowledge for further specialization.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Theory
Course Code	**:** USPH 366 **(**C**)**
Course Title	**:** Physics of Nanomaterials
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Course Objectives:

1. **Understand the Fundamental Principles of Nanomaterials**
   Explore the basic concepts, structure, and properties of nanomaterials, including quantum confinement, surface effects, and dimensionality, and how these influence physical behaviours.
2. **Analyse the Synthesis Techniques of Nanomaterials**
   Learn about the various methods for synthesizing nanomaterials such as chemical vapor deposition (CVD), sol-gel processes, and mechanical methods, and their impact on the materials' structure and properties.
3. **Examine the Electrical, Optical, and Magnetic Properties of Nanomaterials**
   Investigate the unique electrical, optical, and magnetic properties of nanomaterials and how these properties can be tailored for different technological applications.
4. **Characterize Nanomaterials Using Advanced Techniques**
   Gain proficiency in characterizing nanomaterials using techniques such as atomic force microscopy (AFM), scanning tunnelling microscopy (STM), and transmission electron microscopy (TEM).
5. **Explore the Applications and Impacts of Nanomaterials**
   Evaluate the role of nanomaterials in cutting-edge technologies such as nanotechnology, medicine, electronics, and energy, as well as their societal and environmental implications.

Course Outcomes:

After successful completion of the course student will be able to –

CO1: Demonstrate an understanding of fundamental principles

Students will be able to explain key concepts such as quantum confinement, surface effects, and the influence of dimensionality on the properties of nanomaterials.

CO2: Analyze and compare synthesis techniques

Students will critically assess various nanomaterial synthesis techniques (e.g., chemical vapor deposition, sol-gel, mechanical methods) and evaluate their influence on the structure and properties of nanomaterials.

CO3: Evaluate the unique properties of nanomaterials

Students will analyze and predict how the electrical, optical, and magnetic properties of nanomaterials differ from bulk materials, and discuss how these properties can be engineered for specific applications.

CO4: Apply quantum mechanical principles to nanoscale systems

Students will use quantum mechanical models to explain nanoscale phenomena such as electron confinement, energy band modification, and the behavior of photons and phonons in nanostructures.

CO5: Utilize advanced characterization techniques

Students will demonstrate the ability to interpret data from techniques such as AFM, STM, and TEM, applying these tools to characterize the structural and physical properties of nanomaterials.

CO6: Assess the applications and implications of nanomaterials

Students will evaluate the use of nanomaterials in various industries, such as electronics, energy, and biomedicine, and critically analyze their environmental, ethical and societal impacts.

CO7. Research design and analysis

Develop the ability to design research questions related to nanomaterials, conduct literature reviews, analyze experimental data, and effectively communicate research findings.

Topics and Learning Points

Unit 1. Nanomaterials **(10L)**

1.1 Introduction and structures of nano materials

1.2 Brief history of nanomaterials and challenges in nanotechnology

1.3 Significance of nano-size and properties

1.4 Classification of nanostructured materials

Unit 2. Methods of synthesis of nanomaterials **(15L)**

2.1 Bottom-up and Top-down approaches

2.2 Physical methods:

a) High energy ball milling,

b) Physical vapour deposition,

c) Ionized cluster beam deposition,

d) Sputter deposition,

e) Spray pyrolysis etc.

2.3 Chemical methods:

a) Colloidal method,

b) Co-precipitation and

c) Sol-gel method

2.4 Hybrid method: Electrochemical and chemical vapour deposition.

2.5 Properties of nanomaterials: Mechanical, Electrical, Thermal, Optical, solubility, melting point, and Magnetic properties

Unit 3. Characterization Techniques **(12L)**

3.1 Introduction,

3.2 **X-ray diffraction:**

a) Basic principle,

b) Experimental methods of X-ray diffraction: Rotating Crystal method, Powder (Debye Scherer) method,

c) Analysis of cubic structure by powder method,

3.3 **Thermo gravimetric analysis (TGA)-** Principle, Working and Applications,

3.4 **Ultra-Violet (UV) Spectroscopy** - Principle, Working and Applications,

3.5 **Electron microscopy (SEM)-**Principle, Working and Applications,

3.6 Transmission Electron Microscopy (TEM)- Principle, Working and Applications, Problems

Unit 4. Special nano materials and applications **(8L)**

4.1 Carbon based material,

4.2 Quantum dots,

4.3 Nano tubes,

4.4 Nano rods

4.5 Applications:

a) Nanoelectronics

b) Medical, Biological,

c) Automobiles

d) Space

e) Defence

f) Sports,

g) Cosmetics

h) Cloth industry

References:

1. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
2. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
3. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
4. Nanostructure and nanomaterials synthesis, Properties, and applications, by G. Cao, Imperials College Press, London.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Physics of Nanomaterials **Course Code**: USPH 366 **(**C**)**

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	2	1	2	2	3	1	2	2
CO 2	3	3	1	3	2	3	1	2	2
CO 3	3	3	1	3	2	3	1	2	2
CO 4	3	3	1	3	3	3	1	2	2
CO 5	3	3	2	3	3	3	2	2	3
CO 6	3	3	2	3	3	3	3	3	3
CO7	3	3	2	3	3	3	3	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as they build a comprehensive understanding of nanomaterials, quantum mechanics, characterization techniques, and applications.

PO2: Critical Thinking and Problem Solving

- CO2 to CO7 have a strong relation (3) as they require analytical thinking, evaluation of synthesis techniques, application of quantum principles, and research design.
- CO1 has a moderate relation (2) since it focuses on fundamental understanding rather than problem-solving.

PO3: Social Competence

- CO5, CO6, and CO7 have a moderate relation (2) as they involve ethical considerations, environmental impact, and collaborative research discussions.
- CO1 to CO4 have a weak relation (1) since they are more technical and focused on material science rather than social aspects.

PO4: Research-related Skills and Scientific Temper

- CO2 to CO7 have a strong relation (3) as they require evaluating experimental techniques, analyzing data, designing research questions, and interpreting results.
- CO1 has a moderate relation (2) as it provides foundational knowledge for further research.

PO5: Trans-disciplinary Knowledge

- CO4 to CO7 have a strong relation (3) as they involve quantum mechanics, material science, physics, and engineering concepts.
- CO1 to CO3 have a moderate relation (2) since they focus on nanomaterial properties but do not integrate multiple disciplines as deeply.

PO6: Personal and Professional Competence

- CO1 to CO7 have a strong relation (3) since they develop critical knowledge and skills applicable to professional careers in nanotechnology, materials science, and research.

PO7: Effective Citizenship and Ethics

- CO6 and CO7 have a strong relation (3) as they evaluate the ethical, societal, and environmental implications of nanotechnology.
- CO5 has a moderate relation (2) since advanced characterization techniques can have industrial and regulatory impacts.
- CO1 to CO4 have a weak relation (1) since they focus on technical knowledge.

PO8: Environment and Sustainability

- CO6 has a strong relation (3) as it assesses the environmental impact of nanomaterials.
- CO5 and CO7 have a moderate relation (2) since characterization and research design can include sustainability aspects.
- CO1 to CO4 have a weak relation (1) as they are focused on material properties rather than environmental concerns.

PO9: Self-directed and Life-long Learning

- CO5 to CO7 have a strong relation (3) as they require continuous learning, research skills, and adaptability to new developments in nanotechnology.
- CO1 to CO4 have a moderate relation (2) as they provide foundational knowledge that supports further learning.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Practical
Course Code	: USPH 367
Course Title	: Practical-IV
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Outcomes:

After successful completion of the course student 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 analyze various experimental parameters concerning their application.

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

Students must perform any **EIGHT** experiments from the list given below plus any **TWO** activities. **(TOTAL 10 experiments).**

1. Study of XRD spectrum of any material
2. Characteristics of G. M. tube
3. e/m by Thomson method
4. Study of Gaussian distribution by G.M. tube

5. Determination of the diameter of a thin wire using a laser beam
6. Calibration of Si diode & a Copper constantan thermocouple temperature sensors
7. Study and use of Anderson's Bridge
8. Determination of Surfact tension by Quincke's method
9. Michelson interferometer
10. Newton's Ring

Additional Activities (Any-2)

1. Demonstrations: Any 2 demonstrations equivalent to 2 experiments
2. Study tour with report equivalent to 2 experiments
3. Mini project equivalent to 2 experiments
4. Computer aided demonstrations (Simulations or animations)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Practical-IV **Course Code**: USPH 367

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	2	1	2	2	3	1	2	2
CO 2	3	3	1	3	2	3	1	2	2
CO 3	3	3	1	3	2	3	2	2	2
CO 4	3	3	1	3	3	3	1	2	2
CO 5	3	2	3	2	3	3	2	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as they provide hands-on experience in laboratory procedures, experimentation, and theoretical understanding of physics concepts.

PO2: Critical Thinking and Problem Solving

- CO2 to CO7 have a strong relation (3) since they involve data collection, analysis, experimental modeling, and application of experimental findings to solve problems.
- CO1 and CO5 have a moderate relation (2) as they focus on technical skills and teamwork rather than critical thinking.

PO3: Social Competence

- CO5, CO6, and CO7 have a moderate relation (2) as laboratory experiments often require collaboration, teamwork, and effective communication.

- CO1 to CO4 have a weak relation (1) since they are more focused on individual learning and experimentation.

PO4: Research-related Skills and Scientific Temper

- CO2 to CO7 have a strong relation (3) as they involve scientific data collection, hypothesis testing, research methodology, and experimental validation.
- CO1 has a moderate relation (2) as it provides the technical skills needed for experimentation but does not emphasize research directly.

PO5: Trans-disciplinary Knowledge

- CO4 to CO7 have a strong relation (3) as they integrate physics with experimental methods, data science, and applied sciences.
- CO1 to CO3 have a moderate relation (2) since they focus on foundational skills without explicitly incorporating interdisciplinary approaches.

PO6: Personal and Professional Competence

- CO1 to CO7 have a strong relation (3) as they develop hands-on technical skills, data analysis abilities, laboratory safety knowledge, and teamwork skills essential for professional careers.

PO7: Effective Citizenship and Ethics

- CO3, CO5, CO6, and CO7 have a moderate relation (2) as laboratory safety, teamwork, and ethical handlings of data are important aspects of responsible citizenship in science.
- CO1, CO2, and CO4 have a weak relation (1) as they focus more on experimentation rather than ethical or societal aspects.

PO8: Environment and Sustainability

- CO3 to CO7 have a moderate relation (2) as experimental models and laboratory procedures can be optimized for sustainability, efficiency, and minimizing environmental impact.
- CO1 and CO2 have a weak relation (1) since they focus on technical aspects rather than sustainability.

PO9: Self-directed and Life-long Learning

- CO5 to CO7 have a strong relation (3) as they promote continuous learning through research, experimentation, and collaborative problem-solving.
- CO1 to CO4 have a moderate relation (2) as they provide foundational knowledge that supports further learning and specialization.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Practical
Course Code	: USPH 368
Course Title	: Practical-V
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Outcomes:

After completion of the course, the student should 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.

Total-10 Experiments

Students must perform any **EIGHT** experiments from the following**.**

1. Characteristics of UJT
2. UJT as Relaxation Oscillator

3. Design and built astable multivibrator using IC 555/IC 741

4. Voltage to current convertor (V to I)

5. Study of Multiplexer and Demultiplexer

6. Characteristics of Thermister

7. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter

8. Current to voltage converter (I to V)

9. Constant current source using IC 741

10.Flip-flops

References:

1. Principles to Electronics - V. K. Mehta
2. Principles of Electronics- Malvino
3. Operational Amplifier – Ramakant Gaikwad
4. Digital Electronics – R.P. Jain
5. Data Converter- B.S.Sonde

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- VI) **Subject**: Physics

Course: Practical-V **Course Code**: USPH 368

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	2	1	2	2	3	1	2	2
CO 2	3	3	1	3	2	3	1	2	2
CO 3	3	3	1	3	2	3	2	2	2
CO 4	3	3	1	3	3	3	1	2	2
CO 5	3	2	3	2	3	3	2	2	3
CO 6	3	3	2	3	3	3	2	2	3
CO7	3	3	2	3	3	3	2	2	3

Justification

PO1: Disciplinary Knowledge

- CO1 to CO7 have a strong relation (3) as they provide hands-on experience in laboratory procedures, experimentation, and theoretical understanding of physics concepts.

PO2: Critical Thinking and Problem Solving

- CO2 to CO7 have a strong relation (3) since they involve data collection, analysis, experimental modeling, and application of experimental findings to solve problems.
- CO1 and CO5 have a moderate relation (2) as they focus on technical skills and teamwork rather than critical thinking.

PO3: Social Competence

- CO5, CO6, and CO7 have a moderate relation (2) as laboratory experiments often require collaboration, teamwork, and effective communication.

- CO1 to CO4 have a weak relation (1) since they are more focused on individual learning and experimentation.

PO4: Research-related Skills and Scientific Temper

- CO2 to CO7 have a strong relation (3) as they involve scientific data collection, hypothesis testing, research methodology, and experimental validation.
- CO1 has a moderate relation (2) as it provides the technical skills needed for experimentation but does not emphasize research directly.

PO5: Trans-disciplinary Knowledge

- CO4 to CO7 have a strong relation (3) as they integrate physics with experimental methods, data science, and applied sciences.
- CO1 to CO3 have a moderate relation (2) since they focus on foundational skills without explicitly incorporating interdisciplinary approaches.

PO6: Personal and Professional Competence

- CO1 to CO7 have a strong relation (3) as they develop hands-on technical skills, data analysis abilities, laboratory safety knowledge, and teamwork skills essential for professional careers.

PO7: Effective Citizenship and Ethics

- CO3, CO5, CO6, and CO7 have a moderate relation (2) as laboratory safety, teamwork, and ethical handling of data is important aspects of responsible citizenship in science.
- CO1, CO2, and CO4 have a weak relation (1) as they focus more on experimentation rather than ethical or societal aspects.

PO8: Environment and Sustainability

- CO3 to CO7 have a moderate relation (2) as experimental models and laboratory procedures can be optimized for sustainability, efficiency, and minimizing environmental impact.
- CO1 and CO2 have a weak relation (1) since they focus on technical aspects rather than sustainability.

PO9: Self-directed and Life-long Learning

- CO5 to CO7 have a strong relation (3) as they promote continuous learning through research, experimentation, and collaborative problem-solving.
- CO1 to CO4 have a moderate relation (2) as they provide foundational knowledge that supports further learning and specialization.

CBCS Syllabus for T.Y.B.Sc. Semester-VI Physics (2022 Pattern)

Name of the Programme	**:** B.Sc. Physics
Programme Code	**:** USPH
Class	**:** T.Y.B.Sc.
Semester	**:** VI
Course Type	**:** Practical
Course Code	**:** PH 369
Course Title	**:** PROJECT
No. of Credits	**:** 03
No. of Teaching Hours	**:** 45

Guidelines

It is expected that,

1. The student does work equivalent to about 10 laboratory experiments.
2. The project work is a practical course, and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work done by a student, skills shown by the student, understanding of the physics concepts involved and the presentation of the final report at the time of viva voce.
6. The viva voce should be conducted at the time of evaluation of project work at least for twenty minutes per student. Extra care must be taken in the evaluation of projects done in a pair or group. Delegation of the work done by individuals must be sought from the students in such cases.
7. Any ready-made material used in the report (such as downloaded pages from the web) must be clearly referred to and acknowledged.
8. It is also recommended that a teacher will look after 4 projects at one time.
9. Any non-adherence to this norm should attract a penalty by way of deduction in the marks awarded to a student.

The Project work shall consist of the following Criterions:

1. Working model (Experimental or Concept based simulation/Demonstration Related to Physics).
2. Understanding of the project.
3. Experimental Details.
4. Data collection and Data Analysis.
5. Innovation.
6. Outcomes/Result.
7. Conclusion.