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

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T. Y. B. Sc. Physics

PHY 3601: Classical Electrodynamics

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

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

Learning Objectives

a) To understand the meaning of Maxwell's equations.

b) To understand concept of Polarization & magnetization of materials.

a) To understand dielectrics and effect of dielectric on electric field.

Learning Outcomes

After successful completion of the course student will be able to

CO1: Articulate concepts of evaluating electric fields due to line charge, surface charge and volume charge using Coulomb's law and Gauss's law. Explain mechanism of polarization in dielectrics.

CO2: Demonstrate special techniques to calculate potential due to some charge distribution.

CO3: Explain motion of charged particle in electromagnetic field. Deduce Biot Savart's law from Ampere's law.

CO4: Compare magnetic properties of material on the basis of total spin of electrons in atom. Distinguish between diamagnetic and paramagnetic materials

CO5: Compile Maxwell's set of equations and develops electromagnetic plane wave equation.

CO6: Students can get idea and able to take interest in the research concerning synthesis & application of dielectrics & Magnetic materials.

CO7: Construct Source models for demonstrations of electric field and magnetic field for experimentation.

1. Electrostatics: (18 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.

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.**

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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.

3. Electrodynamics: (16 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.

Reference Books:

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 (PragatiPrakashan)
6) Electromagnetic field and waves - By Paul-Lorrain and Dale R Corson
7) Electricity and magnetism – By Murugeshan (S. Chand)

	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									
CO 4									
CO 5									
CO 6				3					
CO7						2			

Justification

PO1: Disciplinary Knowledge

CO1: Articulate concepts of evaluating electric fields due to line charge, surface charge, and volume charge using Coulomb's law and Gauss's law. Explain the mechanism of polarization in dielectrics. Weightage: 3

This course outcome directly addresses the core concepts of electric fields and polarization, contributing significantly to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Demonstrate special techniques to calculate potential due to some charge distribution.Weightage: 3

Calculating electric potential using special techniques involves critical thinking and problem-solving skills, aligning with PO2.

PO4: Research-related Skills and Scientific Temper

CO6: Students can get an idea and able to take interest in the research concerning the synthesis & application of dielectrics & Magnetic materials.Weightage: 3

Developing an interest in research concerning materials directly contributes to research-related skills and scientific temper, aligning with PO4.

PO6: Personal and Professional Competence

CO7: Construct Source models for demonstrations of electric field and magnetic field for experimentation.Weightage: 2

Constructing source models for demonstrations requires personal and professional competence, connecting with PO6.

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T. Y. B. Sc. Physics

PHY 3602: Quantum Mechanics

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

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

Learning Objectives

a) To understand and learn Theoretical aspects at Quantum Level.

b) To know more about the insight of the microscopic world.

Learning Outcomes

After successful completion of the course student will be able to

CO1: Describe and learn theoretical aspects at Quantum Level.

CO2: Clarify more about the insight of the microscopic world.

CO3: Understand the necessity of Quantum Mechanics.

CO4: Understand the behavior of particles under Classical and Quantum conditions.

CO5: Understand the Operators in Quantum Mechanics.

CO6: Learn about Schrodinger's equations.

CO7: Develop thinking process towards analysis of various quantum based principles / effects.

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 with thought experiment. - Electron diffraction experiment, different forms of uncertainty.
   - 1.7: Problems
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).

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2.5: Probability current density, equation of continuity

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

2.7: Problems

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

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, ml , ms .

4.4: Problems

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

5.1: Definition of an operator in Quantum mechanics. - Eigen function and Eigen values.

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.

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	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									
CO 4									
CO 5									
CO 6									
CO7		2		2					

Justification

PO1: Disciplinary Knowledge

CO1: Describe and learn theoretical aspects at the Quantum Level.Weightage: 3

Learning theoretical aspects at the Quantum Level is fundamental to disciplinary knowledge in quantum mechanics, strongly aligning with PO1.

PO2: Critical Thinking and Problem Solving

CO2: Clarify more about the insight of the microscopic world.Weightage: 3

Gaining insight into the microscopic world requires critical thinking and problem-solving skills, strongly aligning with PO2.

CO7: Develop a thinking process towards the analysis of various quantum-based principles/effects.Weightage: 3

Developing a thinking process for the analysis of quantum-based principles requires critical thinking, aligning strongly with PO2.

PO4: Research-related Skills and Scientific Temper

CO7: Develop a thinking process towards the analysis of various quantum-based principles/effects.Weightage: 2

Justification: Developing a thinking process towards the analysis of quantum principles contributes to scientific temper, aligning partially with PO4.

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T. Y. B. Sc. Physics

PHY 3603: Statistical Physics

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

Paper Code: **PHY3603** Title of Paper: **Statistical Physics**

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

Learning Objectives

a) To understand various concepts of statistics and to apply them in thermodynamics.

b) To understand the necessity of studying Statistical Mechanics in light of knowledge of Classical and Quantum Mechanics.

c) To understand the behavior of particles under Classical and Quantum condition.

Learning Outcomes

After successful completion of the course student will 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: 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.

1. **Elementary Concepts of Statistics: [6 L]**
   - 1.1 Revision of concepts and laws of thermodynamics
   - 1.2 Probability, distribution functions
   - 1.3 Random Walk and Binomial distribution
   - 1.4 Calculation of mean values,
   - 1.5 Probability distribution for large-scale N
   - 1.6 Problems
2. **Statistical Distribution of System of Particles: [8 L]**
   - 2.1 Specification of state of system,

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2.2 Microstate and Macrostates

2.3 Thermodynamic Probability

2.4 Constraints on a system

2.5 Basic Postulates of statistical mechanics

2.6 Postulate of equal a priori probability

2.7 Probability Calculations

2.8 Problems

3. Interactions in the systems [9 L]

3.1: Density of state

3.2: Behaviour of density of state of a system

3.3: Equilibrium and constraints

3.4: Systems in thermal equilibrium

3.5: Boltzmann Canonical Distribution

3.6: Thermal Interaction

3.7: Mechanical Interaction

3.8: General Interaction

3.9: Problems

4. Statistical Ensembles: (8 L)

4**.1** Micro canonical Ensemble (Isolated System)

4.2 Characteristics of microcanonical ensemble

4.3 Canonical ensembles

4.4 Grand canonical ensemble

4.5 Simple application of canonical ensemble

4.6 Molecules in an Ideal gas

4.7 Problems

5. Mean Values, Entropy and Partition function: (9 L)

5.1 Mean values in canonical ensemble

5.2 Mean energy

5.3 Mean square energy

5.4 Mean Square Deviation

5.5 Mean Pressure

5.6 Entropy and Partition Function Definition

5.7 Entropy in terms of Partition Function and Mean Energy

5.8 Entropy and probability

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5.9 Problems

6. **Quantum Statistics: (8L)**

6.1 Symmetric and Anti-Symmetric Wave Functions

6.2 Quantum distribution function

6.3 Introduction to:

6.3.1 Maxwell-Boltzmann's statistics

6.3.2 Bose-Einstein Statistics

6.3.3 Fermi-Dirac Statistics

6.4 Problems

REFERENCES:

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

2. Fundamentals of statistical and thermal physics - By F. Reif

3. Perspectives of modern physics - By A. Beiser

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

5. A primer of Statistical Mechanics - By R.B. Singh

6. Statistical Mechanics - By Gupta, Kuma

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

Justification

PO1: Disciplinary Knowledge

CO1: Understand the relevant quantities used to describe macroscopic systems, thermodynamic potentials, and ensembles.Weightage: 3

This directly contributes to understanding disciplinary knowledge, as it involves grasping fundamental concepts related to macroscopic systems and thermodynamics.

PO2: Critical Thinking and Problem Solving

CO4: Design statistical tools to study thermodynamic interactions in ensembles.Weightage: 3

The design of statistical tools involves critical thinking to address thermodynamic interactions, aligning with the development of critical thinking skills.

PO4: Research-related Skills and Scientific Temper

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

Weightage: 2

Understanding partition functions is a fundamental research-related skill in statistical mechanics (PO4).

PO5: Trans-disciplinary Knowledge

CO5: Compare the MB, BE, and FD statistics and classify particles according to them.Weightage: 2

Comparing different statistics involves understanding trans-disciplinary aspects related to quantum mechanics and statistical mechanics (PO5).

PO9: Self-directed and Life-long Learning

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

Weightage: 3

Understanding quantum statistics is crucial for self-directed learning in advanced physics topics (PO9).

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T. Y. B. Sc. Physics

PHY 3604: Nuclear Physics

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

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

Learning Objectives:

a) The present Nuclear Physics course is designed to cover all areas of the subject with research and application of nuclear energy.

b) In India, courses on nuclear physics are provided on different levels like bachelor, master, and doctoral.

c) The subject is mainly applied in nuclear power generation and nuclear weapons.

d) A few other applications of the subject are nuclear medicine, magnetic resonance imaging and radiocarbon dating in geology and archaeology which we have tried to incorporate.

Learning Outcomes:

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

CO2: understand the fundamental constituents of matter and lay 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: explain the principle of phase stable orbit, principle, construction and working of particle accelerators like Cyclotron and Betatron and their use in new experimentations

CO5: Classify and explain the principle, construction and working of Geiger-Muller counter, Wilson Cloud Chamber and the Scintillation counter.

CO6: Explain outlines of Pauli Neutrino hypothesis, Beta and Alpha Ray Spectrum, nuclear energy levels from Beta decay.

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

1. **Basic Properties of Nucleus (06 L)**

1.1 Composition, 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 Stability of nuclei

1.8 Problems

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

2.5 Specific activity and its units

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

2.7 Problems

3. Nuclear forces (09 L)

3.1 Meson theory of nuclear forces

3.2 Properties of nuclear forces

3.3 Elementary particles

3.4 Quarks model for elementary particles

3.5 Problems

4. Particle Accelerator and Detectors (08 L)

4.1 Introduction to particle Accelerators

4.2 Linear (electron/proton Linac) Cyclic (Cyclotron)

4.3 Classification of Nuclear Detector

4.4 Gas filled Detectors (G. M. counter)

4.5 Problems

5. Nuclear Reactions (09 L)

5.1 Introduction to Nuclear reactions

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5.2 Q value equation

5.3 Exothermic and Endothermic reaction

5.4 Conservation laws

5.5 Problems

6. Nuclear Energy (06L)

6.1 Nuclear fission

6.2 Chain reaction and critical mass

6.3 Nuclear reactor and its basic components

6.4 Homogeneous and heterogeneous reactors

6.5 Power reactor

6.6 Nuclear fusion

6.7 Stellar energy

6.8 Problems

Reference Books

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.)

	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					
CO 4						3			
CO 5									
CO 6									2
CO7									

Justification

PO1: Disciplinary Knowledge
CO1: Understand the fundamental principles and concepts governing classical nuclear and particle physics.
Weightage: 3
This directly contributes to the development of disciplinary knowledge in nuclear and particle physics (PO1).
PO2: Critical Thinking and Problem Solving
CO2: Understand the fundamental constituents of matter and lay the foundation for the understanding of unsolved questions about dark matter, antimatter, and other research-oriented topics.
Weightage: 3
Grasping the fundamental constituents of matter and exploring unsolved questions requires critical thinking and problem-solving skills (PO2).
PO4: Research-related Skills and Scientific Temper
CO3: Knowledge of their applications, interactions of ionizing radiation with matter, and the key techniques for particle accelerators, the physical processes involved in nuclear power generation.
Weightage: 2
Understanding applications and interactions of ionizing radiation involves research-related skills in nuclear physics (PO4).
PO6: Personal and Professional Competence
CO4: Explain the principle of phase stable orbit, principle, construction, and working of particle accelerators like Cyclotron and Betatron and their use in new experimentations.
Weightage: 3
Understanding the principles and working of particle accelerators contributes to personal and professional competence in experimental physics (PO6).
PO9: Self-directed and Life-long Learning
CO6: Explain outlines of Pauli Neutrino hypothesis, Beta and Alpha Ray Spectrum, nuclear energy levels from Beta decay.
Weightage: 2
Explaining complex concepts in nuclear physics contributes to self-directed and life-long learning (PO9).

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T. Y. B. Sc. Physics

PHY 3605: Electronics-II (A)

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

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

Learning Objectives

a) To understand the operation of UJT, JFET and their applications.
b) To understand basic application circuits of opamp.
c) To understand combinational logical circuits
d) To understand active filters using opamp.
e) To understand basics of timer IC 555 and its applications
f) To understand different types of flip-flops and their operation.
g) To understand sequential logical circuits

Learning 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 opamp 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: Use of knowledge for problem addressing in day today life by performing research project

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
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

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analog multiplexer.

2.5: Problems

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

3.5: Filters: First order LPF and HPF with design

3.6: Problems

4. TIMER (IC555): (6L)

4.1: Block diagram of IC 555 Timer

4.2: Astable Multivibrator

4.3: Monostable Multivibrator

4.4: Bistable Multivibrator

4.5: Problems

5. FLIPFLOPS: (12L)

5.1: RS flip flop using NAND/NOR Gate

5.2: Clocked R-S flip-flop (Latch)

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

6. **COUNTERS: (12L)**

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 Electronics Principles (8th edition), Malvino (Tata McGraw Hill, New Delhi).

2 Digital Principles and Applications, 8th Edition, Donald P Leach, Albert Paul Melvino, Shah McGraw-Hill Education,

3 Modern Digital Electronics (3rd Edition), R. P. Jain, (Tata McGraw Hill, New Delhi)

4. OP-Amps and Linear Integrated circuits, Ramakant A. Gayakwad Prentice-Hall of India, New Delhi 4th Edition

	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									
CO 4									
CO 5									
CO 6									
CO7				2		2			

Justification

PO1: Disciplinary Knowledge

CO1: To analyze performance parameters based on the study of characteristics of electronic devices like UJT, JFET, and their applications.Weightage: 3

Analyzing electronic device characteristics directly contributes to disciplinary knowledge in electronics (PO1).

PO2: Critical Thinking and Problem Solving

CO2: To understand opamp circuits and its usefulness in different applications.Weightage: 3

Understanding the application of opamp circuits requires critical thinking and problem-solving skills (PO2).

PO4: Research-related Skills and Scientific Temper

CO7: Use of knowledge for problem addressing in day-to-day life by performing a research project.

Weightage: 2

Performing a research project involves research-related skills and contributes to scientific temper (PO4).

PO6: Personal and Professional Competence

CO7: Use of knowledge for problem addressing in day-to-day life by performing a research project.

Weightage: 2

Applying knowledge for problem-solving in daily life demonstrates personal and professional competence (PO6).

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T.Y.B.Sc. Physics

PHY 3605: B] Advanced Electronics

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

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

(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:

1. To familiarize with different sensors.
2. To elucidate sensors and signal conditioning circuits.
3. To explain signal conditioning circuits.
4. To familiarize with process control system and its objectives.

Learning Outcomes: After the 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: Design application based instrumentation for demonstration using advanced electronics knowledge

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

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

1. Sensors: (14 L)

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 Motion sensors: Types of motions, Accelerometers' principles, Types of accelerometers, applications

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

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1.7 Optical sources: Conventional light sources, Laser principles

1.8 Problems

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.

3. Digital signal conditioning (12 L)

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.

4. Introduction to Process Control: (10 L)

4.1 Control systems: Process control principles,

4.2 servo mechanism,

4.3 Discrete state Control of systems

4.4 Process control block diagram Identification of elements, block diagram

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

4.6 Evaluation criteria

4.7 Numerical Problems On Above Lectures

4.8

Reference Books:

1. Process Control Instrumentation Technology by C.D. Johnson Pearson Education 8th edition (Economic Edition).

2. Computer Based Industrial Control by Krishna Kant (Eastern Economic Edition)

3. Instrument of Device System by Rangan, Mani, Sharma 4. Instrument measurement and analysis by B. C. Nakra, K. K. Chaudhari

4. Electronic Instrumentation- H S Kalsi Tata McGraw Hill

5. Instrumentation, Measurement and Analysis, TMH (2003) Nakra, B.C. and Chaudhry, K.K.,

6. Doebelin, E.O. and Manic, D.N., Measurement Systems: Applications and Design, McGraw Hill (2004).

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

Justification

PO1: Disciplinary Knowledge

CO1: Apply different methods for the measurement of various physical quantities.Weightage: 3

Applying different methods for measurement requires a solid foundation in disciplinary knowledge (PO1).

PO2: Critical Thinking and Problem Solving

CO2: Describe signal conditioning circuits.Weightage: 2

Describing signal conditioning circuits involves critical thinking in understanding and articulating complex electronic processes (PO2).

PO4: Research-related Skills and Scientific Temper

CO5: Design application-based instrumentation for demonstration using advanced electronics knowledge.

Weightage: 3

Designing application-based instrumentation requires research-related skills and scientific temper to implement advanced electronics knowledge (PO4).

PO6: Personal and Professional Competence

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

Weightage: 3

Utilizing knowledge in project work demonstrates personal and professional competence (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 societal demands aligns with effective citizenship and ethical considerations (PO7).

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T. Y. B. Sc. Physics

PHY3606: A] Physics of Nanomaterials

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

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

Learning objectives:

1. To foundational knowledge of the Nanoscience and related fields.
2. The main objectives of course are to introduce the basic physics behind size effect of nano materials and to understand the working principle of equipment used in nanostructures.
3. To make the students acquire an understanding the Nanoscience and Applications.
4. To help them understand in broad outline of Nanoscience and Nanotechnology.

Learning outcomes:

CO1: Learn about the background on Nanoscience.
CO2: Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment.
CO3: Apply their knowledge to develop Nanomaterials.
CO4: Can apply the knowledge to develop new applications using 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. Nanomaterials (06L)

1.1 Introduction and structures of nano materials

1.2 Brief history of nano materials and challenges in nanotechnology

1.3 Significance of nano-size and properties

1.4 classification of nano structured materials

1.5 Properties of nano materials: Mechanical, Electrical, Thermal, Optical, solubility, melting point, and Magnetic properties

2. Introduction to methods of synthesis of nano materials (14L)

2.1 Bottom-up and Top-down approaches

2.2 Physical methods:

a) High energy ball milling,

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b) Physical vapour deposition,

c) Ionized cluster beam deposition,

d) sputter deposition,

2.3 Chemical methods:

a) colloidal method,

b) co-precipitation and

c) sol-gel method

d) spray pyrolysis

e) Chemical bath deposition (CBD)

2.4 Hybrid method: Electrochemical and chemical vapour deposition.

3. Introduction to Characterization Techniques (14L)

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 RAMAN: Principle, Working and Applications,

Problems

4. Special nano materials and applications (14L)

4.1 Nano materials:

a) Carbon based material

b) Quantum dots

c) Nano tubes

d) Nano rods

e) Thin Film

4.2 Applications:

a) Nano electronics,

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b) Medical,

c) Biological,

d) Automobiles,

e) Space,

f) Defence,

g) Sports,

h) Cosmetics,

i) Textile industry

Reference Books:

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.

List of Practicals

1. Crystallite size determination using Xray diffraction (Debye Scherrer Equation) from the given XRD data.
2. To determine the optical band gap of the material from the given UV-visible spectroscopy data.
3. To prepare the nano powder using the wet chemical method (co-precipitation method).
4. To prepare the nano powder using sol gel method
5. To deposit nano crystalline CdS thin film using chemical bath deposition method.
6. To measure the thickness of the deposited film using gravimetric method.
7. Demonstration of thin film deposition method using thermal evaporation technique.

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	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									
CO 4				3		3			
CO 5									2
CO 6									
CO7									

Justification

PO1: Disciplinary Knowledge

CO1: Learn about the background on Nanoscience.Weightage: 3

Learning about the background of Nanoscience directly contributes to building disciplinary knowledge in the field, aligning with PO1.

PO2: Critical Thinking and Problem Solving

CO2: Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on the environment.Weightage: 3

Understanding the synthesis, application, and environmental impact of nanomaterials involves critical thinking and problem-solving skills, contributing to PO2.

PO4: Research-related Skills and Scientific Temper

CO3: Apply their knowledge to develop Nanomaterials.Weightage: 3

Applying knowledge to develop nanomaterials aligns with research-related skills and the development of scientific temper (PO4).

PO6: Personal and Professional Competence

CO4: Can apply the knowledge to develop new applications using advanced science and engineering principles to materials systems.Weightage: 3

: Applying knowledge to develop new applications demonstrates personal and professional competence (PO6).

PO9: Self-directed and Life-long Learning

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

Proficiency in acquiring and analyzing data demonstrates self-directed and life-long learning skills (PO9).

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T. Y. B. Sc. Physics

PHY3606: B] Solar Energy Conversion Devices

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

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

Learning 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

Learning Outcomes

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.

Unit 1: Photovoltaic converters (12L)

Photovoltaic effect, types of solar cell, 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, performance dependence of a solar cell on band gap energy, Types of heterojunction, construction of energy band diagram of heterojunction, Mott – Schottky relation, problems.

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

Fabrication technology of Silicon solar cell, Single, poly – and amorphous silicon, GaAs, CdS, Cu_2S, $CuInSe_2$, CdTe etc. technologies for fabrication of single and polycrystalline silicon solar cells, solar cell modules, photovoltaic systems, dye-sensitized solar cell, perovskite solar cell, problems

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Unit 3: Photochemical Converters (12L)

Semiconductor – electrolyte interface, Helmholtz double layer, Gouy-Chapman model, Stern model, Principle of photoelectrochemical solar cells, photoelectrolysis cell, driving force of photoelectrolysis, alkaline fuel cell, semiconductor- septum storage cell, concept of photocatalysis and photoelectrocatalysis process, problems.

Unit 4: Thermoelectric Converters (12L)

Thermoelectric effects, solid state description of thermoelectric effect, Kelvin's thermodynamic relations, analysis of thermoelectric generators, basic assumptions, temperature distribution and thermal energy transfer for generator, co-efficient of performance for thermoelectric cooling, problems.

Reference Books:

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 W Angrist

Practical List:

1. Solar Still
2. Solar Dryer
3. Solar Cooker
4. PV-IV Characteristics
5. PV-Water Pumping System
6. PV-Spray System
7. Wind Energy Conversion

	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						
CO 4				3					
CO 5							3		
CO 6						3			
CO7									2

Justification

PO1: Disciplinary Knowledge

CO1: The course providing a basic understanding of theory and practice of various photovoltaic technologies and design concepts.Weightage: 3

The course content covering various photovoltaic technologies and design concepts directly contributes to building disciplinary knowledge in the field (PO1).

PO2: Critical Thinking and Problem Solving

CO2: To understand the physical principles of the photovoltaic (PV) solar cellWeightage: 3

Understanding the physical principles of PV solar cells involves critical thinking, contributing to PO2.

PO3: Social Competence

CO3: Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.Weightage: 2

Discussing the positive and negative aspects of solar energy demonstrates an understanding of its social and environmental impact, contributing to social competence (PO3).

PO4: Research-related Skills and Scientific Temper

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

Weightage: 3

Applying knowledge to use solar energy for domestic purposes involves research-related skills and aligns with the practical application of scientific principles (PO4).

PO6: Personal and Professional Competence

CO6: Can implement ideas and knowledge to replace unnecessary high wattage electricity source in domestic appliances.Weightage: 3

Implementing ideas to replace high wattage electricity sources in domestic appliances demonstrates personal and professional competence (PO6).

PO7: Effective Citizenship and Ethics

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CO5: Take initiation in awareness program for the promotion and more use of solar energy for society.Weightage: 3

Taking initiation in awareness programs for the promotion of solar energy aligns with effective citizenship and ethical considerations (PO7).

PO9: Self-directed and Life-long Learning

CO7: Knowledge should be transferred to society through demonstrations of solar equipment.Weightage: 2

Transferring knowledge to society through demonstrations involves sharing expertise and contributes to self-directed and life-long learning (PO9).

This mapping suggests a strong alignment with disciplinary knowledge, critical

T.Y.B.Sc. Physics

PHY 3606: C] Sensor and Its Applications

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

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

Course Objectives:

5. To elucidate sensors and signal conditioning circuits.
6. To introduce different error analysis methods.
7. To familiarize with different sensors and transducers.
8. To explain signal conditioning circuits.

Learning Outcomes: After the 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.

1. SENSORS/TRANSDUCERS: 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, Photoemissive, Photo Diode/ Photo Transistor, Photovoltaic, LVDT, Strain Gauge

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

2. SIGNAL CONDITIONING: 12L

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.

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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

4. SMART SENSORS & ITS APPLICATIONS 12L

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

Reference Books:

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)

List of Experiments:

1. To draw I/O characteristics of the following photo transducers.
    1. LDR
    2. Photodiode
    3. Photo Transistor
    4. Optocoupler
2. Fabricate an application circuit using photo transducers as a switch and as a
3. To measure density of given solution using simple hydrometer.
4. To measure vibration of motor or compressor system using a vibration meter and piezoelectric sensors.
5. To perform noise measurement using condenser microphone.

	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									
CO 4									
CO 5					3				
CO 6				2					
CO7						2			

Justification

PO1: Disciplinary Knowledge

CO1: Apply different methods for the measurement of various physical quantities.Weightage: 3

Applying different methods for measurement directly contributes to building disciplinary knowledge in the field (PO1).

PO2: Critical Thinking and Problem Solving

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

Weightage: 3

Analyzing, formulating, and selecting suitable sensors for industrial applications involves critical thinking and problem-solving skills, contributing to PO2.

PO4: Research-related Skills and Scientific Temper

CO6: Design application-based instrumentation for demonstration using sensors.Weightage: 2

Designing application-based instrumentation involves applying research-related skills to create practical demonstrations, contributing to research-related skills and scientific temper (PO4).

PO5: Trans-disciplinary Knowledge

CO5: Identify various optical transducers.Weightage: 3

Identifying various optical transducers requires knowledge beyond the core discipline, contributing to trans-disciplinary knowledge (PO5).

PO6: Personal and Professional Competence

CO7: Use of knowledge in electronics based project work for demonstration.Weightage: 2

Using knowledge in electronics-based project work demonstrates personal and professional competence (PO6).

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T.Y.B.Sc. Physics

PHY 3607: Physics Practical-I

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

Credit: 2

Total-10 Experiments

Learning Outcomes: After the 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 analyse various experimental parameters concerning their application .
CO7: Experimental Models for easy understanding and explanation Physics concepts.

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

1. Viscosity of liquid by rotating cylinder method.
2. Youngs modulus of steel by flexural vibrations of a bar
3. Study of XRD spectrum of any material
4. Thermal & electrical conductivity of Cu
5. Characteristics of G. M. tube
6. e/m by Thomson method
7. Study of Gaussian distribution by G.M. tube
8. Determination of the diameter of a thin wire using a laser beam
9. Rigidity modulus of Brass
10. Calibration of Si diode & a Copper constantan thermocouple temperature sensors

Practical From Optional Course (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)

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	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

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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 3608: Physics Practical-II

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

Credit: 2

Total-10 Experiments

Learning Outcomes: After the completion of the course student 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.

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

11. Characteristics of JFET
12. Design and built astable multivibrator using IC 555/IC 741
13. Integrator and differentiator using IC 741
14. Instrumental amplifier using three op-amps
15. Digital to Analog Converters
16. Schmidt trigger
17. Plotting of graph using MS-Excel
18. Plotting of graph using origin software
19. Study of Multiplexer and Demultiplexer
20. Active Filters
21. Temperature controller using AD590
22. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter

Practical From Optional Course (Any-2)

5. Demonstrations: Any 2 demonstrations equivalent to 2 experiments
6. Study tour with report equivalent to 2 experiments
7. Mini project equivalent to 2 experiments
8. Computer aided demonstrations (Simulations or animations)

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	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

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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 3609: Project -Part II

Class: T.Y. B. Sc. Sem: VI Paper IX

Credit: 2

Learning Outcomes: After the completion of the course student 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.

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T.Y.B.Sc. (Physics) (Sem-VI) Physics Project-II (PHY3609)

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. It is recommended that the College will provide consumables/contingencies for every project, to the tune of Rs. 750 /- each. (*If the students paid extra fee other than laboratory fee then college will provide financial assistance for the Project work.)

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.

TULJARAM CHATURCHAND COLLEGE BARAMATI

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	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.

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